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TABLE OF CONTENTS

The Late Quarternary Paleoenvironment of Texas: A Model for the Archeologist
Vaughn M. Bryant Jr. and Harry J. Shafer 1

A Discussion of Possible Asiatic Influences On Texas Pleistocene Lithic Technology
Leland W. Patterson 27

On Fluting Folsom: Notes on Recent Experiments
J. B. Sollberger 47

A Lithic Reduction Sequence: A Test Case In the North Fork Reservoir Area, Williamson County, Texas
Patience E. Patterson. 53

The Garza Occupation at the Lubbock Lake Site
Eileen Johnson, Vance T. Holliday, Michael J. Kaczor and Robert Stuckenrath 83

Prehistoric Ritual Skull Burials at the Crenshaw Site (3 MI 6), Southwest Arkansas
Mary Lucas Powell. 111

Neutron Activation Analysis of West Texas Ceramics: A Statistical Evaluation
Carolyn Ekland 119

NOTES

A Polychrome Vessel from Goliad County, Southern Texas
Anne A. Fox and W. S. Fitzpatrick 133

A Painted Pebble from a Site on the Nueces River, Southern Texas
Thomas R. Hester 139

Water Separation Procedures at the 1976 Texas Archeological Society Field School: An Appraisal of Results
John E. Keller and Bruce B. Fullem 145

IN MEMORIAM

David Espy 151
James M. Malone 153

BOOK REVIEWS

Archeological Investigations at Proposed Big Pine Lake, 1974-1975, Lamar and Red River Counties, Texas, Robert J. Mallouf
S. Alan Skinner 155
Excavations at the Harris County Boys' School: Analysis of Galveston Bay Area Mortuary Practices
Clell L. Bond 159

THE AUTHORS 161

THE LATE QUATERNARY PALEOENVIRONMENT OF TEXAS: A MODEL FOR THE ARCHEOLOGIST

VAUGHN M. BRYANT JR. AND HARRY J. SHAFER

ABSTRACT

Archeological, paleontological, plant macrofossil, hydrological and palynological evidence is used to construct a model of late Quaternary vegetations in Texas. These available data sources suggest that: (1) during the Wisconsin Interpluvial Period (33,500-22,500 BP) most of Texas contained a scrub and grassland vegetation; (2) with the onset of the Wisconsin Fullglacial Period (22,500-14,000 BP) a mosaic of woodlands, parklands and scrublands replaced the earlier grasslands in many regions of Texas north of Bexar County; (3) during the Lateglacial Period (14,000-10,000 BP) there was a widespread loss of woodland areas in Texas and a loss or major reduction of many Pleistocene fauna; and (4) during the Postglacial Period (10,000 BP-present) the final vegetational changes occurred leading to the establishment of our present Texas flora and fauna. Also discussed are the possible implications that this paleoenvironmental model has in examining the sequences of human adaptation from the late Pleistocene to protohistoric times in Texas.

INTRODUCTION

Archeologically and botanically the state of Texas is situated in a critical location. Archeologically it stands at the lower end of the Great Plains and north of the great civilizations that developed and flourished in Mesoamerica. It is situated on the western fringe of the Southeastern horticultural traditions and on the eastern fringe of the Puebloan area.

We do not know when mankind first began to settle in Texas, but there is enough available evidence to suggest that people were occupying certain areas by at least the end of the Pleistocene era. Evidence of this is seen in the deposits of late Pleistocene archeological remains such as Bonfire Shelter (Dibble 1968), the Lubbock Lake Site (Black 1974), the Levi Site (Alexander 1963), and other similar locations in Texas where the faunal remains of extinct Pleistocene animals are associated with the presence of prehistoric man. Even earlier locations are claimed such as those of Crook and Harris (1958), where radiocarbon dates have recorded the suspected activities of ancient man to periods as early as 38,000 years ago. In short, the archeological history of much of Texas is already well documented to some degree and the resources — although rapidly and steadily diminishing — are presently numerous and varied.

On the other hand, our present knowledge of the botanical record of Texas is not nearly as well documented. Deevey was one of the first to recognize the critical location of Texas in reference to possible ancient plant migrations when he suggested that during the Quaternary period major plant migrations occurred across portions of central and south Texas into Mexico (Deevey 1949). Lucy Braun (1955) offered a counterview since she believed that little or no vegetational or climatic changes occurred in Texas during the entire Quaternary period. Later, Dillon (1956) and then Martin and Harrell (1957) proposed still other phytographic reconstructions suggesting moderate vegetational and climatic changes in Texas during portions of the Quaternary period.

Zoologists such as Blair (1958) and paleontologists such as Graham (1976), Lundelius (1967, 1974) and Slaughter (1963) have also offered their interpretations of Quaternary vegetational changes in Texas. Based upon the fossil evidence of extinct and extant fauna these authors have suggested that more than 10,000 years ago certain regions of Texas were probably covered by large wooded areas while in other regions there were savannas. Other clues revealed by the fossil animal record suggest that there was probably a north-south temperature gradient change which undoubtedly affected the range and distribution of both plants and animals.

The recovery and analysis of pack rat nests found in montane areas of west Texas (Wells 1966; van Devender *et. al.* 1977) have also provided data useful for the interpretation of late Quaternary vegetational changes. Pack rats (*Neotoma*) make their nests from objects they find in their environment. Often these items include fruits, nuts and leaves which can later be identified and dated. Using information recovered from pack rat nests in the Chisos Mountains of west Texas Wells (1966) found that during the Fullglacial Period (*ca.* 20,000 BP) yellow pine woodlands probably covered large areas of the Chisos Mountains and may have expanded outward into regions of lower elevation as well. In other pack rat nests from the Guadalupe Mountain area van Devender, *et. al.* (1973) found traces of spruce and Douglas Fir needles suggesting that these plants formed part of the Fullglacial age woodlands in that region.

Another approach to the study of Late Quaternary displacement, migration and reconstruction of paleovegetations in Texas has been the study of sequential changes in the fossil pollen record.

Although these types of data are difficult to obtain, they are often more reliable as a paleoenvironmental indicator than either the archeological or paleontological evidence. Fossil pollen grains are considered more useful as indicators since they can be directly linked to the plant groups which produced them whereas man and other animals are mobile and thus their remains can sometimes be found outside the areas of their optimum habitats.

The earliest attempts to obtain fossil pollen data and to apply them to problems related to the paleoenvironment of Texas were made during the 1940's and early 1950's by Potzger and Tharp (1943; 1947; 1954) after they analyzed a series of peat deposits in east and central Texas. Their analysis of the Patsche peat bog in Lee County revealed the presence of fossil fir, spruce, pine, maple, basswood, birch, chestnut, walnut and alder pollen in the lowermost deposits. Variations in the pollen composition of other deposits from that same bog were interpreted by Potzger and Tharp to represent a late Quaternary vegetational sequence that began with an early cool-moist period, progressed through a warm-dry period, changed to a warm-moist period and finally ended in modern times with a warm-dry interval characterized by the establishment of the present Post Oak Savanna vegetational zone. Potzger and Tharp (1954) later analyzed other Texas peat deposits in nearby Milam and Robertson Counties and determined that those pollen records were similar to the ones they had recovered at the Patsche Bog. Although useful, these original studies by Potzger and Tharp did not contain any information concerning the chronological age of any of the deposits. Even so, they still suggested that their earliest pollen records represented the Wisconsin Fullglacial time period and that they were approximately 20,000 years old.

No additional fossil pollen studies were conducted of Texas deposits until the 1960's when Graham and Heimsch (1960) discovered and sampled the Soefje peat bog in Gonzales County located in southcentral Texas. Graham and Heimsch also reexamined the original peat samples which were collected in the late 1940's by Potzger and Tharp from the Gause Bog in Milam County. These new studies led Graham and Heimsch to construct a new interpretation of the central Texas Late Quaternary Paleoenvironmental history. Their study offered a more detailed analytical survey than those conducted by Potzger and Tharp and led Graham and Heimsch to reject the original four-stage climatic sequence proposed by Potzger and Tharp. Instead Graham and Heimsch proposed that central Texas environments were cool and moist prior to 12,500 years ago and that after that time there was a gradual warming trend that went through several minor fluctuations until it ended in the warm-dry conditions found in central Texas today.

The earliest pollen studies conducted in west Texas began in 1961, when Hafsten published a pollen analytical record of sediments collected in a series of playa lakes located on and near the Llano Estacado. His study was significant since it provided a dated chronology covering a time span of more than 35,000 years and resulted in a proposed four-stage vegetational sequence for areas of west Texas and the Llano Estacado. His sequence consisted of: (1) an interval more than 30,000 years ago when grasslands were common in west Texas and on the Llano Estacado, (2) a period between 22,500-14,000 years ago when many of the grassland regions were replaced by conifer woodlands, (3) a transition period between 14,000-10,000 years ago when many of the conifer woodlands decreased in area and were being replaced by scrub grasslands and (4) the establishment of the present grasslands in the lower elevations of west Texas and the Llano Estacado around 10,000 years ago.

Later, studies by Olfield and Schoenwetter (1975) of archeological deposits and other playa lake deposits also provided additional information concerning suspected vegetational changes in west Texas during the past 30,000 years. Although important, the studies by Olfield and Schoenwetter did not significantly alter any of the major original paleoenvironmental reconstructions proposed by Hafsten (1961).

THE PALEOENVIRONMENTAL RECORD

Prehistoric archeological research involves, either directly, or indirectly, the study of human artifacts. Artifacts are the products of man's behavioral responses that are used in an attempt to adapt to the physical and cultural environment.

Even though artifacts constitute the basic data source most often used by American archeologists it is essential that archeologists go beyond this level of inquiry and examine other elements such as the present and past environmental setting before trying to trace the evolution of cultural systems and trying to explain the process of cultural change. Before one tries to describe or offer hypotheses to explain cultural changes, such as the adoption of plant and/or animal domestication or a long term hunter-gatherer continuum, one should begin such explanatory statements with a workable model of the paleoenvironment. This type of caution is clearly demonstrated by Clark (1960: 308) when he emphasized his view as to the importance of the paleoenvironment in a study of cultural process: "... it is essential that the environment and ecological setting of cultures ... be established as accurately as possible, for, without this knowledge, we can hardly begin to interpret the cultural evidence."

Unfortunately, most archeologists rarely have an opportunity to examine the cultural systems that they are studying within the framework of an established paleoenvironmental model. However, when such models are available they serve as a valuable known in the examination of cultural change and the establishment of environmental parameters which could influence the course of human adaptive responses.

A paleoenvironmental model for Texas covering the last 30,000 years is offered herein as a background of data against which the changes in the cultural responses in Texas prehistory can be measured. Our model represents a generalized view. Although useful in the broad sense, it is not precise enough to reflect localized or isolated changes that may have occurred in the microenvironment of a specific locale. Also, the weakest area of our model is the last 2000 year segment since repeated testing has demonstrated that in these deposits the pollen is often poorly preserved.

There are available cultural records for Texas that hint of significant ecological and cultural changes over much of the state during the 13th century A.D. (Dillehay 1974) yet there is little paleoenvironmental data from Texas to suggest what the related ecological changes may have been. These ecological changes may be related to significant climatic fluctuations in the American Southwest during that time interval (Dean & Robinson 1977) yet our paleoenvironmental data for Texas is not yet precise enough to indicate whether or not this effect carried over into Texas.

The model that we are presenting in the remainder of this paper is offered as a beginning point and should not be viewed by the reader as the final analysis on this subject. Instead, it should serve as a test for new data that becomes available in the future. Hopefully, it will undergo modifications and refinements in the years to follow.

Fossil pollen records from lake sediments, archeological deposits, peat bogs, and fossil pack rat middens are the sources of data used to propose a tentative vegetational sequence for areas of Texas covering portions of the late Quaternary period. The majority of these data have been collected from fossil pollen records in areas of central, eastcentral, west and southwest Texas. Unfortunately, no fossil pollen records are yet available for regions of northeast, southcentral or south Texas. This lack of pollen information from those regions is due to several factors. First, there has only been a limited number of attempts to recover fossil pollen from deposits in these regions and second, what few attempts have been made have generally resulted in a failure to find fossilized pollen.

In spite of these limitations we shall devote the remainder of this paper to a discussion of what is presently known about the paleoenvironmental record of Texas. We shall discuss these late Quaternary environmental changes in Texas using the time period chronology originally proposed by Hafsten (1961).

In our paper when we refer to a "woodland" we are interpreting it to mean an open canopy forest containing an understory of herbaceous shrubs or grasses. Likewise, we view a "parkland" as consisting of a grassland which is periodically interrupted by isolated trees and/or large clumps of trees. Our term "savanna" refers to a grassland containing a few scattered trees and shrubs but still indicates an area where the continuity of the grassland is basically uninterrupted. Finally, our term "scrub grasslands" is used to refer to a prairie-like grassland vegetation containing large numbers of scrubby plants and an occasional tree or small stand of trees in the more favorable locales.

In this paper we view west Texas as containing two essentially different physiographic and habitat zones: (1) the upland plateau areas of the Llano Estacado and (2) the rolling hills and montane areas of far west Texas.

Wisconsin Interpluvial Period — 33,500-22,500

The only fossil pollen evidence yet available for the Wisconsin Interpluvial Period in Texas comes from the studies by Hafsten (1961) and Oldfield and Schoenwetter (1975) since deposits thus far examined in other regions of Texas do not contain fossil pollen that far back in time. In Hafsten's original study of playa lake deposits located on and near the edges of the Llano Estacado he found that the fossil pollen evidence could be interpreted to indicate that prior to the maximum spread of the advancing Wisconsin glaciation (30,000 years ago) the vegetation in that region of west Texas could be characterized as a scrub grassland with trees either totally absent or very sparce. Furthermore, he suggested that these fossil pollen data implied a fairly stable cool-moist climate during most of the Wisconsin Interpluvial Period until the beginning of the Fullglacial Period around 22,000 years ago.

Additional fossil pollen analyses of west Texas playa lake sediments were later conducted by Oldfield and Shoenwetter (1975). Their data led them to suggest that Hafsten's vegetational reconstruction for the Wisconsin Interpluvial Period was basically correct but that it had failed to note a series of localized minor vegetational fluctuations. Oldfield and Schoenwetter interpreted these minor vegetational shifts to mean that during this time period regions of the Llano Estacado may have been intermittently invaded by areas of scattered discontinuous open parklands composed of spruce, pine and juniper. However, their fossil pollen records, like those of Hafsten's, suggest that most of this region of west Texas was probably covered by a mixed scrub and grassland prairie vegetation during most of the Wisconsin Interpluvial Period.

Since fossil pollen records are lacking for other areas of Texas during this same time period it is difficult to reconstruct the precise vegetational composition for the rest of the state. On the other hand, we would like to propose a few speculations. A fossil pollen study of deposits in southcentral Missouri by Mehringer, King, and Lindsay (1970), for example, revealed that that region was dominated by an open vegetation consisting of grasses and herbaceous plants with only a few scattered conifers around 30,000 years ago. By projecting a similar pattern for areas south of the Ozarks we find that north and central Texas might also have been covered by a similar scrub and grassland vegetation during this Wisconsin Interpluvial Period. Whether or not this is an accurate reconstruction of the central and north Texas vegetation during this early period is unknown.

The vegetation of south and east Texas during the Wisconsin Interpluvial Period is an even greater mystery. By extrapolating from neighboring areas, we suspect that both south and east Texas were composed mainly of scrubby vegetation with some areas of grasslands present. In addition, east Texas may have represented an ecotonal region between the proposed grasslands and scrub areas to the west and the deciduous forests of the southeastern United States. If so, then there were probably at least limited areas of east Texas which remained forested throughout the entire Wisconsin Interpluvial Period.

Wisconsin Fullglacial Period (22,500-14,000 B.P.)

As the climate grew cooler with the establishment of the Fullglacial period, conifers and certain deciduous trees probably began to invade the grassland regions of Texas. This assumption is supported by both the pollen and faunal records of west and central Texas.

In deposits from Rich and Arch Lake located on the Llano Estacado Hafsten (1961) recovered a fossil pollen record showing a steady and rapid rise in the percentages of both spruce and pine pollen. In conjunction with this rise in conifer pollen was a decrease in grass and herbaceous pollen. Similar pollen records from nearby Crane Lake also reveal that by 15,000 years ago conifer pollen completely dominated the fossil pollen rain in a large area on and around the southern edge of the Llano Estacado. In some cases the pine pollen accounted for over 90% of all fossil pollen recovered in certain strata from this time period. Hafsten interpreted this information to imply that there was a woodland vegetation of spruce and pine covering much of the Llano Estacado region north of the Pecos River. Hafsten also stated that he believed most of the pines were primarily ponderosa pine and that although spruce trees were also present, they were probably not very abundant. In addition, Hafsten suggested that fir (*Abies*) trees were probably not part of the Wisconsin Fullglacial Period vegetation on any part of the Llano Estacado in Texas.

Oldfield and Schoenwetter (1975) examined other playa lake deposits on the Llano Estacado and concluded that the Fullglacial vegetation in most of west Texas (including the Llano Estacado) probably consisted of a continuous coniferous forest composed primarily of a mixture of ponderosa pines and spruce (either *Picea engelmannii* or *Picea punguns*). They also stated that they believed the conifer forests of that time period contained approximately 40% pine trees and 60% spruce trees in the areas of higher elevation while in the lower elevations the mixture of conifers was about 75% pine and 25% spruce. Furthermore, like Hafsten, they agreed that the true fir (*Abies*) was probably not present in any area of west Texas during the Fullglacial Period.

It was originally believed that high conifer pollen counts, similar to the ones discovered in west Texas Fullglacial deposits, were reliable indicators of a widespread woodland type vegetation. More recently, this interpretation has been questioned by Martin (1964) and Martin and Mehringer (1965) who suggest that these Fullglacial pollen records may reflect widespread conifer parklands rather than woodlands.

In an extensive study of the modern pollen rain in grassland and conifer woodland areas of eastern Washington and western Idaho Mack and Bryant (1974) noted that percentages of pine pollen as high as 50% could be recovered in grassland areas approximately

30 miles from the nearest forest. In general, however, the average percentage of pine pollen for most of the grassland areas, near forested regions was only 30-40%. In other studies of the modern pollen rain in the Pacific Northwest Mack and Bryant (1978) found that percentages of pine pollen could reach as high as 80% in surface samples collected in conifer parklands composed primarily of pines and grasses. They also noted that percentages of pine pollen could reach as high as 70% in surface samples collected in scrub grasslands where only a few isolated pine trees were present. It should be pointed out, however, that Mack and Bryant (1974, 1978) were examining the modern pollen rain in and around the Columbia Basin region of Washington state which is surrounded by extensive conifer forests composed of pines, spruce, Douglas fir and fir. Thus, long distance transport of conifer pollen undoubtedly helped to elevate the percentages of these pollen types in the nearby grassland and parkland regions of the Columbia Basin. This phenomenon is easier to understand in light of some of their other data (Mack and Bryant 1974) which show that in locales more than 30 miles away from heavily forested areas the percentages of pine pollen in grassland areas begin to drop below the 30-40% mark recovered in locales closer to the forested regions. However, conifer parkland locales were able to maintain percentages of pine pollen as high as 70% even in areas located more than 30 miles away from heavily forested regions.

Using the above information as a possible collary for the west Texas Fullglacial pollen records, we would like to suggest a modification to the interpretation proposed by Hafsten (1961) and Oldfield and Schoenwetter (1975). The high percentages of fossil pine pollen may, as Hafsten has suggested, represent a continuous conifer woodland covering much of west Texas including the Llano Estacado. On the other hand, we believe that the same pollen data could instead be interpreted to represent a Fullglacial period vegetation characterized by some large areas of conifer forests (primarily confined to elevated regions in west Texas) mixed with parklands and even some large areas of grasslands and scrub grasslands on the Llano Estacado.

Fossil pollen records from Bonfire Shelter located in the Amistad Reservoir area of southwest Texas also can be used to help interpret the Fullglacial period vegetational record. Although no radiocarbon dates are yet available from the lowermost pollen bearing strata in Bonfire Shelter, we believe that those deposits (which are composed entirely of thick limestone spalls) were produced primarily by severe ice wedging that loosened spalls from the roof and walls of the shelter during the cold winters of the late Fullglacial period. Very high percentages (over 80%) of mostly haploxylon type (pinyon) pine pollen was recovered from these spall zone deposits and suggests that during the late Fullglacial period southwest Texas was probably covered by a mosiac of woodland, parkland and scrub grassland vegetations composed primarily of grasses, pinyon pines and perhaps some junipers. We believe that junipers were a component of the southwest Texas Fullglacial period vegetation even though its pollen was not recovered at Bonfire Shelter. Juniper pollen, like the pollen of certain other conifers such as Douglas fir, is fragile and does not preserve well in akaline sediments similar to the ones found in Bonfire Shelter. Therefore, the absence of juniper pollen in the fossil record of this period does not necessarily mean that juniper trees were not fact presence.

We suspect that the proposed ponderosa pine and spruce woodlands of the higher elevations in west Texas did not invade the Amistad region but were instead confined to areas north and west of the region. In addition, the fossil pollen record from Bonfire Shelter also suggests that spruce trees were not present in the Amistad region during any portion of the Fullglacial Period.

As mentioned earlier, van Devender *et al.* (1978) recovered macrofossil traces of spruce and Douglas fir (—*seudotsuga*) in pack rat nests from the Guadalupe Mountains in deposits dating from the late Fullglacial period. The presence of Douglas fir macrofossil remains in pack rat nests of this time period and the corresponding absence of its pollen grains in Fullglacial age deposits from all areas of west Texas is not unexpected. Douglas fir trees produce relatively low quantities of pollen and its pollen is often poorly represented in areas where its trees are found in association with heavy pollen producers such as spruce and pines (Baker 1976); this also seems to be true even when Douglas fir is dominant. Therefore, we suspect that Douglas fir trees were probably present in most areas of west Texas (including the Llano Estacado) during the Fullglacial yet it is difficult to estimate how abundant they may have been.

Fossil pollen records from deposits in central Texas suggest that the invastion of Fullglacial forest elements into Texas was not restricted to regions of west Texas. Fullglacial age deposits recovered from Boriack Bog located in Lee County, Texas, reveal a record of spruce, poplar, birch, hazelnut, ash, maple, alder, dogwood, hickory, basswood, oak, and pine in deposits radiocarbon dated as older than 15,500 years ago (Bryant 1977a).

This suggests that at least a portion of the central Texas late Fullglacial vegetation was composed of deciduous woodlands with some conifers present.

Today central Texas is not represented by either a uniform soil or vegetation composition (Gould 1975) and we suspect that some of these same differences may well have existed as far back as the late Fullglacial period. Fossil pollen data are lacking for the Edwards Plateau region of central Texas west of Austin which today represents an area of grasslands mixed with junipers, oaks and mesquite. The eastern part of central Texas is today represented by blackland prairies and post oak savannas yet fossil pollen data are available and suggest that it was more heavily forested than at present.

In Lee County at the Boriack Bog location, for example, Fullglacial age peat deposits are dominated by high percentages of alder pollen (Bryant 1977a). Alder plants can either be shrub species or tree species yet their pollen look essentially identical. Therefore, it is possible that the alder pollen found in Boriack Bog could have come from either alder trees or from the shrub species of this plant. Furthermore, since alder tends to produce great quantities of airborne pollen, its pollen is often over represented in any fossil record (Janssen 1966).

Other tree pollen types such as basswood, maple, poplar, and spruce pollen are also present but are not as well represented in the fossil record of Fullglacial age deposits in Boriack Bog. This may in part be the result of under representation of their pollen in the fossil record. Unlike alder, these plants produce either low quantities of pollen or their pollen grains are fragile and thus easily destroyed by microorganisms and other similar mechanism of destruction before they can become preserved and later recovered for analysis. We suspect that each of these plant types was probably an important component in the regional vegetation of the eastern portion of central Texas during the Fullglacial period even though these plants are weakly represented in the fossil pollen record.

The pine and oak pollen percentages in these early deposits from Boriack Bog range from a low of 4% to a maximum of 15% yet in actuality these plants may have been only weakly represented in the vegetation in that time period. Like alder, both of these plants produce great quantities of airborne pollen which is easily dispersed and is capable of traveling great distances. In fact, recent pollen studies (Bryant 1977a) demonstrated that most (if not all) of the fossil pine pollen in Boriack Bog probably came from large stands of loblolly pines located 30 miles southwest of the bog near Bastrop. We have found no evidence to suggest that large groups of pines were growing any nearer to Boriack Bog during the Fullglacial period than they are today.

Implications concerning the paleoenvironmental record of the Fullglacial period can also be based upon the presence or absence of certain animals which are known to prefer specific types of plant habitats. Plaeontological evidence is most useful when an entire faunal assembledge is present and can be used to speculate on the potential vegetational and climatic extremes that may have been present. Often this is not possible and instead limited interpretations must be cautiously reported and must be based upon the isolated presence of a single faunal type. Slaughter (1963), for example, has found the faunal remains of the giant beaver (*Castoroides*) in northeast Texas Fullglacial deposits suggesting that that region could have been forested and may have had a cool or cold climate. Further south at Friesenhahn Cave Graham (1976) recovered the remains of the forest dwelling long-nosed peccary (*Mylohyus*), the mastodon (*Mammut*) — which although not restricted to a forest habitat preferred those areas when they were available (Martin and Guilday, 1967) — and the tapir (*Tapirus*) which is usually associated with humid forest environments. All of those fauna were found in deposits dating from the Fullglacial period and which also contained a pollen record (Hall, personal communications) suggesting a mosiac of prairie grasslands mixed with woodland and parkland areas. Lundelius (1967, 1974) has shown that a number of animal species such as the masked shrew (*Sorex cinereus*) and the bog lemming (*Synaptomys cooperi*) lived in areas of north and central Texas up through the early part of the Postglacial period before they disappeared from Texas. Both of these animals currently live in more northern areas of North America and are today found in cool, wet habitats. Their earlier presence, and their current absence, in Texas infers earlier climatic conditions similar to those reflected by the fossil pollen record of Boriack Bog.

Geological and hydrological studies of sediments on the Llano Estacado by Reeves (1963) can also be used to infer cool and humid conditions for the Fullglacial period in west Texas. Reeves has interpreted his data to suggest that during the Fullglacial period midsummer temperature averages were at least 9°F cooler than at present and were accompanied by an annual precipitation rate of approximately 33-34 inches with a maximum annual evaporation rate no higher than 44 inches per year (this compares with present rates of 12-20 inches of annual rainfall and an annual evaporation rate of 60 inches). He feels that it would require at least these estimated rates to maintain the west Texas playa lake basins at their known Fullglacial age levels.

In summary, it appears that most of east, central, north and west Texas was considerably cooler and more humid than today and was covered by areas of grasslands, woodlands and parklands during most of the Fullglacial Period. Few data are available for south Texas during the Fullglacial Period but the pollen records from Friesenhahn Cave do contain higher percentages of grass pollen than pollen records of similar age deposits in central, southwest and west Texas. Based upon that information we would conclude that from Bexar County south, the Fullglacial period vegetation was probably composed of larger areas of grass and scrublands and fewer areas of parklands or woodlands.

Lateglacial Period — 14,000-10,000

The Lateglacial period in Texas represents a time when most of the woodland and parklands regions of Texas began to disappear leaving behind only isolated remnants of earlier widespread areas. This suspected vegetational shift during the Lateglacial period is seen in the fossil pollen records of the Llano Estacado and other regions of west Texas (Hafsten 1961; Oldfield and Schoenwetter 1975) which show a rapid decline in the percentages of pine pollen and the almost total loss of spruce pollen by 10,000 years ago. The Lateglacial age replacement of the west Texas mixed conifer woodlands and parklands by large regions of scrub grasslands is reflected in the fossil record by marked declines of pine and spruce pollen accompanied by sharp rises in grass and herb pollen during the entire duration of the Lateglacial period.

Fossil pollen records recovered from the Amistad Region also reflect a widespread loss of the pinyon woodland areas during the Lateglacial period. Lateglacial deposits at Bonfire Shelter contain a fossil pollen record suggesting that some pinyon trees were still present in the region but that they were probably becoming more restricted to isolated parkland areas that were shrinking in size and being replaced by an expansion of grass and shrub areas. This proposed shift in the vegetational composition of the lower Pecos River area during the Lateglacial period may have resulted from a variety of factors including a suspected reduction in the availability of groundwater moisture combined with increasing evaporation rates caused by elevated summer temperatures.

Central Texas also experienced vegetational changes during the Lateglacial period even though at first these vegetational changes were probably subtle. Lateglacial sediments the Boriack and Gause peat bogs of central Texas (Bryant 1977a) contain a fossil pollen record indicating a gradual reduction in the forest cover of the area, and by inference, a gradual degeneration of the climate. The fossil pollen records indicate that by the end of the Lateglacial period in central Texas many of the dominant plants that once lived in the region were now gone. These plants included taxa such as the willow, birch, spruce, basswood, alder, tupelo and ash. In addition, the percentages of pollen from other tree genera such as the oaks were also slightly reduced. If fossil pollen records were also available for regions of north, east and south Texas we suspect that they would also indicate similar trends in vegetational change during the Lateglacial period.

In general the available pollen evidence suggests that throughout the Lateglacial period most regions of Texas were undoubtedly getting warmer and drier. This assumption is supported by the widespread loss of woodland areas and reduction in parkland regions throughout the areas of Texas where they had thrived during the previous Fullglacial period.

The fossil fauna records of Lateglacial Period deposits in Texas reveal the loss of many animals suggesting that their vegetational habitats and the accompanying climates were changing rapidly. Graham (1976) states that, "the most significant changes in the faunal history of central Texas occurred between Groups I and II". His "Group I" refers to the faunal record up through the Lateglacial Period and the significant changes that he refers to are the sequential disappearances of animals found today only in areas of North America where climates are considerably cooler and more moist than the present climates of central Texas. Graham's list of animals in Group I that disappeared during this period include the masked shrew (*Sorex cinereus*), the ermine (*Mustela erminea*), the meadow vole (*Microtus pennsylvanicus*), the long-tailed shrew (*Sorex vagrans*), and the hare (*Lepus townsendii*). Similar losses of these and other Pleistocene fauna were also noted for the Lateglacial Period from regions of north and west Texas (Lundelius 1967, 1974). In deposits at the Lubbock Lake Site (located on the Llano Estacado) Johnson (1974) found that by the end of the Lateglacial period the regional vegetation of that area would have had to contain large open grassland regions in order to support the known fauna that were living there. Missing from those terminal Lateglacial deposits at Lubbock Lake were woodland vertebrates whose remains had been found associated with earlier Lateglacial deposits but which disappeared before 10,000 years ago. The invertebrate faunal remains at the Lubbock Lake Site (Johnson, 1974) also imply a similar vegetational and climatic trend towards drier and warmer conditions throughout the Lateglacial period.

Postglacial Period — 10,000 Years Ago To The Present

The onset of the Postglacial period in Texas was not accompanied by any sudden or radical changes in the regional vegetation (Bryant 1969, 1977a; Hafsten 1961; Oldfield and Schoenwetter 1975). In the southwest Texas area the inferred mosiac vegetation of woodlands, parklands and scrub grasslands of the previous Lateglacial Period were now being gradually replaced by larger areas of scrub grasslands between 10,000-7,000 years ago. This interpretation is based upon the fossil pollen record at Bonfire Shelter (Bryant 1969) and Hinds Cave (Bryant 1977b) which show gradual reductions in the percentages of fossil pollen from trees such as the pinyon pine. Sufficient fossil pinyon pine was recovered from the deposits in this 3,000 year interval to suggest that there were still some limited areas (perhaps in protected canyons and in some upland locales) where pinyons still flourished in the Amistad region.

Preliminary analysis of plant remains recovered from Hinds Cave and Baker Cave in the Amistad region (Dering 1977) demonstrates that by 8,500 BP local aboriginal groups were already exploiting plants such as agave, yucca, sotol and cactus which are generally associated with fairly xeric environments. Furthermore, Dering has not yet recovered any plant macrofossil remains of pinyon nuts in those deposits which further suggests that perhaps the pinyons had already retreated beyond the limits of the aboriginal's food gathering range at these sites by 8,500 BP. An alternate hypothesis would be that for some reason the prehistoric peoples of the Amistad region did not collect or use pinyon nuts even though they were available. This alternate hypothesis is possible yet we feel it is highly unlikely that these early groups would have ignored such a valuable food source had it been available for exploitation (Shafer and Bryant 1977).

There are only limited fossil pollen records available from areas of southwest Texas during the next 3000 year interval from 7,000-4,000 BP. The fossil pollen record from Centipede Cave (Johnson 1963) is incomplete and based largely upon inadequate pollen counts of less than 200 grains per sample. In spite of these shortcomings, it must at least be considered since it represents one of the few fossil pollen sequences yet available for any portion of this 3,000 year time interval. During his analysis of these deposits Johnson (1963) noted that there did not appear to be any dramatic changes in either the vegetational composition or climate in the Amistad area but that his data did suggest a progressive degeneration of the previous mesic vegetation, and by inference, an elevation of moisture evaporation rates and/or reduction in rainfall. Johnson also noted the apparent increase in agave pollen around the end of this 3000 year period.

Recent pollen studies of deposits in Hinds Cave (Bryant 1977b) have produced a fossil pollen record covering a time span from approximately 9000-3000 BP. The main characteristics of the Hinds Cave pollen record from this time period are: (1) high percentages of grass and herb pollen, (2) low percentages of pine and other tree pollen and (3) significant amounts of economic pollen from plants such as sotol and agave. Since this preliminary analysis from Hinds Cave is based upon only eight of the more than 60 pollen samples scheduled for analysis from that site we hesitate to place too much emphasis upon their represented data since much of it could represent an artifact created by the activities of man rather than a true picture of the regional paleoenvironment. Hopefully, the analysis of additional samples from this site will help clarify the true meaning of this first series of pollen samples. The important feature of this information is that we now have the prospect of obtaining an excellent series of pollen samples in the lower Pecos area of Texas from a time period which up until now has yielded only a very few sediment samples which contained any fossil pollen at all.

Until more paleoenvironmental data can be utilized from the fossil pollen record for the time span between 7000-4000 BP must rely upon what other evidence already exists. This other evidence consists primarily of data which suggest that areas of southwest Texas along the Rio Grande and lower Pecos Rivers were subjected to intervals of severe flooding during much of this 3000 year period (Patton 1977). These periods of erosion and flooding are clearly marked in the alluvial terraces and sediments of archeological sites in this region such as the Devil's Mouth Site (Johnson 1964) located on the Rio Grande and Arenosa Shelter (Dibble 1967) located on the Pecos River. Of the 22 major floods identified by Patton (1977) in the deposits at Arenosa Shelter dating from 4,500 B.P. to the present almost one half of them (ten) occurred between 3,200-4,500 BP.

The causes of erosion and flooding during this 1,300 year period are not fully understood. One possible explanation is that perhaps minor rises in summer temperatures or short periods of drought may have led to partial removal of the upland vegetation thereby allowing increased rainfall runoff and increases in river discharge. Another possible explanation could be increased precipitation during the later portion of this period as suggested by Haynes (1968). This possible increase in annual precipitation may have been caused by a series of active frontal systems moving further inland than usual. Although no actual climatological evidence exists for this type of frontal system phenomenon in the past, these storm systems do move through the area today and can release great amounts of moisture in a short period of time. In the summer of 1975, for example, we were in the lower Pecos River region when such a frontal system released over five inches of rainfall in less than eight hours. The resulting runoff filled many streams that were normally dry and it also caused some major erosional activity along the alluvial banks of the lower Pecos River.

Still another possibility for the widespread alluvial erosion between 3,200-4,500 BP could have come from short periods of intense rainfall associated with the aftermath of a hurricane that may have moved unusually far inland from either the Pacific or Gulf Coast areas. A recent example of that phenomenon occurred in 1954 when Hurricane Alice moved inland over the Rio Grande Valley and the resulting rainfall almost completely filled the Falcon Reservoir on the Rio Grande in the span of a few days. Based upon available records Patton (1977) calculated that at the height of that flood Arenosa Shelter on the Pecos River was more than 30 feet under water and that the Pecos River reached a peak depth of over 80 feet. Since a person can easily wade across the Pecos River during low water periods this estimate has increased significance.

The last 4000 years of the Postglacial Period in southwest Texas is represented by fossil pollen types indicating a gradual and continual trend towards increased aridity. Only once around 2,500 years ago was this apparent trend interrupted. At Bonfire Shelter and the Devil's Mouth Site, fossil pollen records dating from around 2,500 years ago show marked increases in the percentages of both pine and grass pollen suggesting a brief return of somewhat cooler and more mesic conditions (Bryant 1969). This apparent mesic interval, however, was short-lived and soon the trend toward increased aridity was resumed and has continued in southwest Texas until the present.

The analysis of fossil pollen from playa lakes (Hafsten 1961; Oldfield and Schoenwetter 1975) reveal a Postglacial trend towards increased aridity and the establishment of large dry grassland areas lacking trees except along major drainages and in areas of higher elevation in areas of west Texas, including regions of the Llano Estacado. Hafsten's fossil pollen records from the several playa lakes on the Llano Estacado also show an apparent mesic interval occurring around 2,500 years ago. Like the fossil pollen records of the Amistad Region in southwest Texas, the playa lake fossil pollen records show that this brief interval was characterized by higher percentages of both grass and pine pollen but that it too was short-lived. Soon after it ended, the warming and drying trend in both southwest and west Texas continued until the present.

Peat deposits in central Texas also reveal a fossil pollen record suggesting a continual trend towards drier and warmer conditions following the end of the Lateglacial period (Bryant 1977a). Sediments from a number of peat bog locations in central Texas, all dated as being younger than 10,000 years, show declines in most tree pollen types (with the exception of oak) and significant increases in herb and especially grass pollen during the last 10,000 years.

The gradual, yet continual, loss of most tree pollen and the corresponding rise in grass and herb pollen during the Postglacial period in central Texas suggests that east of the Edwards Plateau the Fullglacial mixed deciduous woodlands that were first reduced to parklands during the Lateglacial period were finally reduced to the present savanna type vegetation during the Postglacial period.

The fossil pollen records from central Texas bog deposits covering the time span of the Altithermal Period (7,000-4,500 B.P.) as defined by Antevs (1955), suggest a continual trend towards less mesic conditions. During this nearly 3,000 year period there are no indications in the fossil pollen records that the climate in central Texas was either significantly warmer, wetter, drier or cooler than either the interval before or after that period. What is instead revealed is a fossil record showing a gradual, yet continual, trend towards a more xeric vegetation and, by inference, a warmer and drier climate. The fossil pollen record also implies that the present widespread area of post oak savanna vegetation in central Texas (Gould 1975) was probably more or less established in its present form and distribution by 3,000 years ago.

USING THE PALEOENVIRONMENTAL MODEL FOR INTERPRETING TEXAS PREHISTORY

Our presentation suggesting that there have been major environmental changes in Texas during the last 30,000 years should come as no new revelation to prehistorians despite the fact that many seem to currently work in ignorance of the aboriginals' environmental conditions. We feel that it is essential to construct a workable framework of the paleoenvironment prior to Anglo settlement and land utilization in any area under archeological study. In that way the archeologist can approach his data with a confident understanding of the biological and natural resources that may have been available to the aborigines. After all, it was the distribution of these natural resources together with the aboriginal technology that constituted the major determinant factors in the evolution, settlement and resource utilization patterns.

We suggest that the paleoenvironmental model offered above should serve as a background for more specific regional studies (such as the one we are currently conducting in the lower Pecos region). More importantly, the model can serve as a known variable in exploring the processes of culture change as they are recognized through the study of Texas prehistory. For example, there are two common errors that are often made by Texas archeologists in regard to paleoenvironmental changes. The first concerns the environmental changes that occurred at the end of the Pleistocene and the second concerns the Big Game Hunting tradition in Texas. It is often assumed by archeologists that the environmental changes at the end of the Pleistocene were both sudden and uniform throughout the state; that is, about 10,000 years ago the ice age (and Paleo-Indian Stage) was over, the big game was gone and a new lifeway, the Archaic, evolved. We have already tried to demonstrate that the environmental changes that occurred during the Lateglacial and early Postglacial periods were not uniform and that each region was probably affected differently. Furthermore, our records indicate that the changes were demonstrably gradual, occurred over several thousand years and probably went completely unnoticed by successive generations of aborigines. These changes, however, were nonetheless manifested over time and eventually created concomitant changes in the human adaptive systems.

Knowledge of a gradual, regionally specific environmental change has important implications on the second commonly expressed assumption that a rather uniform big game hunting tradition (symbolized in the term Paleo-Indian), existed throughout Texas. The lingering influence of Krieger's (1964) Stage concept as it was used in the *Handbook of Texas Archeology* (Suhm, Krieger and Jelks 1954) is undoubtedly largely responsible for the present day expression of this view. If one considers the paleoenvironment, animal behavior and habitat it is easily conceivable that the so-called Paleo-Indian or big game hunting concept may only have been applicable to the Plains and peripheral Plains environments of Texas — if even there! We seriously doubt that big game hunting would have been economically sound as a major subsistence pattern in any of the parkland and woodland areas of eastern Texas where the species of big game were probably dispersed or not present in large numbers. Indeed, to our knowledge, there is no confirmed association of artifacts of late Pleistocene age associated with the remains of big game faunal remains in any of Texas outside the Plains and its associated environments. Therefore, the obvious implication of these data is that hunting and gathering (Archaic) adaptations, in all probability, represented the initial and the continuous prehistoric adaptive patterns in large areas of Texas.

Part of the interpretive problem regarding the Paleo-Indian vs. the Archaic issue is that archeologists sometimes are too often blinded by some certain overworked assumptions such as projectile point form. Lanceolate points are usually regarded as Paleo-Indian forms, while stemmed points are often attributed to the Archaic subsistance pattern. At present we know too little about form, function and context of use to rely with any degree of certainty upon this assumption any longer. That lanceolate shaped points are indicative of antiquity is demonstrable but as Shafer (1975) has pointed out, shape alone does not adequately indicate what was actually being hunted.

Our work at Hinds Cave in the lower Pecos area is offered as an example of how the paleoenvironmental model can be used by the archeologist on a regional basis. The majority of the earlier archeological research in the lower Pecos region emphasized chronology building and identifying stylistic changes through time (Alexander's [1974] work at Conejo Shelter represents one of the very few exceptions) whereas from the beginning our work at Hinds Cave was an interdisciplinary archeological and botanical project aimed at an intensive investigation of the paleoecology and adaptive patterns utilized by the site's occupants. The occupation sequence at Hinds Cave covers approximately 9000 years of prehistory, making it an excellent site for examining the relationship between the cultural adaptive changes and paleoenvironmental change that occurred through time. The preliminary report of our findings (Shafer and Bryant 1977) is tentative since the research is still in progress. However, even at this stage we are finding exciting results such as the ones related to the paleoenvironmental study that indicate a gradual dessication of the area by an encroachment of Chihuahuan desert plants by at least 8,500 years ago. Another aspect we are finding indicates that chronological changes, (i.e. projectile point period markers) evidently had little bearing on either the basic subsistence pattern or the prehistoric economic patterns. And finally, even at this point we feel confident in saying that at Hinds Cave there was probably a long continuum with little significant changes in the overall exploitative system during the past 9000 years.

SUMMARY

The paleoenvironmental model presented in this article has very broad implications useful for the interpretation of Texas prehistory since it provides an opportunity for archeologists to view culture histories in a broader context beyond what is generally offered by artifacts alone. In compiling these data we have attempted to examine both published and unpublished works relating to fossil pollen analyses, paleontological studies, hydrological reports, enthnobotanical studies still in progress and archeological records. From these data we have discovered that for the most part little is really known about the past 30,000 year record of environmental change in Texas. Some information does exist but when available it is generally fragmentary or relates only to a small region of Texas. Hopefully, as research in this area continues we will someday have a more nearly precise image of what really happened environmentally in Texas and how our current interpretations for the past 30,000 year period will be affected.

We also offer this model as a basis for explaining culture change as it is observed in the archeological record. Archeological sites contain the behavioral products of man's attempt to cope with the environment. Since this is such a critical aspect of archeological reports we present reasons why we feel an understanding of the paleoenvironment is so essential in archeology.

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REFERENCES CITED

Antevs, Ernst
1955 Geologic — Climatic Dating in the West. *American Antiquity*, Vol. 20, No. 4, pp. 317-335.

Alexander, Herbert L.
1963 The Levi Site: A Paleo-Indian Campsite In Central Texas. *American Antiquity*, Vol. 28, No. 4, pp. 510-527.

Alexander, Robert K.
1974 The Archeology of Conejo Shelter: A Study of Cultural Stability at an Archaic Rockshelter Site in Southwestern Texas. Ph.D. dissertation, The University of Texas at Austin.

Baker, Richard G.
1976 Late Quaternary Vegetation History of the Yellowstone Lake Basin, Wyoming. *U.S. Geological Survey Paper No. 729 E.*, U.S. Government Printing Office.

Black, Craig C.
1974 History and Prehistory of the Lubbock Lake Site. *The Museum Journal*, Vol. XV. Texas Tech University. Lubbock, Texas.

Blair, W. Frank
1958 Distribution Pattern of Vertebrates in the Southern States in Relation to Past and Present Environments. *Zoogeography*, American Association For the Advancement of Science, pp. 433-468.

Braun, E. Lucy
1955 The Phytogeography of Unglaciated Eastern United States and its Interpretation. *Botanical Review*, Vol. 21, pp. 297-375.

Bryant, Vaughn M. Jr.
1969 Late Fullglacial and Postglacial Pollen Analysis of Texas Sediments. Ph.D. dissertation, The University of Texas at Austin.
1977a A 16,000 Year Pollen Record of Vegetational Change in Central Texas. *Palynology*, Vol. 1, pp. 143-156.
1977b Preliminary Pollen Analysis from Hinds Cave. In: Archeological and Botanical Studies at Hinds Cave, Val Verde County, Texas. Texas A&M University Anthropology Research Laboratory *Special Series* No. 1, pp. 70-77.

Clark, D.
1960 Human Ecology during the Africa South of the Sahara. *Current Anthropology* Vol. 1, pp. 307-324.

Crook, W. W. and R. K. Harris
1958 A Pleistocene Camp Site near Lewisville, Texas. *American Antiquity*, Vol. 23, No. 3, pp. 233-246.
Dean, Jeffrey S. and W. J. Robinson
1977 Dendroclimatic Variability in the American Southwest from A.D. 680-1970. (Final report to the National Park Service). Laboratory of Tree-Ring Research Publication. Tucson, Arizona.
Deevey, E. S.
1949 Biogeography of the Pleistocene. *Geological Society America Bulletin*, Vol. 60, pp. 1315-1416.
Dering, J. Phil
1977 Plant Macrofossil Study: A Progress Report. In: Archeological and Botanical Studies at Hinds Cave, Val Verde County, Texas. Texas A&M University Anthropology Research Laboratory *Special Series* No. 1, pp. 84-102.
Dillehay, Tom D.
1974 Late Quaternary Bison Population Changes on the Southern Plains. *Plains Anthropologist* Vol. 19, No. 65; pp. 180-196.
Dillon, L. S.
1956 Wisconsin Climate and Life Zones in North America. *Science*, Vol. 123, pp. 167-176.
Dibble, David S.
1967 Excavations at Arenosa Shelter, 1965-1966. Report Submitted to the National Park Service by the Texas Archeological Salvage Project, Austin, Texas.
Dibble, David S. and Dessamae Lorrain
1968 Bonfire Shelter. A Stratified Bison Kill Site, Val Verde County, Texas. *Texas Memorial Museum, Miscellaneous Papers*, No. 1, pp. 1-78.
Gould, Frank W.
1975 *Texas Plants — A Check List and Ecological Summary.* Texas Agricultural Experiment Station Publication No. MP-585, Texas A&M University, College Station, Texas.
Graham, R. W.
1976 Pleistocene and Holocene Mammals, Taphonomy, and Paleoecology of the Friesenhahn Cave Local Fauna, Baxer County, Texas. Ph.D. dissertation, The University of Texas at Austin.
Graham, Allen and Charles Heimsch
1960 Pollen Studies of Some Texas Peat Deposits. *Ecology*, Vol. 41, pp. 785-790.
Hafsten, Ulf
1961 Pleistocene Development of Vegetation and Climate in the Southern High Plains as Evidenced by Pollen Analysis. *Paleoecology of the Llano Estacado*. Museum of New Mexico Press, pp. 59-91.
Haynes, C. Vance
1968 Geochronology of Late Quaternary Alluvium. In: *Means of Cornolation of Quaternary Successions*. University of Utah Press, pp. 591-631.
Janssen, C. R.
1966 Recent Pollen Spectra from The Deciduous and Coniferous-Deciduous Forests of Northeastern Minnesota: A Study in Pollen Dispersal. *Ecology*, Vol. 47, No.5, pp. 804-825.

Johnson, Eileen
1974 Zooarcheology and the Lubbock Lake Site. In: C. C. Black (ed.) *History and Prehistory of the Lubbock Lake Site*, Texas Tech University, pp. 107-122. Lubbock, Texas.
Johnson, Leroy
1963 Pollen Analysis of two Archeological Sites at Amistad Reservoir, Texas. *The Texas Journal of Science*, Vol. 15, No. 2, pp. 225-230.
1964 The Devil's Mouth Site: A Stratified Campsite at Amistad Reservoir Val Verde County, Texas. *Archaeology Series*, No. 6, Department of Anthropology, University of Texas, Austin, Texas.
Krieger, Alex D.
1964 Early Man in the New World. In: Jesse D. Jennings and Edward Norbeck (eds.) *Prehistoric Man in the New World*. The University of Chicago Press.
Lundelius, Ernest L.
1967 Late Pleistocene and Holocene Faunal History of Central Texas. *Pleistocene Extinction, The Search For a Cause*. Yale University Press, pp. 287-320 New Haven, Connecticut.
1974 The Last 15,000 Years of Faunal Change in North America. *The Museum Journal*, Vol. XV, pp. 141-160.
Mack, Richard N. and V. M. Bryant Jr.
1974 Modern Pollen Spectra from the Columbia Basin, Washington. *Northwest Science*, Vol. 48, No. 3, pp. 183-194.
1978 Modern Forest Pollen Spectra from Washington and Northern Idaho. *Botanical Gazette* (in press).
Maher, L. J.
1963 Pollen Analysis of Surface Materials from the Southern San Juan Mountains, Colorado. *Geological Society America Bulletin*, Vol. 74, pp. 1485-1503.
Martin, Paul S. and John E. Guilday
1967 A Bestiary for Pleistocene Biologists. In: *Pleistocene Extinctions, the Search for a Cause*. Yale University Press, pp. 1-62, New Haven, Connecticut.
Martin, Paul S. and B. F. Harrell
1957 Pleistocene History of Temperate Biotas in Mexico and the Eastern United States. *Ecology* Vol. 38, pp. 468-480.
Martin, Paul S. and P. J. Mehringer, Jr.
1965 Pleistocene Pollen Analysis and Biogeography of the Southwest. In: *The Quaternary of the United States*. Princeton University Press, pp. 433-451, Princeton, New Jersey.
Mehringer, P. J., J. E. King and E. H. Lindsay
1970 A Record of Wisconsin A Vegetation and Fauna from the Ozarks of Western Missouri. In: *Pleistocene and Recent Environments of the Central Great Plains*. University of Kansas Press, pp. 173-184, Lawrence, Kansas.
Oldfield, Frank and James Schoenwetter
1975 Discussion of the Pollen Analytical Evidence. In: *Late Pleistocene Environments in the Southern High Plains*. Fort Burgwin Research Center Publication No. 9, pp. 149-178.
Patton, Peter C.
1977 Geomorphic Criteria for Estimating the Magnitude and Frequency of Flooding in Central Texas. Ph.D. dissertation, The University of Texas at Austin.

Potzger, J. E. and B. C. Tharp
1943 Pollen Record of Canadian Spruce and Fir from a Texas Bog. *Science*, Vol. 98, pp. 584-585.
1947 Pollen Profile from a Texas Bog. *Ecology*, Vol. 35, No. 4, pp. 462-466.
1954 Pollen Study of Two Bogs in Texas. *Ecology*, Vol. 35, No. 4, pp. 462-466.
Reeves, C. C.
1963 Pleistocene Climate of the Llano Estacado, II. *The Journal of Geology*, Vol. 74, No. 5, pp. 642-647.
Sellards, E. H., G. L. Evans and G. E. Meade
1947 Fossil Bison and Associated Artifacts from Plainview, Texas, with Descriptions of Artifacts by Alex D. Krieger. *Bulletin of the Geological Society of America*, Vol. 58, pp. 927-954.
Shafer, Harry J.
1975 Early Lithic Assemblages in Eastern Texas. Paper presented at the Paleo-Indian Lifeways Symposium, Lubbock, Texas.
Shafer, Harry J. and V. M. Bryant, Jr.
1977 Archeological and Botanical Studies at Hinds Cave, Val Verde County, Texas. Texas A&M University Anthropology Research Laboratory *Special Series* No. 1...
Slaughter, B. H.
1963 Some Observations concerning the Genus Smilodon, with Special References to *Smilodon fatalis*. *The Texas Journal of Science*, Vol. 10, pp. 68-81.
Suhm, Dee Ann, A. D. Krieger and E. B. Jelks
1954 An Introductory Handbook of Texas Archeology. *Bulletin of the Texas Archeological Society* Vol. 25, pp. 1-256.
Van Devender, T. R., P. S. Martin, A. M. Phillips, III, and W. G. Spaulding
1978 Late Pleistocene Biotic Communities from the Guadalupe Mountains, Culberson County, Texas. In: R. H. Wauer and D. H. Riskind (ed.) *Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, U. S. and Mexico* Government Printed Office, Washington (in press).
Wells, Philip V.
1966 Late Pleistocene Vegetation and Degree of Pluvial Climatic Change in the Chihauhuan Desert. *Science* Vol. 153, No. 3739, pp. 970-975.
Wilson, L. R.
1966 Palynology of the Domebo Site. In: Frank Leonhardy (ed.), A Paleo-Indian Mammoth Kill in the Prairie-Plains. *Contribution of the Museum of the Great Plains*, No. 1, pp. 44-50.

A DISCUSSION OF POSSIBLE ASIATIC INFLUENCES ON TEXAS PLEISTOCENE LITHIC TECHNOLOGY

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ABSTRACT

Details of the lithic technology from an archeological site of possible Pleistocene age in Medina County, Texas are presented. This lithic collection is similar to assemblages from the early Upper Paleolithic of northeast Asia, with some Mousterian-like elements. This Texas lithic technology may be related to an Asiatic migration to the New World at approximately 25,000 B.C., as proposed by Borden and Muller-Beck.

INTRODUCTION

Over the years, there has been a great amount of speculation on the origin of the Paleo-Indian lithic tradition in the New World, with early dates for use of fluted projectile points, as summarized by Haynes (1967). References are too numerous to summarize, and they provide a number of differing opinions. While there seems to be a consensus that early peopling of the New World was from Asia, there is not general agreement on the chronology or subsequent technological developments (Wormington 1971). Borden (1969) has pointed out that there is increasing evidence for people being in southern North America during the last glaciation, when the route to Asia may have been blocked by ice. Borden proposed a Protowestern Tradition crossing the Bering land bridge from Asia to Alaska at about 25,000 B.C., and proceeding southward through the intermontane plateau of British Columbia, to become the forerunner of the Paleo-Indian tradition in southern North America. This paper will consider some evidence from Texas for the Paleo-Indian deriving from a movement from Asia at some time before the terminal Pleistocene, at a period when an ice-free passage to southern North America was available.

While reports on Paleo-Indian sites south of Canada are becoming more numerous (cf. Kraft 1973 and Frison 1974), with the exception of Dragoo (1973a,b) there have been few serious attempts to compare these collections with others, in an effort to find technological sources. Probably because of the proximity to Asia, more work has been done in the far north to characterize early lithic assemblages of possible Asiatic derivation. This includes reports by MacNeish (1964), West (1973a,b), Anderson (1970), and Irving (1971). Even more work has been done on post-Pleistocene

Asiatic contacts with North America, especially microblade technology as recently summarized by Smith (1974).

Muller-Beck (1966) proposed the movement of Upper Paleolithic people over the Bering land bridge to the New World at approximately 25,000 B.C., with lithic technology having some Mousterian-like elements. Rudenko (1961: 209) has noted the presence of Mousterian traits in the Siberian Upper Paleolithic. Borden (1969: 6-9) then hypothesizes the possible movement of these people southward into western North America. The Paleo-Indian fluted point is viewed as a subsequent indigenous development, especially prominent east of the Rocky Mountains. Borden has named the original lithic technology arriving from Asia the "Proto-western Tradition." Principal lithic traits are: "large biface knives and leaf-shaped points, scrapers in a wide range of size and type, occasionally crude or even well made blades, but never microblades. Varying quantities of pebble tools are usually present." (Borden 1969: 8). Chapman (1975: Fig. 2-3) presents a similar collection of traits as being available for export from Asia in the early Upper Paleolithic.

Hadleigh-West (1973a,b) has reported on similar early type lithic materials in the Tangle Lakes area of Alaska. This has been named the Amphi-theater Mountain Complex, and is described as a late Middle Paleolithic stone industry. Hadleigh-West notes the possible Asiatic affiliation of this Technology. Soviet archeologists would seem to be noting Mousterian-like elements in the Upper Paleolithic in northeast Asia, with terms such as "Epi-Levallois cores" (Powers 1974: 31). Hadleigh-West (personal communication) feels that this is an unfortunate choice of terminology, as these cores are simply generalized forms from the Upper Paleolithic. Chard (1974: 207) does not see any clear cut Asiatic lithic tradition affiliations with North America before terminal Pleistocene time. MacNeish (1976) describes a Pleistocene "Stage III" lithic tradition with blades, burins, and leaf-shaped points found throughout the Americas that fits well with Borden's Protowest Tradition. D'Amare (1965) has noted Mousterian-like elements in early lithic assemblages of the Americas.

I feel that a body of evidence now exists to support the concept of Asiatic early Upper Paleolithic technology as the forerunner of Paleo-Indian technology, with fluted points evolving from leaf-shaped points. Wormington (1962) has previously discussed this hypothetical evolution of projectile points. Borden (1969: 8) has given possible examples of this tradition in North America, and his Protowestern label seems to be an appropriate and handy title.

SITE 41 ME 3, MEDINA CO. TEXAS

There is a site with an undated surface collection in central Texas that appears to have all of the qualifying traits of the early lithic tradition being discussed. This assemblage can best be described as similar to an Asiatic early Upper Paleolithic collection, with several Mousterian-like elements. Site 41 ME 3 in Medina County, Texas was originally published (Patterson 1975) as a brief survey of a quarry site, with Paleo-Indian type prismatic blade technology. Enough additional material has now been found on this site to propose that it is also a hilltop campsite. Appropriately, a hilltop campsite would match the concept of early occupation, as later Archaic period sites in central Texas seem more oriented to lower riverine adaptation. Irving and Cinq-Mars (1974: 65) and Dragoo (1973a: 46) have noted the tendency in other locations for early sites to be on high ground as "lookout" sites, J. F. Epstein (personal communication) has noted high elevation Paleo-Indian sites in northern Mexico, and Patterson and Adams (1977) have described an archeological complex of this nature in Kendall County, Texas. J. J. Hester (1975: 249) has noted the tendency of Paleo-Indian campsites in the southern high plains to be located on high ground as possible "lookout" sites.

Site 41 ME 3 is located in the rolling foothills on the southern edge of the central Texas hill country, at the boundary of the Edwards Plateau. The surface geology is Cretaceous, with a thin layer of more recent soil. Lithic raw materials are available as flint nodules in the weathered limestone. The area presently supports a large deer population, and earlier, large herd animals were probably present, such as buffalo and elk, and possibly Pleistocene fauna such as horse and elephant. Because of the thin soil layer and because of limited time available to the writer, work on this site has been limited to surface collection. No materials suitable for radiocarbon dating have been found. Although only a surface collection is available, the lithic artifacts comprise a rather homogeneous technology, and it is felt that only one cultural tradition is present.

Lithic traits of site 41 ME 3 appropriate to the concept of the Protowestern Tradition are:

1. Mousterian-like technology
   a. discoidal cores
   b. thick flake scrapers, steeply retouched by percussion
   c. Mousteroid points
   d. notched tools
   e. denticulates

TABLE 1. SITE 41 ME 3 GENERAL LITHIC COLLECTION 12/75

	No.	%
discoidal cores	13	0.9
blade cores	13	0.9
amorphous cores	12	0.9
blade core fragments	8	0.6
blade core trim flakes, facial	3	0.2
large hammerstone	1	0.1
pebble tools, chopper-like	4	0.3
bifaces		
35 to 50 mm square	17	1.2
50 to 70 mm square	15	1.1
over 70 mm square (see original)	10	0.7
fragments	10	0.7
biface subtotal	52	3.7
beaked tools and gravers	42	3.1
notched tools	54	3.9
denticulates	17	1.2
flake choppers	3	0.2
Mousteroid points	8	0.6
unifacial ovoid scrapers	9	0.7
dihedral burin on blade	1	0.1
dihedral burin on biface	1	0.1
oblique burins on flakes	2	0.1
heat treated flint (more possible)	8	0.6
small triangular bifaces	4	0.3
leaf shaped projectile points	4	0.3
leaf shaped preforms	13	0.9
table subtotal	272	19.7

TABLE 2. SITE 41 ME 3 FLAKE COLLECTION 12/75

	No.	%
irregular shaped flint flakes (A)		
15 to 20 mm square	14	1.0
20 to 25 mm square	69	5.0
25 to 35 mm square	229	16.6
35 to 50 mm square	400	28.8
50 to 70 mm square	187	13.5
over 70 mm square	23	1.7
subtotal	922	66.6
blade-like flakes (B)		
15 to 20 mm wide	4	0.3
20 to 25 mm wide	9	0.7
25 to 30 mm wide	26	1.9
30 to 35 mm wide	26	1.9
35 to 40 mm wide	21	1.5
40 to 45 mm wide	9	0.6
45 to 50 mm wide	3	0.2
50 to 55 mm wide	3	0.2
subtotal	101	7.3
prismatic blades (C)		
10 to 15 mm wide	1	0.1
15 to 20 mm wide	4	0.3
20 to 25 mm wide	25	1.8
25 to 30 mm wide	26	1.9
30 to 35 mm wide	21	1.6
35 to 40 mm wide	7	0.5
40 to 45 mm wide	2	0.1
45 to 50 mm wide	2	0.1
subtotal	88	6.4
table subtotal	1111	80.3
total collection	1383	100.0

(A) over 80% retouched edges; avg. thickness 11.7mm, range 4 to 24 mm

(B) ave. length 58 mm, range 30 to 125mm; avg. thickness 12mm, range 5 to 27

(C) avg. length 62mm, range 39 to 98mm; avg. thickness 10.2mm, range 4 to 23, 31% endscrapers

2. Primitive prismatic blade technology, using direct percussion, with Siberian type prepared platform cores (Powers 1974: 31).

3. An assortment of leaf-shaped and cordiform bifaces from handaxe to projectile point size

4. Pebble tools (chopper-like cores)

5. No microblades

A statistically significant lithic sample has been obtained from site 41 ME 3, as summarized in Tables I and II. All material is flint, principally of grey, black, and brown single colors. While the overall site is very large, winding around a ridge for some 3000 feet, the main concentration of artifacts is in an area of approximately 400 by 600 feet, where the natural outcropping of flint nodules is densest. This collection is rather unique, for the possible early lithic technology represented, in that the complete technology is available for study; including finished artifacts, preforms, cores, and chipping debitage. Direct percussion was used extensively, and there is no evidence of pressure flaking. This is confirmed not only by retouch patterns on artifacts, but also by the analysis of small percussion flakes under 18 mm square in size (Patterson and Sollberger ms), and no evidence of any pressure flakes. Heat treating of flint was used. Several pieces of flint have reddened discoloration and "potlidded" surfaces typical of excessive, non-useful thermal alteration. A large number of flint flakes may show heat treating because of their waxy luster. Some of the artifacts are shown in Figures 1 to 5, including all of the principal diagnostic types.

Several of the artifact types present have been illustrated by Klein (1973: Figs. 6,7) as being typical of the Mousterian, including a large variety of steeply retouched flint flake scrapers, discoidal cores, notches, and denticulates. Both cutting and scraping edge retouch patterns are present on the irregular flint flakes summarized in Table II, with the greatest number indicating possible scraper function. All of the scraper shapes illustrated by Klein for the Mousterian are present, in various combinations of straight, convex, and concave edges. Mousteroid points resemble ones shown by Bordes (1972) from several European Mousterian sites. Laughlin (1975) has demonstrated these points to be present in the New World, at Anangula in the Aleutians. A large variety of bifaces is present on site 41 ME 3 in various sizes, most with leaf-shaped and condiform outlines. Large bifaces have been called handaxes in the Texas hill country for a number of years. The unifacial ovoid scrapers are domed-shaped, resembling turtle shells, and are possible examples of the Levallois flake technique. A few burins are present. One dihedral burin on a prismatic blade segment has been identified by J. F. Epstein (personal

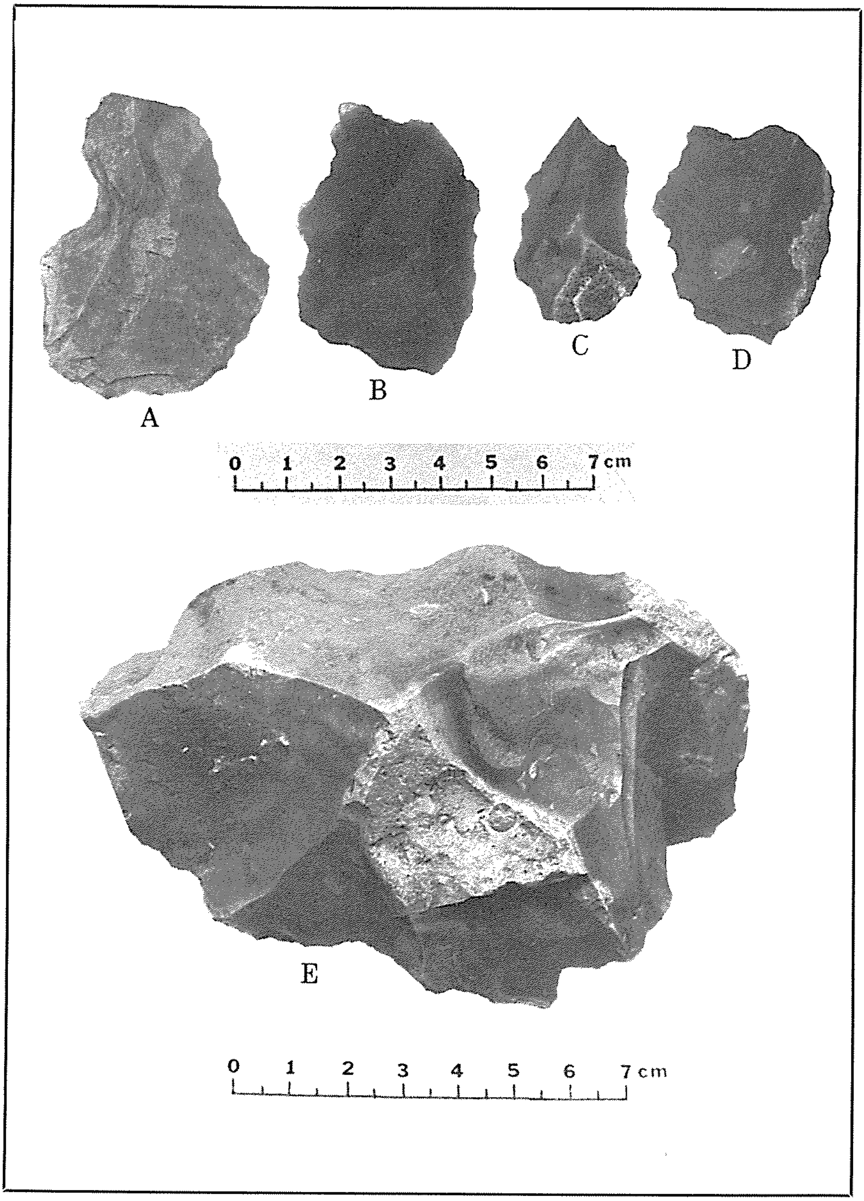

FIGURE 1. *A, Notched tool; B, beaked tool; C, dihedral burin; D, denticulate; E, discoidal core.*

communication) of the University of Texas at Austin. Alexander (1974) feels that burins are firmly established in North American Pleistocene assemblages. Leaf-shaped projectile points are the major type, all with the characteristic stepped retouch from use of direct hard percussion. Some of these points have slight stems, formed by removal of small amounts of material on the lateral edges, but there is no basal grinding. Four percussion-made triangular bifaces present probably represent projectile points and preforms.

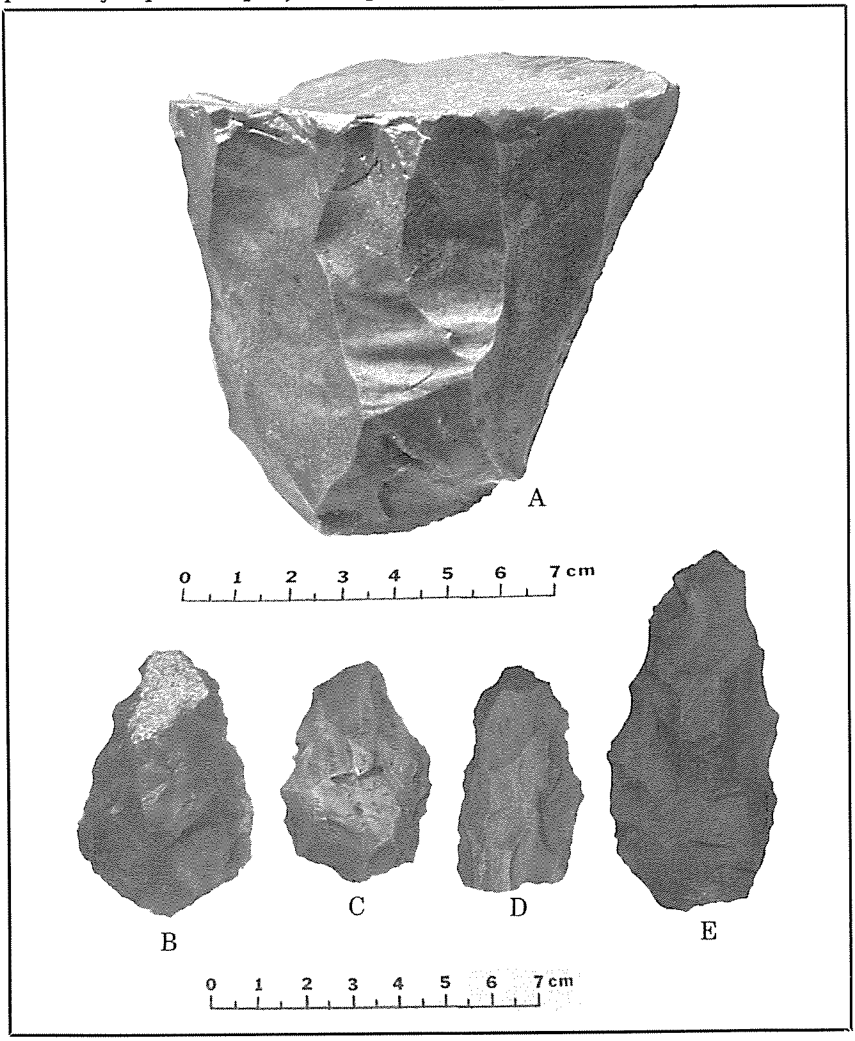

FIGURE 2. *A, semi-conical blade core; B-E, projectile point preforms.*

Blade-like flakes shown in Table II consist of prismatic flakes too short to be classified as blades, and miscellaneous elongated flakes with parallel lateral edges. A true prismatic blade industry is also present, mostly in the form of large wide blades. This is very different from the small blades of the Archaic period in this same Texas hill country, and on the upper Texas coast. Differences in Texas blade technologies have been discussed in a previous paper (Patterson 1976). Both single and multiple facet striking platforms were used, with more cores and blades showing use of single facet platforms. Typical blade cores are semi-conical in shape, with the striking platform formed simply by a single blow to remove the end of a flint nodule. Almost all blades have retouch on one or both lateral edges, and over 30% also show use as end scrapers.

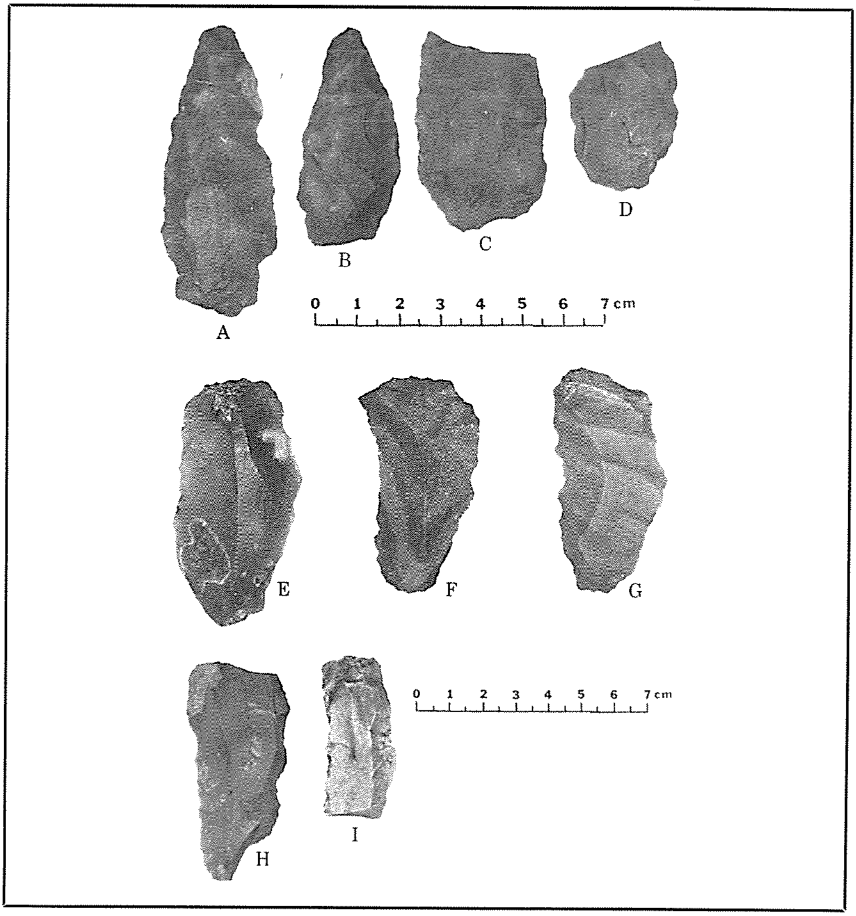

FIGURE 3. *A-D, leaf-shaped projectile points; E-I, prismatic blades.*

The lithic collection from site 41 ME 3 consists of 1383 artifacts and many pieces of small chipping debitage. Compared to other Texas collections, it can be classified as a very heavy tool industry. It remains to be determined if this site is a true Protowestern type site (pre-Clovis) or a later site following the Protowestern tradition. Site 41 ME 3 may not be an isolated phenomenon. Nearby sites have a number of the same lithic traits as site 41 ME 3, with no sign of pressure flaking or other later lithic traits. As with site 41 ME 3, these other sites could be considered as simple quarry sites because of chipping debitage at locations where lithic raw material occurs naturally. However, practically all flint flakes show signs of wear and heavy retouch, and lithic tool kits are present, not just specialized quarry activity remains.

TECHNOLOGICAL COMPARISONS

A number of comparisons are possible for the lithic technology of site 41 ME 3 with other lithic collections to show both similarities and contrasts. Lithic flake thickness is an important attribute. Texas middle to late Archaic sites surveyed by the writer can be classified as thin flake industries, with most flake thicknesses ranging from 2 to 5 mm. This is in sharp contrast with the average flake thickness of 11.7 mm for site 41 ME 3. Wilmsen (1970: Table 7) has summarized several Paleo-Indian collections with thick flakes, although considerable variation is shown. Flake size may also be important. Archaic period sites in this Texas hill country surveyed by the writer have few flakes over 40 mm square (Patterson and Adams 1977), and the large number of flakes over 50 mm square on site 41 ME 3 may be an indication of earlier lithic technology.

Frank C. Hibben (personal communication) of the University of New Mexico sees similarities of the overall lithic technology of site 41 ME 3 with the Sandia, including prismatic blades, leaf-shaped bifaces, denticulates, and Mousteroid points. This is consistent with the Pleistocene nature of site 41 ME 3 proposed here. Although there is not general agreement that the Sandia has pre-Clovis dating, it is at least firmly within the Pleistocene period.

There is a general resemblance of many flakes from site 41 ME 3 with the scrapers described by Alexander (1963) for the Levi Paleo-Indian site in central Texas. Alexander shows a number of basically leaf-shaped points in this collection. Alexander (personal communication) has recently done work on a pre-Clovis stratum at the Levi site, but only crude utilized flakes and bone tools were found. Carl H. Chapman (personal communication) of the University of Missouri has informed me that there is a site (Shriver site) in northwest Missouri which appears to underlie fluted points, that has lithic technology that may be similar to site 41 ME 3, but I have not yet been able to obtain any detailed information on the Missouri site.

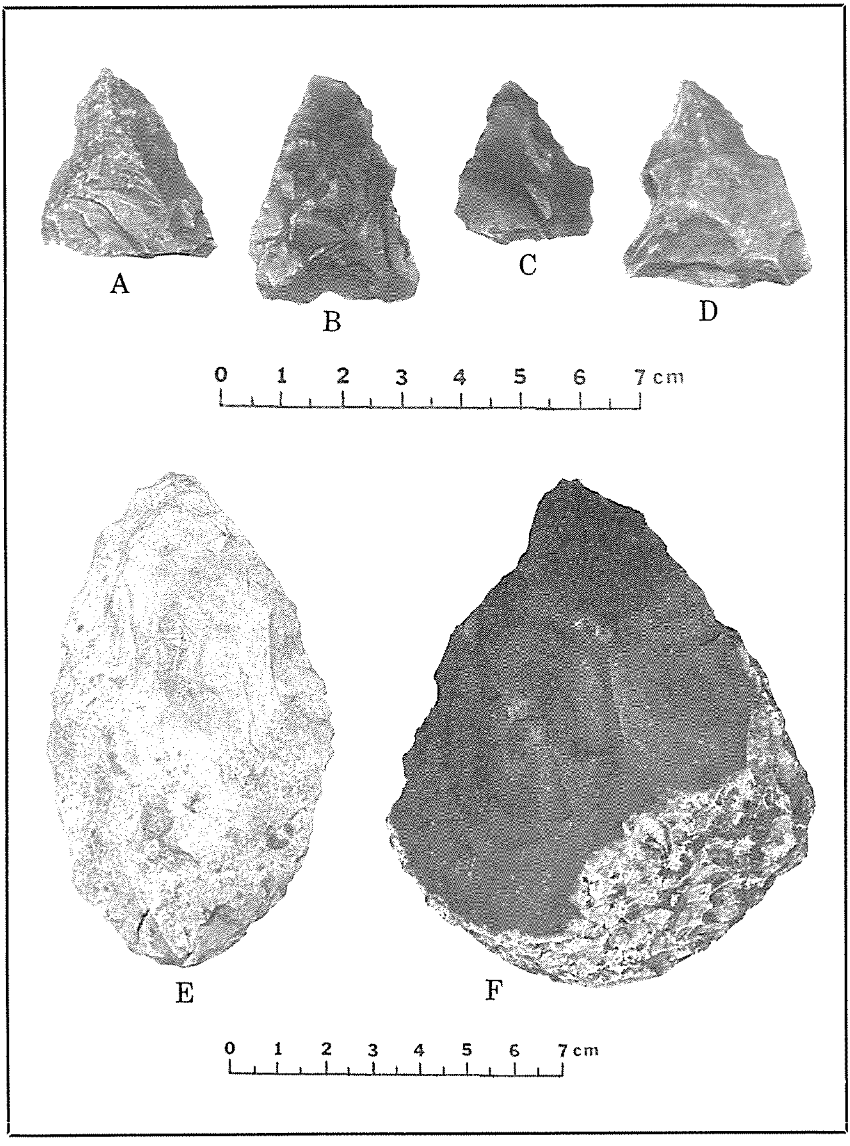

FIGURE 4. *A-D, triangular bifaces; E-F, large bifaces.*

The Wells Creek site in Tennessee reported by Dragoo (1973a) is a Paleo-Indian site with Clovis fluted points. It also has leaf-shaped bifaces, large prismatic blades, thick flake scrapers, discoidal cores, and polyhedral cores. Dragoo (1973b) has discussed possible Asiatic affiliations for the cores. This site could represent the evolved form of the Protowestern tradition. Like site 41 ME 3, the Wells Creek site has beaked, notched, and denticulate flake tools. West's (1973a,b) early Amphitheater Mountain complex in Alaska also contains these tool types.

Paleo-Indian prismatic blade technology is of the large type, with blades generally grouping over 20 mm in width (Converse 1973: 14, Green 1963, Hammatt 1969, Kraft 1973). This is a statistical grouping and some smaller blades can be present. Cores to produce these large blades are similar to the "Epi-Levallois" Siberian cores (Powers 1974: 31), where examples are available. Examples of cores of this type in North America that might fit the Protowestern Tradition have been given by Hadleigh-West (1973a: Pl. III), Dragoo (1973a: Fig. 27), Chapman (1975: Fig. 4-13), and Patterson (1975: Fig. 2). These are polyhedral cores from which large blades have been detached, with acute angle striking platforms. There is a minimum of purposeful striking platform edge preparation, at least on the Texas examples. This type of blade technology can be replicated by direct hard percussion (Sollberger and Patterson 1976, Crabtree and Swanson 1968). Some microblades can be produced fortuitously in small quantities, but not as a distinct industry. One prominent attribute on blades using this manufacturing technique is the high percentage of striking platforms crushed on the dorsal surface, leaving a thin or negligible residual striking platform on the blade. For example, 50% of the blades from site 41 ME 3 have crushed striking platforms. It has been proposed (Sollberger and Patterson 1976) that blade technology introduced into southern North America before the terminal Pleistocene employed direct percussion exclusively, and that indirect percussion and pressure techniques for smaller blades were technologies introduced from Asia in post-Pleistocene time. These later technological introductions apply south of the main glaciation. Lithic techniques could have arrived earlier in Alaska before there was an ice-free passage to the south at the end of the last glaciation, and West 1973a: 10) shows dates for the Denali tradition with microblades as early as 9000 B.C.

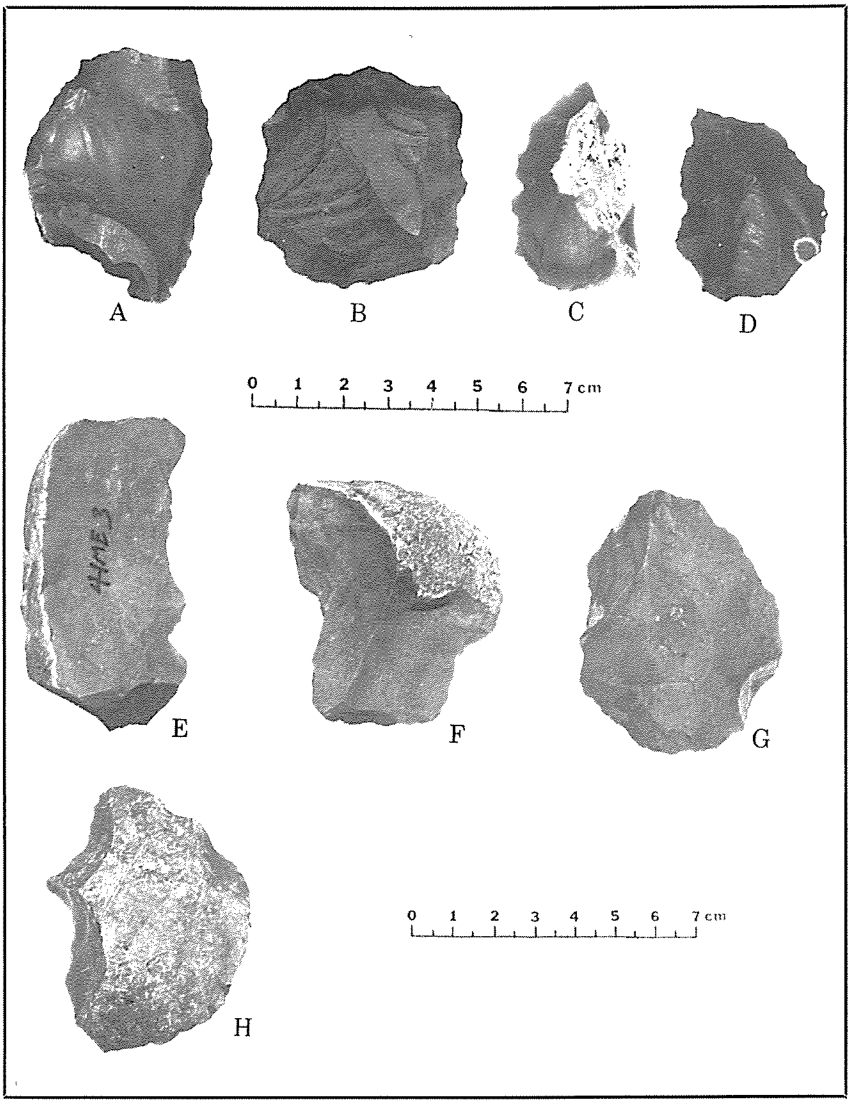

FIGURE 5. *A, unifacial scraper; B, ovoid scraper; C-D, Mousteroid points; E-H, large flake scrapers.*

The lithic elements mentioned here as deriving from a Protowestern tradition in formation of the Paleo-Indian traditions in southern North America can be noted in a number of Paleo-Indian collections. Irwin and Wormington (1970), for example, summarize Paleo-Indian tools from the Plains area, with many of the tool types mentioned for the Protowestern tradition. Kraft (1973) shows similar tool types for a Paleo-Indian site in New Jersey. There are several reasons why few comparisons have been made between lithic technologies of northeast Asia and the Paleo-Indian of southern North America. First of all is the small amount of data previously available for both areas. In North America, many Paleo-Indian kill sites simply did not yield complete lithic collections. Secondly, there has been a general failure to note Pleistocene type lithic technology in North America if not associated with fluted points. Also, more attention has been given to projectile points than to other basic lithic technology. Much more attention has been given to the variability of lithic traits, such as projectile points, in Paleo-Indian collections than in recognizing the basic continuity of this lithic tradition. Some of this continuity has been recognized. Jennings (1974: 133) notes that terminal Pleistocene prismatic blades are similar to Clovis examples. Finally, in comparing Pleistocene lithic collections, a great amount of impressionistic personal opinions have been given, instead of detailed technical analyses.

Two direct comparisons can be made of sites in northeast Asia with site 41 ME 3. One is that every lithic component of the Ust' Kanskaia site (Rudenko 1961), which is represented as a Siberian early Upper Paleolithic collection, is also present in the collection of site 41 ME 3. This includes: discoidal implements, massive flake tools, large prismatic blades, Mousteroid points, leaf-shaped bifaces, burins, beaked tools (perforators), notched tools, and chopping, scraping and cutting tools. Another comparison that can be made for site 41 ME 3 is with the Dyuktai Upper Paleolithic culture (Mochanov 1973) of northeast Asia. Comparable lithic components are: leaf-shaped points, triangular points, large bifaces, large prismatic blades, pebble tools, burins, large scrapers, large flake knives, denticulates, discoidal cores, and polyhedral large blade cores. The later Dyuktai type sites at approximately 11,000 to 12,000 B.C. have a microblade industry using Gobi type wedge-shaped cores, while site 41 ME 3 does not have a microblade component. This may be interpreted that the Texas site is related to the early end of the Dyuktai culture at approximately 25,000 B.C., before the development of microblade technology. Mochanov (1973: 12) has noted the general similarity of the Dyuktai lithic technology with New World Paleo-Indian technology, except for microblades.

It would seem desirable to compare the site 41 ME 3 lithic collection with quarry-workshop sites commonly found in central

Texas. However, surprisingly little has been published on quarry-workshop sites. There is a series of reports on quarry-workshops in Comal County (Hester, Bass and Kelly 1975, Kelly and Hester 1975a,b) with many sites in a complex of apparent Archaic age. There are apparently two classes of quarry-workshops found in central Texas. One type is primarily a quarry-workshop, which may or may not also have been the scene of some lithic tool use. The other type is a campsite located at or near lithic source areas, where complete lithic reductions to finished tools and much tool use occurs. The Comal County quarry-workshops are of the first type of site, and site 41 ME 3 is of the second type. Several comparisons can be made between site 41 ME 3 and the Comal sites:

1. While no detailed data were given for the Comal sites, and large flake tools are present, I have the impression that the flakes generally tend to be smaller than the distribution given in Table II for site 41 ME 3, as small flake tools and a small blade core are mentioned for the Comal sites. I feel that flake size distributions are important information rarely given in archeological reports. The flake size distribution of site 41 ME 3 runs much larger than for Archaic campsites surveyed by the author in Bandera and Kendall Counties.
2. A number of lithic components found at site 41 ME 3 are not present on the Comal sites, indicating a more complex tool kit for the Medina County site. Items not present on the Comal sites include burins, beaks and gravers, and Mousteroid (Mousterian-like) points. The Comal sites also do not have a well defined industry for making and using large prismatic blades in significant quantities.
3. Site 41 ME 3 has a collection of irregular shaped lithic flakes with 9.7% primary cortex flakes, 43.5% secondary cortex flakes, and 46.8% interior flakes. This tends to show a greater emphasis on the lithic reduction process at site 41 ME 3 than at the Comal quarry-workshop sites, where primary flakes averaged 23% (Kelly and Hester 1975b: 13).
4. The high percentage of flakes utilized as tools on site 41 ME 3 would certainly not be expected on sites which are predominantly quarry-workshops, and this is not evidenced on the Comal sites.
5. As a summary comment, published quarry-workshop sites in south-central Texas, which seem to be mainly of Archaic age, simply do not have the "Protowestern" mix of lithic technology.

CONCLUSIONS

From the above discussion, it is proposed that the list of Pleistocene tradition lithic traits in the New World that are possibly derived from northeast Asia include the following elements:

1. discoidal cores
2. thick large flake scrapers, steeply retouched by percussion and in wide variety
3. leaf-shaped and cordiform bifaces and projectile points
4. triangular points
5. large prismatic blades
6. crude polyhedral blade cores, prepared platforms
7. pebble tools, chopper-like
8. no microblade industry (some small blades could be present)
9. notched tools
10. denticulate tools
11. absence of specialized bifacial projectile points with flutes or distinctive stem types
12. beaked tools
13. no significant fine pressure flaking
14. generally thick heavy lithic flake industry
15. burins may be present
16. sometimes Mousteroid points

Many of these traits have long continuity into the later Archaic period in North America, so that the combination of traits in the total lithic collection is the important feature of the Protowestern tradition, along with the absence of traits generally accepted as starting later. Dragoo (1973: 53) thinks that there may be some of these type of heavy tool industry sites in Tennessee. It is hoped that this article will stimulate others to be alert for this type of lithic collection. As shown here, sites do exist in southern North America which fit Borden's criteria for Protowestern assemblages, and work should be done to establish confirming chronology.

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REFERENCES CITED

Alexander, H. L., Jr.
1963 The Levi Site: A Paleo-Indian Campsite in Central Texas, *American Antiquity* Vol. 28, No. 4, pp. 510-528.
1974 The Association of Aurignacoid Elements with Fluted Point Complexes in North America, *International Conference on the Prehistory and Paleoecology of Western North American Arctic and Subarctic, University of Calgary.*

Anderson, D. D.
1970 Akmak, *Acta Arctica*, Fasc. 16, Copenhagen.

Borden, C. E.
1969 Early population movements from Asia into western North America, *Syesis*, Vol. 2, No. 1, pp. 1-13.

Bordes, F.
1972 *A Tale of Two Caves*, Harper and Row.

Chapman, C. H.
1975 The Archaeology of Missouri, I, University of Missouri Press.

Chard, C. S.
1974 *Northeast Asia in Prehistory*, University of Wisconsin Press.

Converse, R. N.
1973 Ohio Flint Types, *Archaeological Society of Ohio, Special Publication.*

Crabtree, D. E. and E. H. Swanson, Jr.
1968 Edge Ground Cobbles and Blade Making in the Northwest, *Tebiwa*, Vol. 11, No. 2, pp. 50-58.

D'Amare, R. T.
1965 El Antropogeno de Siberia y El Hombre Americano, *Investigaciones 8, Instituto Nacional de Antropologia e Historia, Mexico*

Dragoo, D. W.
1973a Wells Creek — An Early Man Site in Stewart County, Tennessee, *Archaeology of Eastern North America*, Vol. 1, No. 1, pp. 1-55.
1973b The Trimmed-Core Tradition in Asiatic-American Contacts, *9th International Congress of Anthropological and Ethnological Sciences, Chicago.*

Frison, G. C.
1974 The Casper Site, Academic Press.

Green, F. E.
1963 The Clovis Blades: an important addition to the Llano Complex, *American Antiquity*, Vol. 29, pp. 145-165.

Hammatt, H. H.
1969 Paleo-Indian Blades from Western Oklahoma, *Bulletin of the Texas Archeological Society*, Vol. 40, pp. 193-198.

Haynes, C. V., Jr.
1967 Carbon-14 Dates and Early Man in the New World, in *Pleistocene Extinctions*, editors P. S. Martin and H. E. Wright, Jr., Yale University Press.

Hester, J. J.
1975 Paleoarchaeology of the Llano Estacado, in Late Pleistocene Environments of the Southern High Plains, F. Wendorf and J. J. Hester, *Fort Burgwin Research Center, Southern Methodist Univ.*

Hester, T. R, F. A. Bass, Jr. and T. C. Kelly
1975 Archaeological Survey of Portions of the Comal River Watershed, Comal County, Texas. *Center for Archaeological Research, University of Texas at San Antonio, Archaeological Survey Report 10.*

Irving, W. N.
1971 Recent Early Man Research in the North, *Arctic Anthropology*, Vol. 8, No. 2, pp. 68-82.

Irving, W. N. and J. Cinq-Mars
1974 A Tentative Archaeological Sequence for Old Crow Flats, Yukon Territory, *Arctic Anthropology*, Supplement 11, pp. 65-81.

Irwin, H. T. and H. M. Wormington
1970 PaleoIndian Tool Types in the Great Plains, *American Antiquity*, Vol. 35, No. 1, pp. 24-34.

Jennings, J. D.
1974 *Prehistory of North America, Second Edition*, McGraw-Hill.

Kelly, T. C. and T. R. Hester
1975a Additional Archaeological Survey in the Dry Comal Watershed, Comal County, South Central Texas. *Center for Archaeological Research, University of Texas at San Antonio, Archaeological Survey Report 10.*
1975b Archaeological Investigations at Four Sites in the Dry Comal Watershed, Comal County, South Central Texas. *Center for Archaeological Research, University of Texas at San Antonio, Archaeological Survey Report 15.*

Klein, R. G.
1973 *Ice-Age Hunters of the Ukraine*, University of Chicago Press.

Kraft, H. C.
1973 The Plenge Site: A Paleo-Indian Occupation Site in New Jersey, *Archaeology of Eastern North America*, Vol. 1, No. 1, pp. 56-117.

Laughlin, W. S.
1975 Aleuts: Ecosystem, Holocene History and Siberian Origin, *Science*, Vol. 189, pp. 507-515.

MacNeish, R. S.
1964 Investigations in the Southwest Yukon, *Papers of the R. S. Peabody Foundation for Archaeology, Vol. 6.*
1976 Early Man in the New World, *American Scientist*, Vol. 64, pp. 316-327.

Mochanov, Y. A.
1973 Early Migrations to America in the Light of a Study of the Dyuktai Paleolithic Culture of Northeast Asia, *9th International Congress of Anthropological and Ethnological Sciences, Chicago.*

Muller-Beck, H.
1966 Paleohunters in America: origins and diffusion, *Science*, Vol. 152, pp. 1191-1210.

Patterson, L. W.
1975 A Quarry Site in Medina County, Texas, *La Tierra*, Vol. 2, No. 1, pp. 19-23.
1976 Blade Technology in the Texas Archaic, in The Texas Archaic: A Symposium, edited by T. R. Hester, *Center for Archaeological Research, University of Texas at San Antonio, Special Report 2.*

Patterson, L. W. and J. H. Adams.
1977 An Archeological Complex in Kendall Co., Texas, *La Tierra*, Vol. 4, No. 2, pp. 6-16.
Patterson, L. W. and J. B. Sollberger
ms. Small Lithic Flake Classification, submitted to *Plains Anthropologist. Journal of Archaeology.*
Powers, W. R.
1973 Paleolithic Man in Northeast Asia, *Arctic Anthropology*, Vol. 10, No. 2.
Rudenko, S. I.
1961 The Ust' Kanskaia Paleolithic Cave Site, Siberia, *American Antiquity*, Vol. 27, No. 2, pp. 203-215.
Smith, J. W.
1974 The Northeast Asian-Northwest American Microblade Tradition, *Journal of Field Archaeology*, Vol. 1, Nos. 3, 4, pp. 347-364.
Sollberger, J. B. and L. W. Patterson
1976 Prismatic Blade Replication, *American Antiquity*, Vol. 41, No. 4, pp. 517-531.
West, F. H.
1973a Old World Affinities of Archaeological Complexes from Tangle Lakes, Central Alaska, *All-Union Conference on the Bering Land Bridge, Khabarovsk, USSR.*
1973b The Significance of Typologically Early Site Collections in the Tangle Lakes, Central Alaska: A Preliminary Consideration, *International Conference on the Prehistory and Paleoecology of Western North American Arctic and Subarctic, University of Calgary.*
Wilmsen, E. N.
1970 Lithic Analysis and Cultural Inference: A Paleo-Indian Case, University of Arizona Press.
Wormington, H. M.
1962 A Survey of Early American Prehistory, *American Scientist*, Vol. 50, No. 1, pp. 230-242.
1971 Comments on Early Man in North America 1960-1970, *Arctic Anthropology*, Vol. 8, No. 2, pp. 83-91.

ON FLUTING FOLSOM: NOTES ON RECENT EXPERIMENTS

J. B. SOLLBERGER

ABSTRACT

Some of the problems and variables involved in the replication of Folsom fluted points are presented. The differences in the more common types of breakage patterns are described along with the possible causes.

This paper describes channel flute fracture patterns which can occur in replicating the classic Folsom projectile point. Crabtree (1966) has presented the only comprehensive description of replicative experiments involving the Folsom type. Others (cf. Judge 1970) have presented analysis and production trajectories which were not checked by replicative procedures. Questions still remain regarding type attributes and production technology for Folsom. I would like, therefore, to make available certain comments on the fluting process that result from my own experiments during the past several years.

Channel flute scars provide some information about Folsom preforming and lateral edge retouch. I have observed three channel flute styles on artifacts (Fig. 1A, B and C) and the technological implications of these attributes deserve comment. The example shown in Figure 1A has the most acute lateral edge angles and represents the fluting of a completed preform with no additional retouch to the edges. The example shown in Figure 1B has an additional series of short flakes removed by lateral edge retouch; these do not extend to the ridge crests of the flute. I use a fluting clamp in my experiments and sometimes retouch the lateral edges to make the preform fit the fluting clamp better (Why did the Indians do such retouching?). The specimen illustrated in Figure 1B has a lateral edge cross-section that is less acute than that on Figure 1A because of this additional edge retouch. The third style of edge flaking on artifacts (Fig. 1C) has lateral edge retouch that was applied after the fluting. This style has the least acute ($\pm 90°$) edge angles. Style C retouch is done from style A or B lateral edges and brings the edges closest to the channel scar ridges and slightly rounds them off without penetrating into the channel scar itself. A fellow flint-knapper, Bruce Bradley, does this replication technique most convincingly. Since these styles represent technological attributes, I suggest that their distribution may have regional significance.

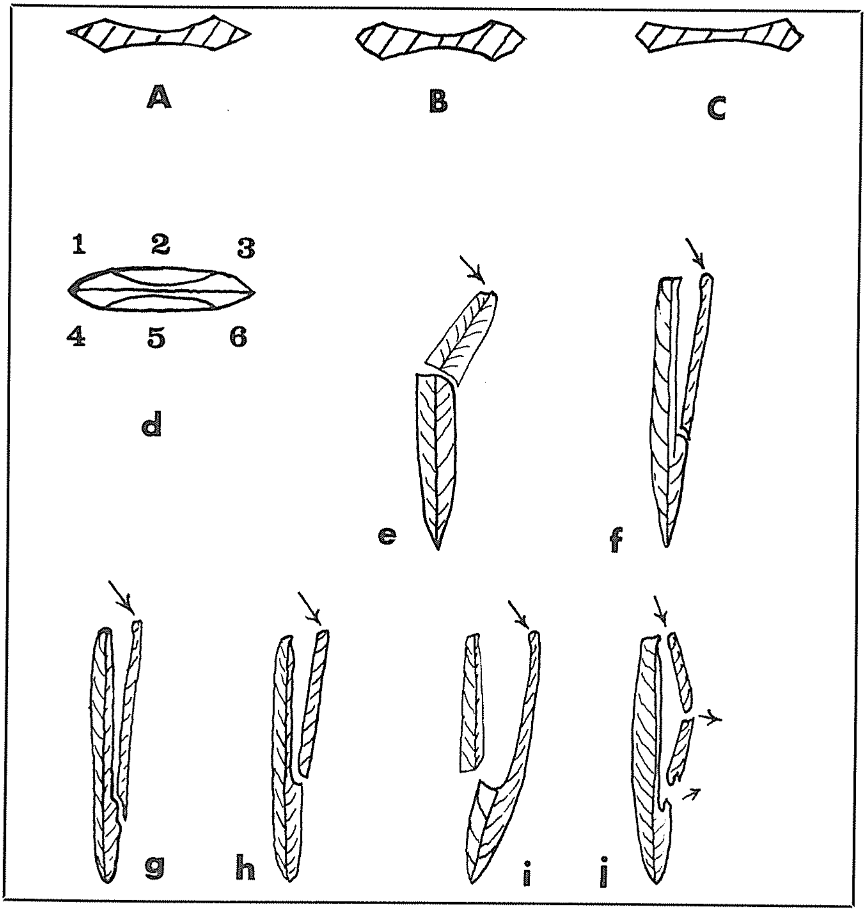

FIGURE 1. *Folsom point cross sections A, B, C styles — described in the text.* Profiles E-J, illustrating break pattern types. Snap breaks are E and F; roll-out fractures are H and I; G is a step fracture; the common hinged fracture is J.

Bradley (personal communication) notes that aboriginal Folsom specimens have channel scars that are virtually free of undulations and compression rings. He suggests that percussion fluting may be the explanation for this. My fluting experiments on Folsom have been almost exclusively by lever-pressure flaking using heat treated Edwards Plateau cherts. Some examples, on identical material, have unblemished channel scars and some are badly undulated or rippled. I attribute these "blemishes" to a lack of "fracture harmony" (Sollberger ms.) and not to pressure or percussion flaking methods.

Regarding preform distal end preparation for fluting, Crabtree (1966) notes that the tip should be beveled to free the end of the flute flake. Judge (1970) believes that the aboriginal flint-knappers had the flutes terminating well short of the distal end, following which the preform was then worked down to the shortest channel scar. My experiments do not follow either of the above fabricating trajectories. I grind the distal tip once for both flutes. Some flute flakes break in removal and some do not. This observation brings up the questions: what percentage of artifact points have tip forming flakes entering the channel scar; and, what percentage of artifact flutes were broken by the Folsom flint-knappers?

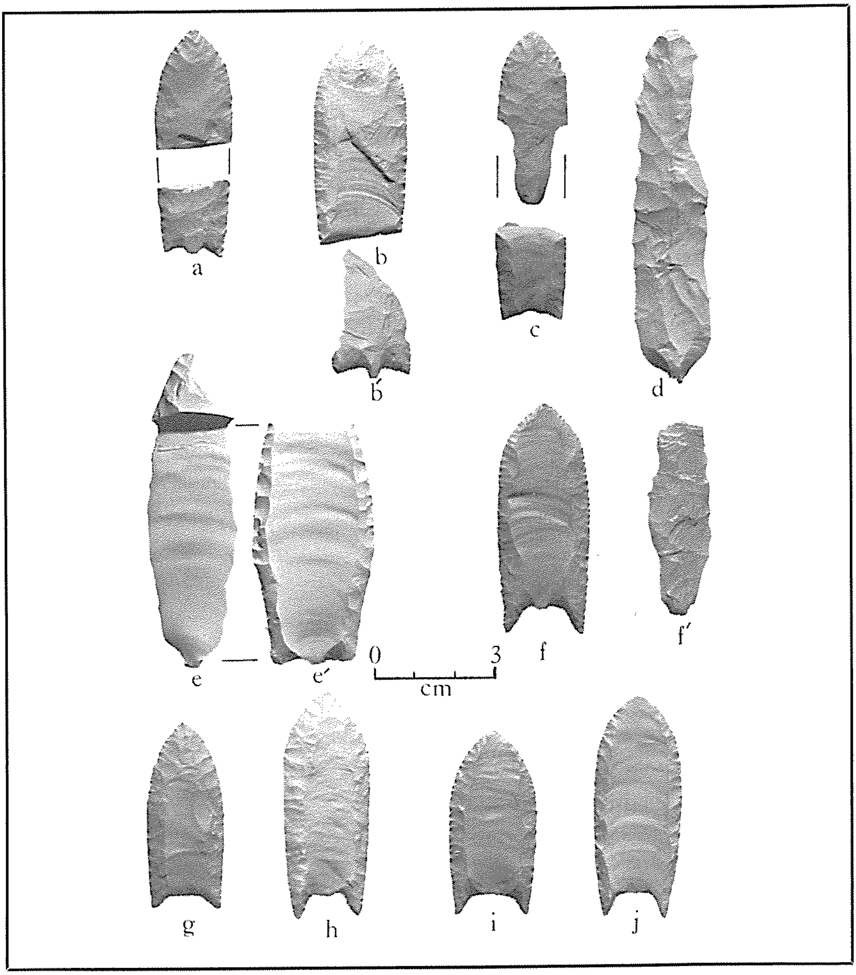

FIGURE 2. *Replications of fluted points and break patterns.*

Crabtree (1966) found that lateral edge clamping and tip support was either necessary or at least a great aid in fluting the preform. My experiments indicate that where both flutes extend from the base to the tip and where each flute flake cross-section is approximately one-sixth of the preform mass (Fig. 1D), lateral edge clamping plus tip support is mandatory to eliminate fracture failures like that illustrated in Figure 2, A, B, C and E. When the lateral edge clamping failed to eliminate bending of the preform or the flute flake was too thick (Fig. 2E), either "end snipping" moved upward from the distal end to the mid-region of the preform (Fig. 2C), or a snap break would occur (Fig. 2A, B). Flute flakes less than full length (Fig. 2G, H) and of a cross section less than about one-sixth of the total point volume, preclude the necessity for lateral edge clamping and tip support (Fig. 2G). However, such fluted points sometimes lack Folsom attributes.

Experiments indicate that most aboriginal Folsom points were fluted on very precisely contoured preforms (finishing flakes sometimes do enter the channel scar). Any prominent facial flake scar ridges (Fig. 2D right edge) causes the flute scar to undulate, thicken, (Fig. 2F) and widen at the ridge points. Low spots on a preform face allow the fracture plane to rise. This, however, is a useful technique for terminating a flute flake short of a distal tip (Fig. 2I). That is, both faces are thinned abruptly just above tip grinding. The preform must then be clamped in a position vertical to the anvil to prevent tip fractures under fluting force loads.

Fracture failures (breakage) in fluting need to be better understood. A classic but common one is the "roll-out" (Fig. 1I and Fig. 2C) which is commonly misclassified as being a "hinged fracture" (Fig. 1J). Roll-out fractures may be either "reverse face" or "front face" (Fig. 1H), and are caused by diminshed downward flaking force. They roll to the front or rear, according to the strength ratio between the flake volume and the mass.

True hinge fractures (Fig. 1J) represent total loss of downward flaking compression advance. This loss is caused by flute flake snapping, platform crushing, percussor bounce, and or mass deflection. True hinge fractures terminate on front, or dorsal, surfaces, not on the reverse faces.

Other unrelated fluting problems that are being confused are "step fractures" (Fig. 1G), and "snap fractures" (Fig. 1E, F). Step fractures are continuations of the original crack tip of fracture advance wherein the fracture plane thins a flute flake by virtue of stepping up (Fig. 1G) prior to termination.

Snap fractures (Fig. 1F; improperly called a step) are not continuations of the original fracture path but are new fractures initiating on the previously formed ventral face. The original fracture plane terminates in the mass (Fig. 1F). The other type of snap fracture (Fig. 1E) is a "tension snap" (bending) that occurs when a ring crack and normal fracture is not properly formed at the striking platform. This is sometimes accompanied with the formation of a rudimentary flute flake attached (Fig. 1B), or not attached (Fig. 2A) to the proximal end. All snap fractures start in tension (as opposed to between tension and compression) by forming two essentially 90° edges (Fig. 1E-F). In termination, snap fractures form one sharp concave edge and one rolled edge.

The horizontal troughs across the channel scars and thickening waves across the flute flake ventral face (Fig. 2F) result from volume changes in the nascent flute flake that alter the velocity of a fracture advance. That is, "sharp-fronted" compression advance is being intermittently altered (see prominent ridge points on Fig. 2D) to a variable front type of advance. Ripples or fine compression rings form on the ventral faces of flakes when sharp fronted compression advance cannot reform to create mirror smooth fracture surfaces.

"Lipping" alone does not indicate that artifacts were fluted by percussion or pressure or by hard or soft hammers. Lipping is essentially absent when the ring crack splits isolated flaking platforms (Fig. 2D-E). Lipping is prominent when the ring crack occurs away from the impact point of the hammer or pressure tool (Fig. 2D).

The specimen shown in Figure 2G was fluted short of the preform length by hand-held pressure, using no tip support, edge grinding, or clamping device. Both flutes are materially less in volume than one-sixth the body cross-section. The preform was random flaked with type A lineal edge retouch. The specimens illustrated in Figure 2H-J, were done by lever pressure with tip support, edge grinding, and using a clamping device. Each point is progressively thinner with longer flute flakes. The replica shown in Figure 2J had knife-sharp edges formed by the flute flakes at both the proximal and distal ends. Following the flute flake removal, lateral edges were retouched to form a Style C Folsom lateral edge character. This retouch does not extend into the channel scar and is not, visibly at least, attributable to post-fluting activities. The ridge has been rounded off, and it is not as sharp as type A and B channel ridges.

In conclusion, it must be said that none of the breakage patterns reported in this paper are exclusive to fluting industries, but are common to all bifacing and thinning processes.

References Cited

Crabtree, Don E.
1966 A Stoneworkers Approach to Analyzing and Replicating The Lindenmeier Folsom. *Tebiwa* Vol. 9, No. 1, pp. 3-39.
Judge, James W.
1970 Systems Analysis and the Folsom-Midland Question. *Southwestern Journal of Anthropology*, Vol. 26, No. 1, pp. 40-51.
Sollberger, J. B.
ms. On the Conversion of Hertzian Cones into Flakes and Blades. Manuscript submitted to *Tebiwa*.

A LITHIC REDUCTION SEQUENCE: A TEST CASE IN THE NORTH FORK RESERVOIR AREA, WILLIAMSON COUNTY, TEXAS

PATIENCE E. PATTERSON

ABSTRACT

A refined model of a lithic reduction sequence designed as a classificatory method for an in-the-field indicator of site function is described. The model was constructed using artifacts from Site 41 WM 88 located along the North Fork of the San Gabriel River in Williamson County, Texas. Further applications of this reduction model or sequence in the central Texas region are discussed.

INTRODUCTION

In past years there have been publications dealing with analyses of stages of lithic artifact manufacture (Holmes 1890; Sharrock 1966; Muto 1971; Skinner 1971, and Collins 1975, to name a few). These various lithic reduction sequences or models offer a suitable framework to study what Collins (1975: 15) refers to as "the adaptive role of lithic technology in the broader cultural context." In short, then, this resulted in the present study, which consists of a synthesis and application of a sequence derived from the models of Sharrock (1966), Muto (1971) and Collins (1975). These were utilized and refined for the analysis of materials recovered as a result of the intensive archeological survey in the North Fork Reservoir area, Williamson County, Texas, in the summer of 1976. A classificatory method was needed as an in-field indicator of site function. To this end, in this report, the application of this refined model as both an analytical and a heuristic device is used to aid the archeologist in making in-field judgments regarding a site's function.

Location and Environment of the Study Area

An archeological survey of portions of the North Fork of the San Gabriel River area in Williamson County, Texas (Fig. 1), was conducted by the Anthropology Research Laboratory, Texas A&M University, under terms of an agreement with the National Park Service Interagency Archeological Service, Denver. The survey took place during May and June, 1976.

The study area lies on both sides of the North Fork of the San Gabriel River, bounded on the west by the "Fourth Crossing", which is 2.9 miles downstream east-southeast of U.S. Highway 183. The eastern boundary lies approximately 2 miles west-northwest of Georgetown, Texas. The north and south boundaries of the reconnaissance area are defined by the 850-foot contour level in the proposed reservoir area, or the U. S. Army Corps of Engineers boundary lines of the reservoir property. The study covers an area of approximately 3,200 surface acres.

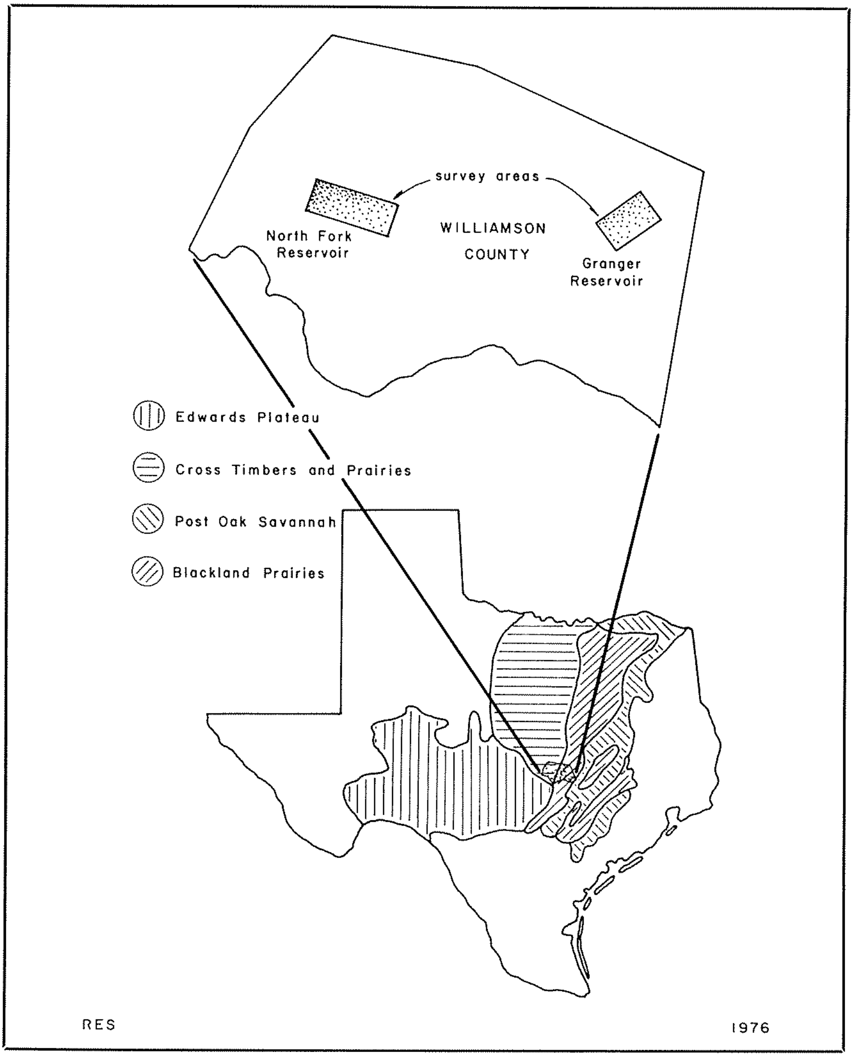

FIGURE 1. *Locations of North Fork and Granger reservoirs including the regional vegetation zones.*

The reconnaissance area is just west of the Balcones Escarpment, which divides the Comanche Plateau from the Coastal Plain (Fenneman 1931: 50-58). Local relief is well pronounced along valley walls ranging from steep slopes to vertical cliffs. The streambed is at an approximate elevation of 700 feet above mean sea level, while the elevations on the rim of the valley rise from 750 feet to 900 feet above mean sea level. The upper reaches of the reservoir exhibit a fairly broad floodplain; closer to the centerline of the dam the relief is somewhat more pronounced with steeper valley walls and less area of floodplain.

The soils are dark colored calcareous clays or sandy loams over a limestone base, with many exposed areas of limestone (Sellards, Adkins and Plummer 1932: 344, 346; and Godfrey, McKee and Oakes 1973). Much of the region is characterized by stoney soils where the bedrock has weathered and the remaining durable quartz and flint have mixed with the soil matrix.

The survey area is included within the Balconian biotic province as defined by Blair (1950: 112-115). The area represents an ecotone of three vegetational zones: Cross Timbers and Prairies, the Edwards Plateau, and the Blackland Prairie (Fig. 1A). Thus the vegetation is a mosaic of taxa, many of them common to all three zones (Bryant and Dering n.d.). There are three generalized regional variations which can be identified. These regional variations are the Upland, Lowland and Riparian. The Upland region is characterized by an understory of predominantly native grasses, brushy plants and immature junipers and oak. The overstory is predominantly juniper and oak. The Lowland region has a thick growth of mesic vegetation. The overstory contains thick growths of trees and shrubs and cleared areas contain tall grasses with occasional trees. The understory includes much the same flora as the Uplands region. The Riparian region is distinctive and usually is confined to the banks of the drainages of permanent waterways. Large trees such as sycamores, cedar, elm, and black walnut are abundant. The understory includes grasses, composites and numerous herbaceous taxa in the shaded areas (Bryant and Dering 1976). There are 57 species of animals known to the area; for a discussion of the fauna see Blair (1950: 113-115).

Previous Investigations

The reconnaissance area is in central Texas, which is an arbitrary geographical unit employed in the archeological study of the prehistory of Texas (Suhm 1960: 63-107).

Prior to the 1976 field reconnaissance of the North Fork area there have been sporadic archeological investigations of a testing and survey nature. The first field reconnaissance was conducted in 1963 by the Texas Archeological Salvage Project (TASP), under the direction of Harry J. Shafer and James E. Corbin; it was a preliminary survey of the areas to be affected by the proposed North Fork Reservoir (Shafer and Corbin 1965). In 1967, the TASP began excavations at two sites, the John Ischy Site (41 WM 49) and the Barker Site (41 WM 71). This was a direct result of recommendations by Shafer's and Corbin's work in 1963. Although published much later (Sorrow 1973), in 1968 further test excavations were undertaken by TASP at eight sites within the North Fork Reservoir area by W. M. Sorrow: 41 WM 33, WM 34, WM 56, WM 57, WM 73, WM 87, WM 88, and WM 115. Sorrow's Ischy Site report was published in 1969 and the Barker Site report in 1970. In 1970 Sorrow carried out further examination of the area for TASP. Additional sites were identified during this latest survey period with some testing being conducted. In 1974, Marsha F. Jackson, representing TAS (changed from TASP to Texas Archeological Survey in 1973), reexamined and assessed some of the previous documented sites and conducted a reconnaissance of some areas which were previously inaccessible (Jackson 1974).

Chronological Constructs

Chronological constructs for central Texas have long been in existence and have undergone constant modification through the years (see Weir 1976 for an exhaustive historical perspective; Prewitt 1976; and Prewitt, in press). Weir (1976: 9-10) points out two important events: (1) J. Charles Kelly's (1947a, 1947b, 1959) attempt to group central Texas archeological materials (primarily projectile points) into units according to the Midwestern Taxonomic System (McKern 1939), which brought about the term *Edwards Plateau Aspect*, and (2) the publication of *An Introductory Handbook of Texas Archeology*, by Suhm, Kreiger and Jelks (1954) in which various interpretations of Texas archeology were brought together in a single volume. In the Handbook, projectile points and ceramics of the state were classified into a spectrum of types, most of which are still in use today as the primary "fossil indicators" or index markers of cultural components (Weir 1976: 10). *The Handbook of Texas Archeology: Type Descriptions* (Suhm and Jelks 1962), revised from 1954, is undoubtedly the most widely used source for temporal placement of artifacts; however, more current evidence has been found and further modification of the chronology of central Texas has taken place. Briefly considered later in this report, and illustrated in Table 1, is the latest chronological construct for the central Texas region (adapted from Weir 1976; Prewitt 1976; and Prewitt, in press). In 1962, Johnson, Suhm and Tunnell distinguished Early, Middle, Late, and Transitional Archaic Periods within Kelly's Edwards Plateau Aspect. This formulation too was based primarily on projectile point variations. In 1967 Johnson presented a construct which again utilized projectile points as time markers. Sorrow, Shafer, and Ross (1967) developed a temporal scheme based on projectile points which was expressed in terms of local and occupational phases. Weir (1976: 13-14) concludes that the periods constructed so far have been considered ends in themselves and have not explained the prehistoric cultural events. Accordingly, Weir (1976) offers a redefinition and division of the Archaic in his *The Central Texas Archaic*. Weir's five phase designations of the Archaic, along with the "Circleville" phase added by Prewitt (in press) make up the chronological construct (Table 1) used here for the North Fork Reservoir and surrounding areas. Weir follows the terminology of Willey and Phillips (1958: 22) in regarding a phase as:

> . . . an archeological unit possessing traits sufficiently characteristic to distinguish it from all other units, similarly conceived, whether of the same or other cultures or civilizations, spatially limited to the order of magnitude of a locality or region chronologically limited to a relatively brief interval of time.

Weir's phases of the Archaic correspond to intervals of stability and change. His (Weir 1976: 5) construct of the central Texas Archaic is seen through, ". . . a simplistic model of cultural change — dissemination to coalescence to proliferation." Weir (1976: 5-7) utilizes Maruyama's (1963: 164-179) ideas of cybernetics or systems research and Birdsell's (1968: 229-240) equilibrium systems to investigate and explain the interrelated subsystems that regulated stability and change during the Archaic.

As yet no manifestations of Prewitt's Circleville phase have been discovered in the North Fork area, but they occur in the nearby Granger Lake Reservoir area (see Fig. 1A; Prewitt 1974: 135-147). No terrace sites in the North Fork area have been extensively excavated; thus the absence of cultural remains relating to the Circleville phase may be apparent rather than real.

Given the surficial nature of the surveys and the cursory subsurface investigations at some sites within the North Fork area, good primary context for the diagnostic projectile points is often

TABLE 1. CHRONOLOGICAL CONSTRUCT OF NORTH FORK AREA AND ACCOMPANYING ARTIFACT NUMBERS

Years B.P.	Phase	Index Markers	Sites 41 WM: 33	34	49	51	52	53	54	56	57	59	71	73	82	87	88	115	206	208	260	261	262	330	360
	Post-Archaic																								
150-650	Toyah Focus																								
		Perdiz	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-
		Cliffton	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-
650-1250	Austin Focus	Scallorn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-
	Archaic																								
1250-1750	Twin Sisters																								
		Darl	-	-	-	-	-	2	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
		Frio	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
		Fairland	-	-	-	-	1	-	-	3	2	-	2	-	-	-	3	-	-	-	-	-	-	-	-
		Ensor	2	-	-	1	2	-	-	3	2	-	2	-	-	-	1	-	-	-	1	-	-	-	-
1750-2600	San Marcos																								
		Marshall	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-
		Montell	-	-	4	-	-	-	-	-	2	1	-	1	-	-	1	2	-	-	-	-	-	-	-
		Marcos	1	-	-	-	-	-	-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
		Castroville	2	1	53	-	1	-	-	-	6	-	-	1	-	-	15	1	-	-	-	-	-	1	1
		Williams	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2600-4000	Round Rock																								
		Pedernales	-	-	79	1	-	-	-	-	14	-	-	5	5	-	8	1	-	-	-	1	1	-	-
		Marshall	-	-	26	-	-	-	-	-	9	-	-	-	-	-	9	-	-	-	-	-	-	-	-
		Bulverde	-	-	20	-	-	-	-	-	8	-	-	1	1	-	7	3	-	-	-	-	-	1	-
4000-5000	Clear Fork																								
		Bulverde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Nolan	-	-	6	-	-	-	1	-	3	-	-	-	-	-	1	-	-	-	-	-	-	-	-
		Travis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Wells	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Tortugas	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5000-7000	San Geronimo																								
		Angostura	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Gower	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Uvalde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Martindale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
		Bell	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Tortugas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7000-8000	Circleville																								
		Angostura	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Meserve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Golandrina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Scottsbluff	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Adapted from Weir 1976, Prewitt 1976, and Prewitt, in press.

lacking. Table 1 illustrates artifact provenience and frequency of occurrence according to the dated phase designations and their associated index markers or projectile point types. Sites 41 WM 49, WM 57, and WM 88 are burned rock middens with the majority of their apparent cultural associations (e.g., index markers, other artifacts and debris) in the Round Rock and San Marcos phases, and some associations with the later Twin Sisters phase. The majority of the sites noted in Table 1 are classed within these same phases. However, at least one site, the Barker Site (41 WM 71), is known to have later cultural associations of types of arrow points of the *Cliffton* and *Perdiz* varieties and ceramics (see Sorrow 1970). Weir (1976: 139) summarizes the Archaic by stating,

> In the three part model for the *Central Texas Archaic* — dissemination/coalescence/proliferation — I visualize groups of people widely dispersed over central Texas at the beginning of the Archaic, coalescing into a cultural continuum (the *Round Rock Phase*), followed by proliferation of different cultural groups over most of Texas and especially the area of the Edwards Plateau.

The clustering of index markers on the Round Rock and San Marcos phases would seem to substantiate Weir's overall projection of his model of dissemination/coalescence/proliferation (1976: 139; see also his discussion of Birdsell's equilibrium systems and Maruyama's cybernetics, 1976: 5-7). This idea of a coalescence into a cultural continuum must be a qualified and tentative conclusion because of the nature of the sampling of sites in the North Fork area.

METHODOLOGY

As far back as 1890, lithic technology has been conceived of as a stage or step-like production process. W. H. Holmes (1890) used the term "blank" to refer to the first stage or form from which final products are derived. Bryan (1939, 1950) took exception to Holmes' work in many respects. However, Bryan (1939: 37) comes to the conclusion in his analysis of the lithics near Cerro Pedernal, in New Mexico, that, "the forms having the aspect of greatest antiquity are merely stages in the fabrication of some modern types."

In the logical progression of events regarding the manufacture of lithic tools it is first necessary for man to have a knowledge of his environment and what his utilization of that environment entails. He must have prior knowledge of making and using stone tools and must be familiar with what qualities particular kinds of stone have which would suit his purposes (Spier 1970: 3 and Clark 1952: 173). He must be knowledgeable as to the location and the method of acquisition of the available lithic resources. The selection of the proper core or nodule of stone (flint) also requires that the artisan have an idea of his end result. This "mental template", according to Deetz (1967: 43-49) dictates the form of artifacts. Through each stage of an artifact's production this culturally dictated idea is foremost in the artificer's mind (see Kroeber 1963: 103). Variations from the ideal are acceptable and recognized to some extent (Deetz 1967: 45). Since, as Deetz points out, lithic technology is a subtractive process in which the reduction of a mass results in an artifact, variations have a higher probability of occurring and being acceptable than variations in an additive process such as pottery making. A potter when making a mistake need only redo or adjust his malleable clay to fit his mental image of the final product. Thus, as a mechanical or technical failure the lithic reject becomes a part of the archeological context as viewed by the archeologist, whereas the corrected mistake on a ceramic vessel is obliterated. The failures can become "fossilized" stages along the continuum of lithic production, and if viewed and analyzed along with other materials from the proper perspective can permit meaningful inference regarding cultural processes.

A variety of cultural variables can come into play which will dictate the outcome of the lithic process. The needs and desires, skills and knowledge of the artisan are some of the variables which through any particular culture direct the process utilized and the ultimate archeological context of the lithic artifact. Ultimately, the archeologist is dependent upon the results of behavior, as we deal only with the objectifications of culture (Taylor 1973: 111).

Before discussing the lithic reduction sequence it would do well to point out that two different kinds of types are distinguished and utilized in the classification of artifacts in archeology (Rouse 1960: 313-323). Rouse refers to "descriptive" types and "historical" types. Julian Steward (1954) would designate those types as "morphological" and "historical-index". Both Rouse's and Steward's terms, descriptive and morphological, refer to types that are based on form, physical or external properties. The second type is the historical or historical-index; these are formed in order to establish differences in time and space (see Rouse 1960: 318; and Steward 1954: 54). There may be some overlapping of the two kinds of types, but they may be distinct because the modes comprising each will have been chosen with significance relative to special problems. This distinction applies specifically to lithic typologies utilized in central Texas archeology and the materials that have been dealt with in the North Fork area in particular. In establishing a chronology for central Texas, historical types have been created and utilized (see Suhm, Krieger and Jelks 1954; Johnson, Suhm and Tunnell 1962; Sorrow, Shafer, and Ross 1967; Weir 1976; Prewitt 1976; and Prewitt, in press). The descriptive or morphological types are used also (see Prewitt 1974: 82-108; Sorrow 1973: 83-104; Sorrow 1969: 26-43 and Jackson 1974: 18-43). Describing and temporally localizing the material results of behavior does not, however, tell us anything of the broader cultural context. In order to ascertain these contexts the archeologist has three sets of attributes on which to base studies: (1) spatial relationships, (2) quantity, and (3) chemico-physical specifications (Taylor 1973: 143). The affinities existing between the cultural remains and the environment are paramount in making inferences regarding cultural processes. A functional conception of type would also serve to bring processual inferences to fruition (Steward 1954: 55-57).

In discussing the lithic reduction sequence utilized as a processual typological tool, five stages or artifact groups are recognized (Fig. 2): (1) core biface or flake; (2) thick biface (blank) or trimmed flake; (3) thinned biface (blank); (4) thinned biface with form (preform); and (5) final product. The production of lithic utensils should, however, be viewed as a continuum. As Collins (1975: 16) points out, the stages or steps along the continuum are not sharply delineated from one another but are distinct enough to merit separation, thereby identifying certain manufacturing processes. Within this system there are certain optional steps such as trimming, shaping, rejuvenation, or even utilization as an option at any given point on the continuum. In reaching each of the five stages on the continuum it is necessary to utilize a mode of reduction. Each stage is generally the precursor to the next stage in the reduction sequence. Manufacturing processes required to reach the stages in the lithic sequence are trimming, shaping, and thinning.

As previously mentioned, one important aspect of the production of lithic utensils is the human error factor, miscalculation, or what is termed "technological failure". Many lithic specimens which have been assigned to type categories and elevated to the status of finished implements, are no more than early stages in the manufacturing process of other "typed" implements as Muto (1971: 1) has pointed out. Some collections when inspected will show a remarkable number of artifacts whose typological categories

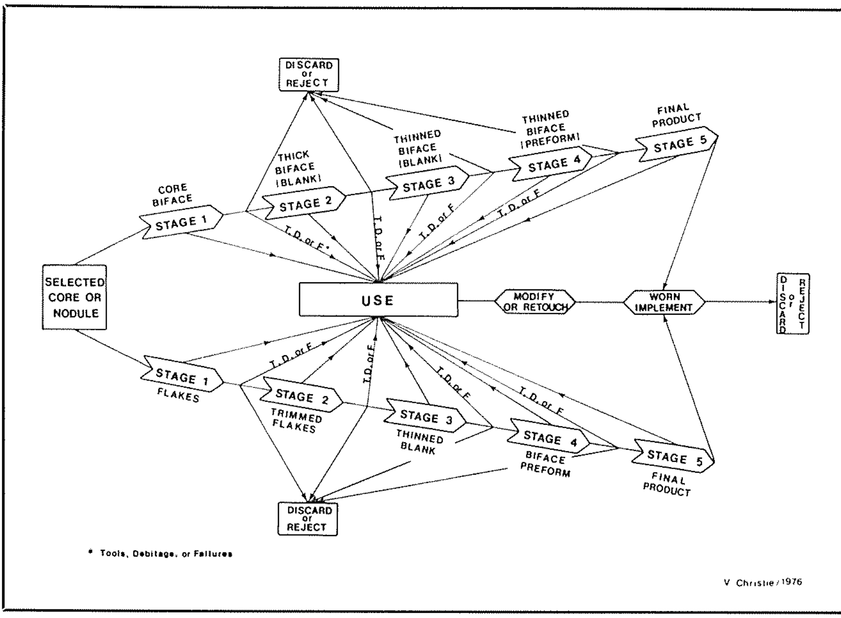

FIGURE 2. *Lithic model or reduction sequence.*

should include "technological failures" within the early stages of production (Prewitt 1974; Shafer and Corbin 1965; Sorrow 1969; and J. W. Edwards Collection and Notes, Texas Archeological Research Laboratory (TARL), n.d.). Within the options available to the artisan the "failure" may be utilized as is, modified and recycled, or discarded, then it becomes part of the unused lithic debitage which remains as a part of the archeological context.

The Artifacts

The archeological study of the North Fork area and the central Texas region is accomplished partly by investigating and explaining the artifactual remains. Stone endures where organic materials such as bone, shell and vegetal matter are claimed by the usually high alkalic soils and humid environment of central Texas in general and the North Fork area specifically. The sites are afforded little or no protection against the elements. For these reasons, lithic artifacts are practically the only source of evidence we have with which to observe the prehistoric era of North Fork. However, man being a very adaptive creature will exploit all available resources for his subsistence and comfort. Assuming that perishable items were an integral part of the technology, we can make only predictive statements concerning the possible use of artifacts of a perishable nature. Bone and shell often times remain but these occurrences are minute relative to the lithic assemblage.

The lithic reduction model or sequence, described previously, was applied to a collection from a test excavation carried out at site 41 WM 88 (in 1968), a burned rock midden located on the south side of the North Fork, approximately 3 miles upstream east of the dam centerline. The sequence or model was first applied to the existing collection to test the feasibility.

Only a small portion of the actual lithic material was intensively used in this report. Those items utilized were the bifacial artifacts relevant to testing the model and those implements determined to have been taken out of the continuum of reduction through the option of utilization. The largest proportion (93%) of the total collection was comprised of the manufacturing debris and debitage. These were originally divided into primary, secondary, and interior flakes. As one might suspect, the primary flakes were smallest in percentage (2%), with the secondary flakes at 12%, and the interior flakes forming 86% of the total number of flakes. The presence of lithic debitage and the stages of lithic production suggest that the inhabitants of the site were manufacturing lithic utensils. The low percentage of primary flakes quoted above are meaningful in light of the nature of the flint found in the area, i.e., more nodular or tabular flint is found than cobble flint. Tabular and nodular flint have less occurrence of cortex than does cobble flint (Harry J. Shafer personal communication). Thus, the total continuum of lithic reduction could be taking place at the site, even with low percentages of cortex or primary flakes.

Tools. These artifacts are the utilized objects resulting from reduction. In the case of the large unifacial tools the first stage was reached and either the flake or the core was removed from further reduction by the maker's choice to utilize it as it was. Further retouch or other specific strategies such as a steep bevel were possibly performed in order to reach the desired utensil. It is also possible that no further work was performed at all but the artifact was simply utilized as it was. As seen in Figure 2, the strategy or linear progression is diverted from the reduction process directly into the optional "use" category. Also in this category are those tools which were products of the reduction, that is, smaller flakes or debitage which were used to perform scraping or cutting functions (Figs. 3 and 4). The 16 tools considered to be removed from the lithic reduction continuum at the first or second stage have the following characteristics: (1) pronounced bulbs of percussion, (2) compression rings of various magnitude, (3) cortex on the dorsal surface or platform area, (4) signs of use and some retouch on at least one edge or surface (Figs. 3 and 4). One artifact (Fig. 4b) is a primary flake with cortex on the dorsal surface and steep beveling along the lower and lateral edges of the artifact. In the illustrations, the artifacts are oriented with the direction of force from the bottom of the figures and the bulb of percussion, where it is discernable, at the base of the photographs. The palm-sized unifacial tool illustrated in Fig. 4b has a thickness of 2.2 centimeters and is 7.0 centimeters in width. The artifact shown in Figure 4a is a fist-sized piece of tabular flint with remains of cortex on both the dorsal and ventral surfaces. Flakes have been knocked off bifacially, one side is beveled and shows wear along the edge. The flake scars on the tool are bi-directional, some traces of negative bulb scars are seen on the ventral surface of the artifact (Fig. 4a).

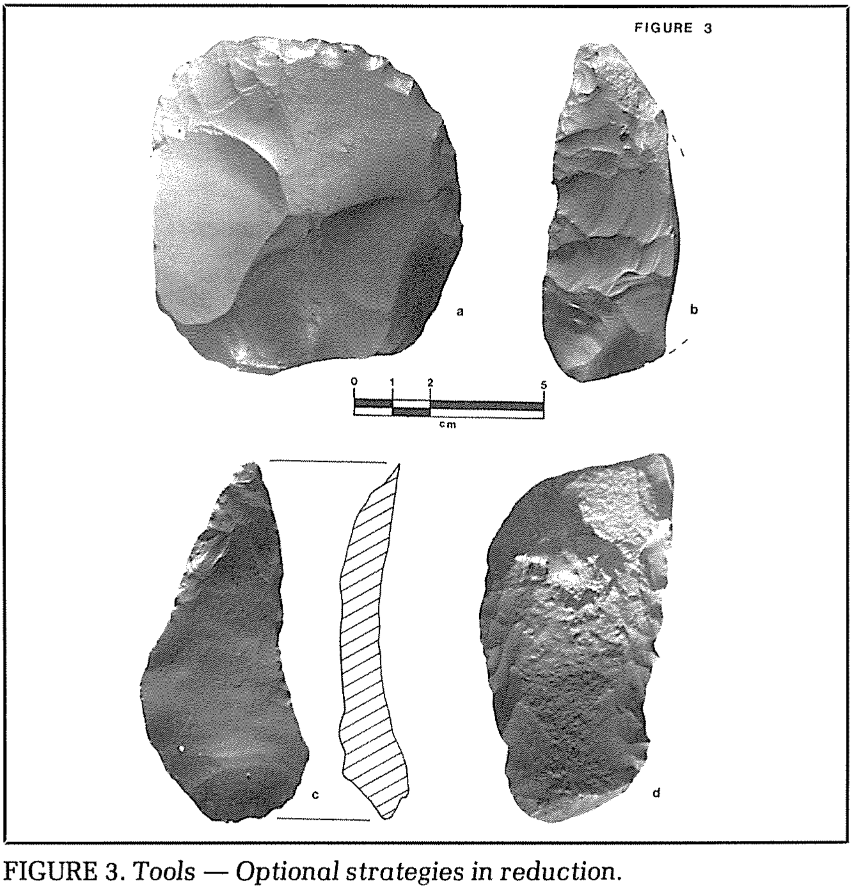

FIGURE 3. *Tools — Optional strategies in reduction.*

Many of these tools have prominent bulbs of percussion which indicate the use of a hard hammer with a direct freehand percussion method (Crabtree 1972: 11-12).

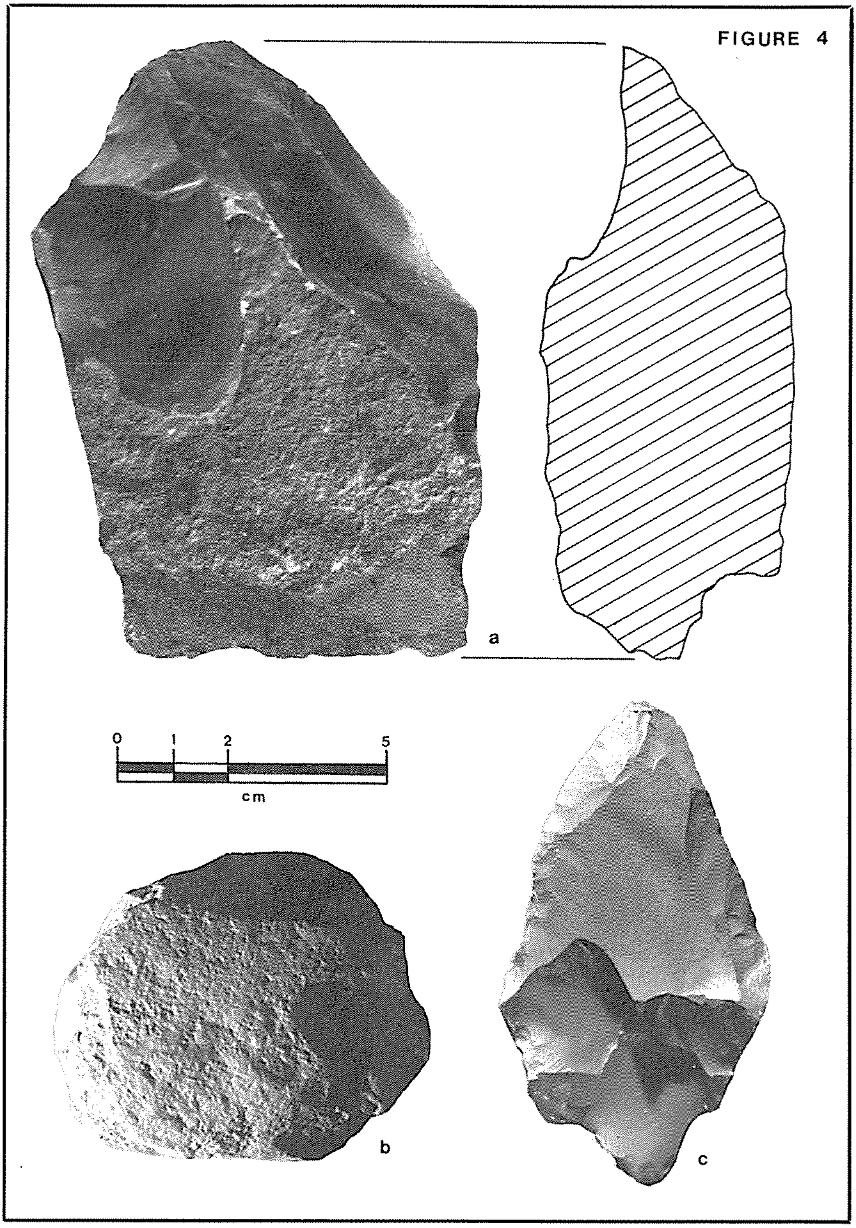

FIGURE 4. *Tools — Optional strategies in reduction.*

Unifacial tools comprise, for the most part, the major category of tools with the exception of the Stage 5 artifacts or final products which are dart points. There is a wide variety of shape and size (Fig. 5). Most are irregularly shaped unifacial tools with some possibly functioning as cutting-scraping tools. Although generally unifacial, slight use is seen on opposing faces of some tools. Other utensils exhibiting steeper bits (Fig. 6) appear to have a stepped series of tiny chip scars extending over the dorsal surfaces of the tools. Wilmsen (1968: 159) suggests that these manifestations are the result of heavy pressured drawing of the implement (in the fashion of an adze or plane) over a tough unyielding surface such as wood or bone. Another use inferred by Wilmsen (1970: 70) is tool back blunting. In Figure 6a the steeply beveled lateral edge (83° edge angle) on the dorsal surface of the tool opposes the ventral surface working edge (62° edge angle). It is possible that the steeper beveled edge was utilized as a heavy duty tool as well as a back blunted edge for the opposing working edge. Through Wilmsen's (1970: 71) inferences this tool (Fig. 6a) could have been utilized in wood working, bone working, heavy cutting or shredding and tool back blunting. Semenov (1964: 83-142) and Wilmsen (1968 and 1970) assign functional connotations to wear patterns and edge angles exhibited on tools. If this is the case the functions of the majority of the tools at 41 WM 88 could be assigned to skinning and hide scraping, sinew and plant-fiber shredding, heavy cutting (bone, wood, or horn) and tool back blunting. The more acute edges of tools (edge angles of 26° to 35°, according to Wilmsen (1970: 70-71) and Semenov (1964: 20), infer cutting operations. However, an important consideration in this is the availability of the lithic resource. If the resource base is minimal or some distance away tools are more likely to get maximum use and retouch. Conservative strategies of recycling, retouch and modification are utilized to get the most out of the lithic utensil. Definite usage and wear patterns, such as polish and/or striations, will be readily apparent throughout an assemblage. Should the resource base be abundant and easily obtainable less conservative strategies of use and retouch could be employed. Thus the tool assemblage recovered might show wear and/or usage, but only to a slight degree, wherein function could only be postulated within broad limits and not definitively stated. The strategy of maximum use of the lithic resource and minimal retouch or modification of utensils seems to apply in the North Fork area. Frison (1968: 149-155) suggested that there was a maximization of tool use to a high degree in his Piney Creek, Wyoming material. Data on the availability of lithic resources was not discussed, making comparisons with the North Fork material difficult.

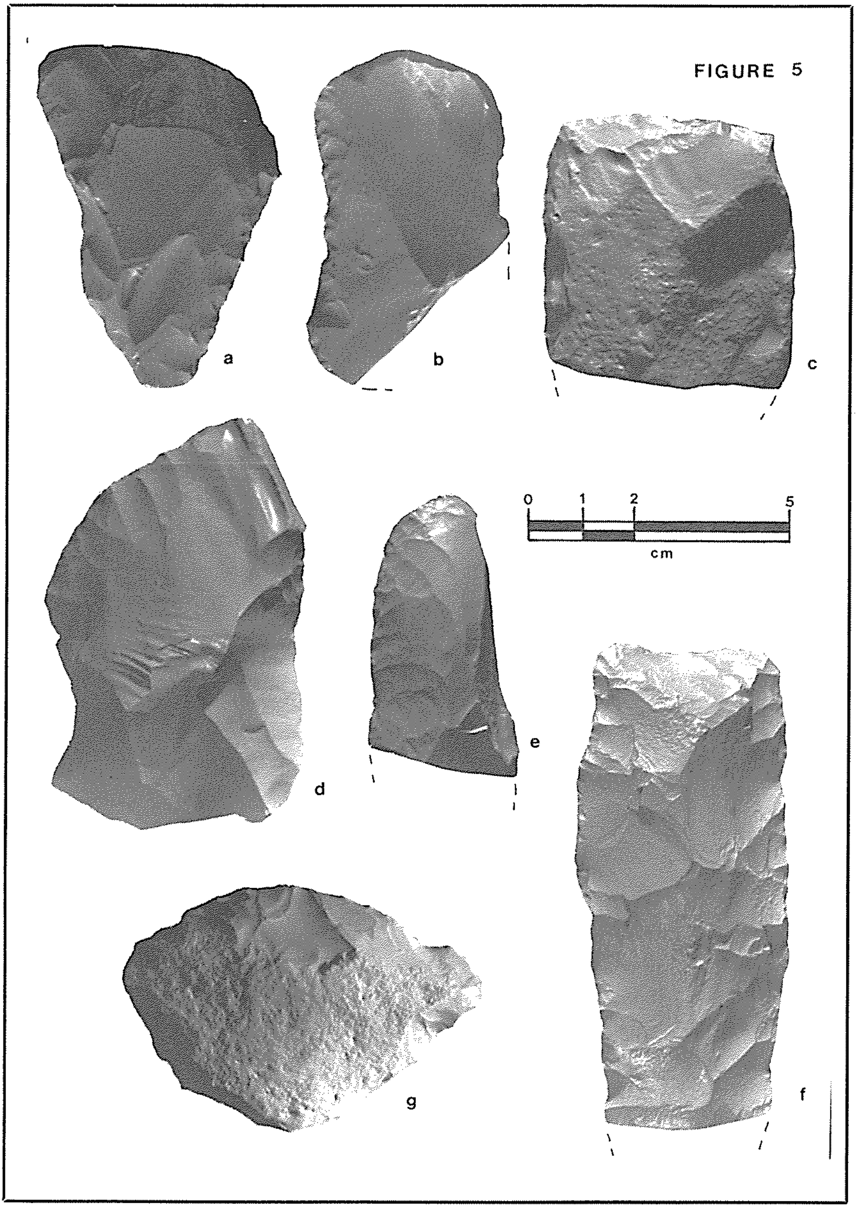

FIGURE 5. *Unifacial tools from 41 WM 88.*

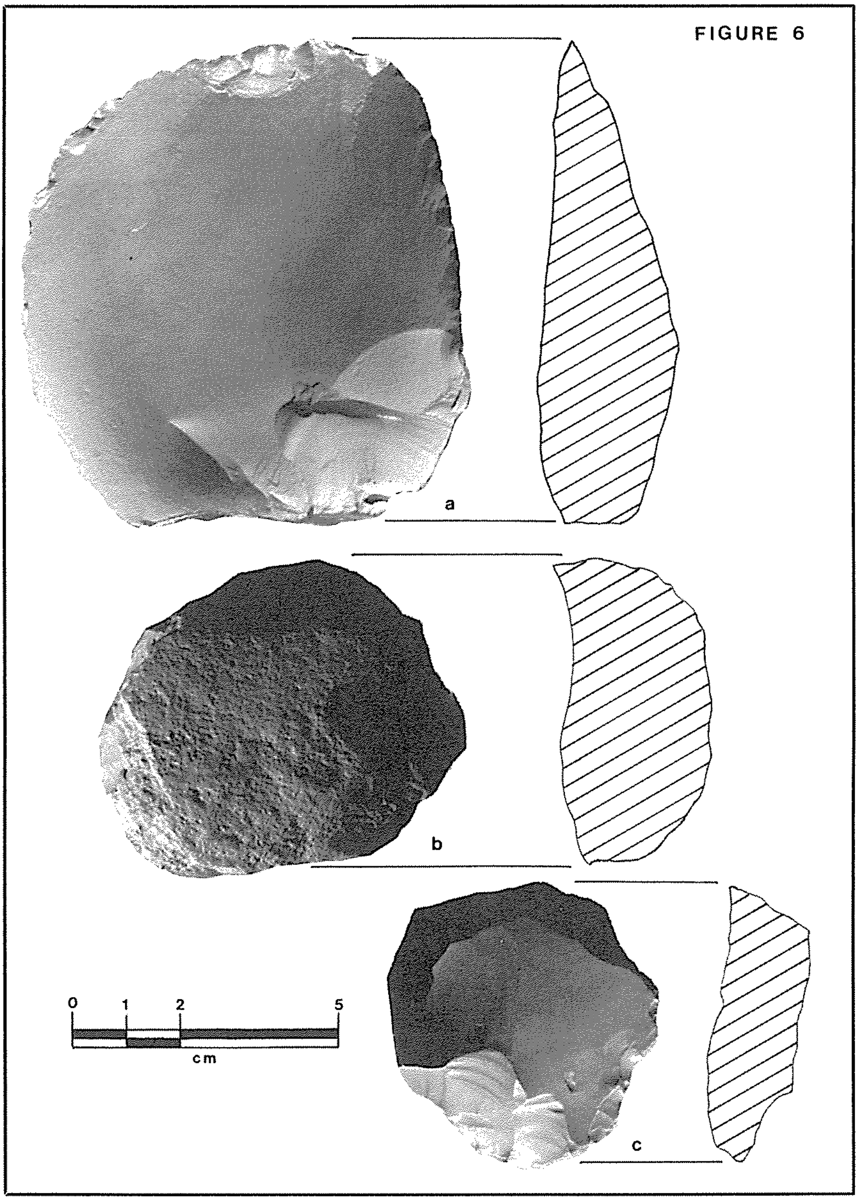

FIGURE 6. *Steep beveled tools from 41 WM 88.*

The Sequence

The lithic reduction sequence is made up of 5 stages. As mentioned before, each successive stage is reached by a reductive process of trimming, shaping, and thinning.

Ancillary to reaching Stage 1 of the sequence there must be an acquisition of raw materials. The raw materials are lithic substances (flint) having the qualities of "elasticity, homogeneity; are cryptocrystalline, isotropic and highly siliceous" (Crabtree 1972: 4-5). The lithic materials ideally have no planes of weakness, no inclusions that would impair conchoidal fracturing, the same properties in all directions in the substances and are able to return to their former state after being depressed by application of force (Crabtree 1972: 33-71; Sememov 1964: 33).

Just as the artisan has a preconceived notion of what qualities the raw materials must have, he also has a mental template of what he will make from his chosen piece of flint. Then his first step in reaching our idea of Stage 1 is to select a suitable core or nodule of flint. The reductive processes by which Stage 1 is reached are removal of the cortex and the initial reduction of the mass. The artisan then has certain options open to him. He can reject further manipulation and utilize the artifact as it is, he can discard it completely, or he can continue to pursue the eidetic imagery of a final product by further reducing the mass through successive stages until it is acceptable. Inherent in this process is the possibility of failure due to technical error or some flaw in the material which cannot be overcome. These failures, when identified, may occur within any of the stages of the sequence. They should not be considered a type or category of their own, but should be classed within the stage for which they can be identified.

Stage 1 — Core biface or flake (Fig. 7). This primary stage is usually represented by a large flake or core biface. In the sample from 41 WM 88 the artifacts measured for length had an average of 8.31 centimeters, average width of 5.76 centimeters, and an average thickness of 1.94 centimeters. In some instances these may still retain evidence of cortex, but are usually bifacially reduced. Evidence of flaking on at least one face is a criterion. Intentional form is not necessarily introduced at this stage. In order to reach Stage 1 the reduction process is one of a preliminary nature. The lithic debris resulting from this reductive process can be discarded, utilized in its present state, or if the flakes are of sufficient size they can be saved to be further reduced to a more finalized product (e.g., dart point, arrow point, or thin knife).

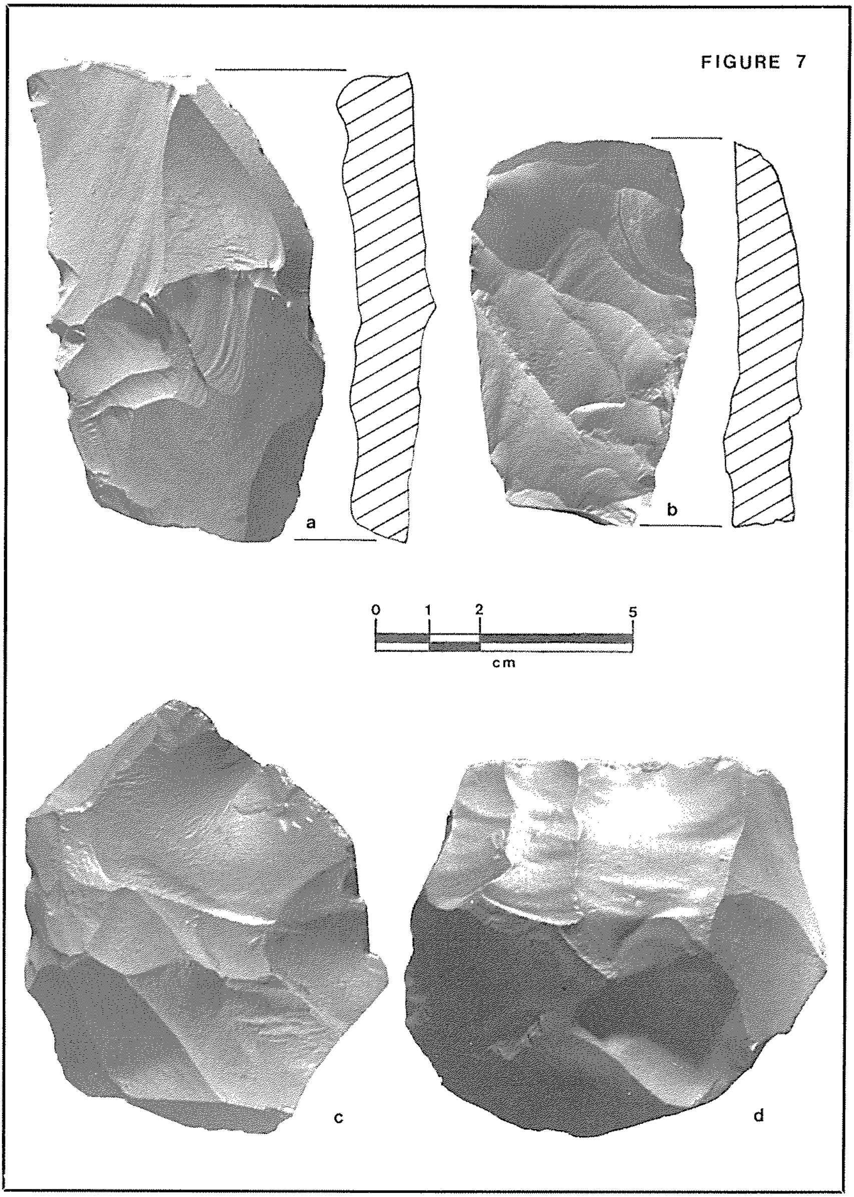

FIGURE 7. *Stage 1 — Lithic reduction sequence.*

Stage 2 — Thick biface or trimmed flake (blank) (Fig. 8). This stage shows bifacial working of the stone to reduce the mass, usually in thickness. The sample from 41 WM 88 has average measurements of length, 6.82 cm; width, 4.43 cm; and thickness, 1.69 cm. Very often at this point the artifact has a very rough subtriangular or lanceolate form and is still thick, relative to the finished produce. The continuation of the reductive process toward this stage will leave a residue of lithic debitage. This debitage can, through the options open to the artisan, be utilized as is or it can be discarded and left as an immediate part of the archeological context. The debitage can contain the manufacturing errors, i.e., those rejects which are failures due to technical error on the part of the artificer or some imperfection in the stone which could not be overcome. Many times it appears that rather than taking time to work out a useful strategy for overcoming some flaw or error, it is more expedient (depending on the availability of resources) to start again with another piece of stone. The rejects can be identified through their characteristic thickness (overall, or in one area which could not be reduced) and fracture lines.

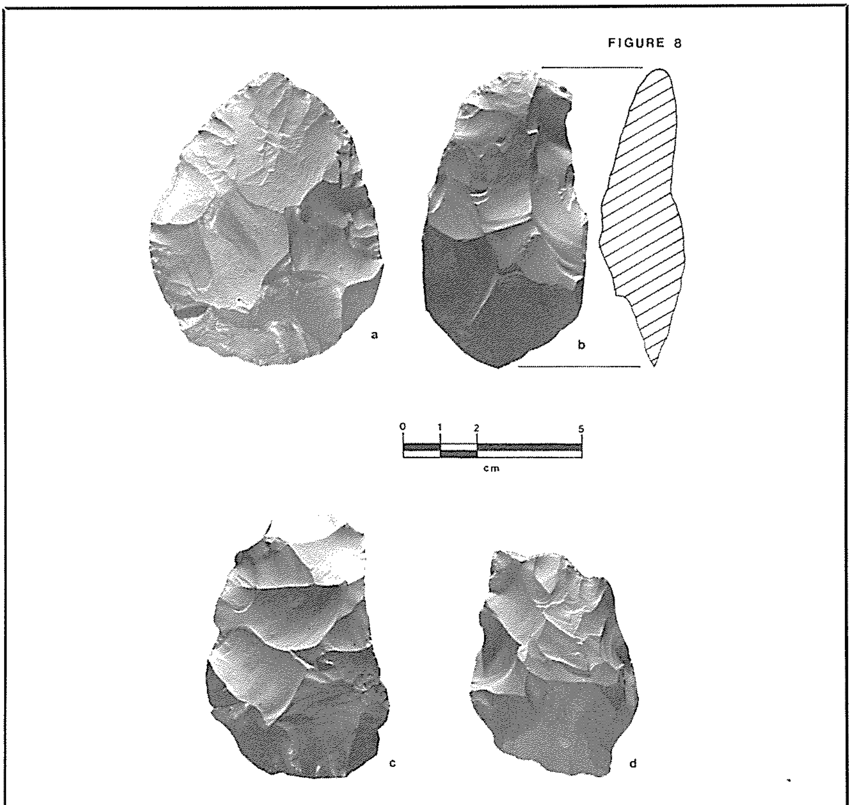

FIGURE 8. *Stage 2 — Lithic reduction sequence.*

Stage 3 — Thinned biface (blank) (Fig. 9). These are usually thinned bifaces with some intentional form evident. The artifacts in this stage are generally thinner pieces having been reduced more in thickness than in overall size. The artifacts assigned to Stage 3 from the sample of 41 WM 88 have an average length of 9.3 cm, average width of 5.16 cm, and an average thickness of 1.3 cm. Once again, options are open to the artisan to discard what he will and/or keep and utilize the debitage. Through the next stages utilization of the debitage would be kept to only light cutting and scraping operations most likely. This is because as reduction proceeds the flakes become thinner and flatter; this would cause less tensile strength in the flake. This reduction process is an ideal, when the thinning flake hinges, runs too deep, or the artifact breaks due to end shock, technological failures occur.

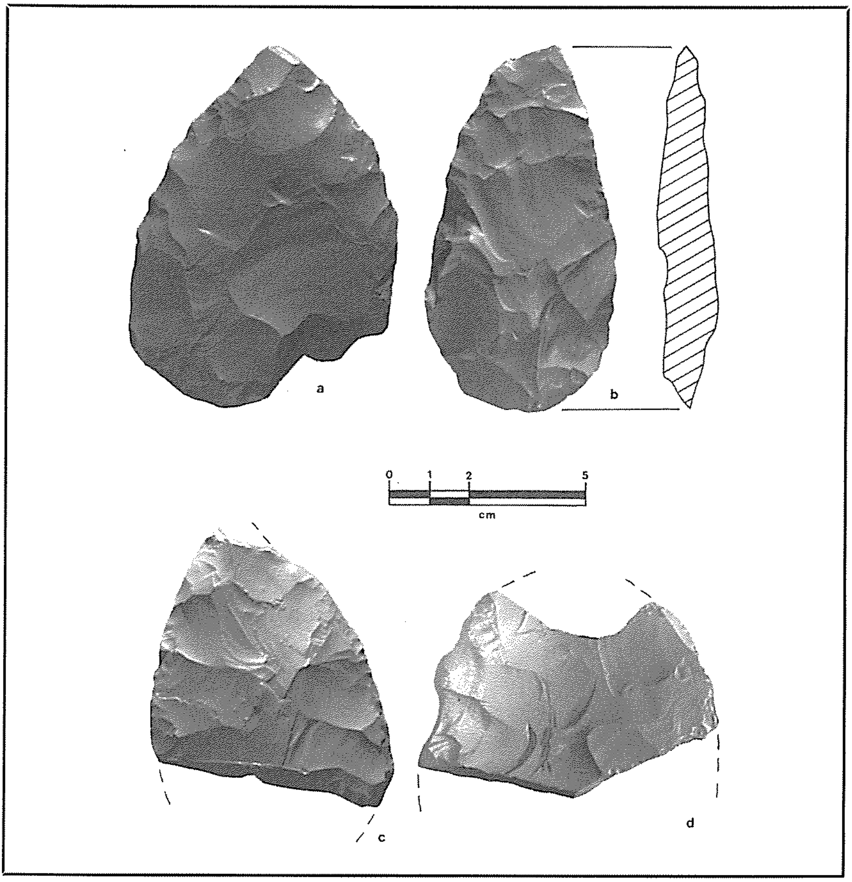

FIGURE 9. *Stage 3 — Lithic reduction sequence*

Stage 4 — Thinned biface with form (preform) (Fig. 10). In this stage the artifacts, for the most part, have been thinned and a triangular or lanceolate form is very clear. From the artifacts measured, it was found that the average length was 7.13 cm; average width was 3.74 cm; and the average thickness was 0.97 cm. In the sample being utilized in this paper (41 WM 88) those artifacts assigned to Stage 4 are all rejects due to technical error or natural imperfection. There is also the possibility of breakage during the time the artifact is a part of the archeological context. Here again, immediate utilization, rejection, or recycling are options that are open to the artisan.

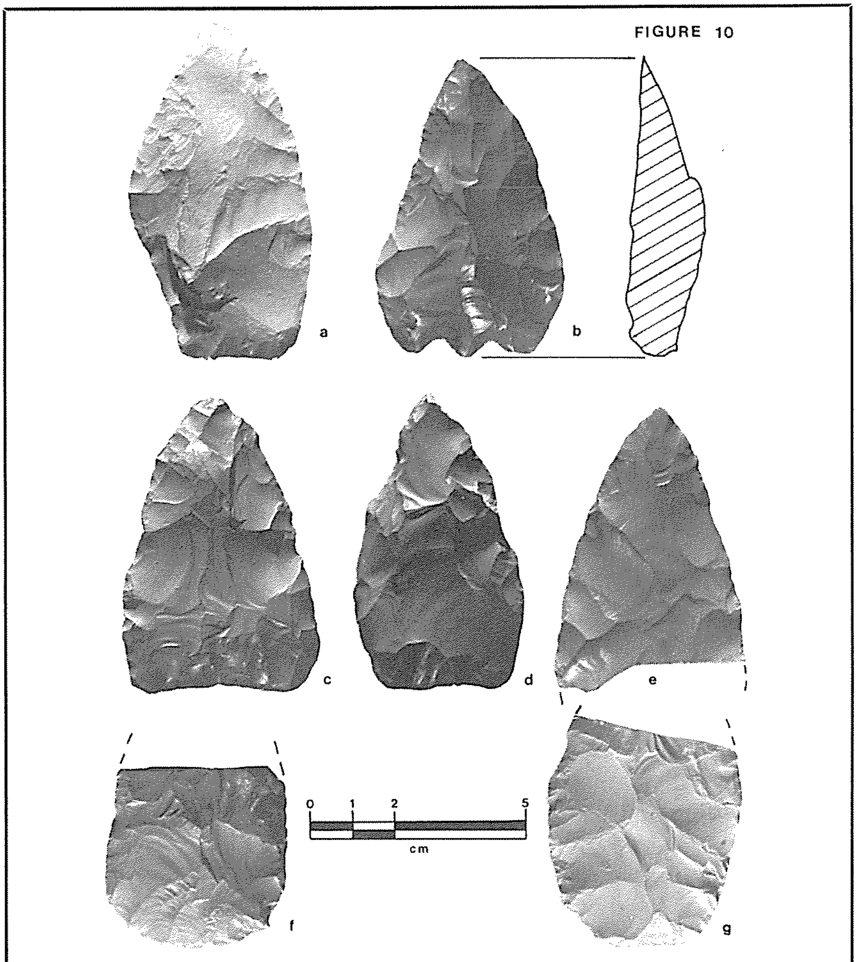

FIGURE 10. *Stage 4 — Lithic reduction sequence.*

Stage 5 — Final product (Fig. 11). In the last stage of the lithic reduction sequence the artifact takes its form usually as a dart point, or arrow point, in the case of our sample from 41 WM 88. In the temporal context of this sample these are the forms the archeologist expects to see, since hunting and gathering are the major subsistence patterns given for the archeological universe in question. In this stage it is sometimes difficult to assess whether the final product was broken during the last stages of manufacture or whether indeed they were finished products being utilized and were discarded due to impact fracture. If recovered by the artisan or owner, he could discard it, modify the artifact and recycle it, or simply sharpen it and use it again for the same purpose if possible. Within this last stage there are product forms typologically organized according to Suhm and Jelks (1962). The average measurements of length, width, and thickness include all the types identified and unidentified. Average length was 5.57 cm; width, 3.0 cm; thickness, 0.77 cm. There are many fragments of Stage 5 artifacts in the sample which were discernable as final products because they consisted of the bases of specific projectile points typical to particular types. However, no measurements were taken and they were not counted as types. Possibilities of breakage other than impact fractures are: (1) thermal fracturing; (2) end shock or the stone exceeding its elastic limits during production or use; and (3) breakage after the artifact has been lost or discarded.

As there are optional strategies along the continuum to maximize the use of the lithic resource there are those strategies which tend to conserve the resource during production. Due to the flint (the artifact) lacking enough mass to withstand the stress, certain strategies, or progressions of reduction are employed to keep the final product intact. It is possible that there are particular reduction strategies for specific projectile point types. Evidence of this for *Pedernales* points is particularly interesting. Specific strategies for *Pedernales* points occur in the fourth and fifth stages of production. According to Harry J. Shafer (personal communication) this process involves first reducing and shaping the base before other final trimming and thinning processes continue. This is accomplished so that end shock or amputation does not occur when thinning the base. This stress needs a greater mass in the blade to withstand the force. First, flute-like thinning flakes are removed from the base, then lateral flakes are removed from the base. Finally, the blade portion of the point is thinned by removing flakes from the edges. This reduction strategy occurs on many *Pedernales* points in the J. W. Edwards Collection (TARL). The process of this strategy is illustrated by both the technological failures as well as the flake scars on final products.

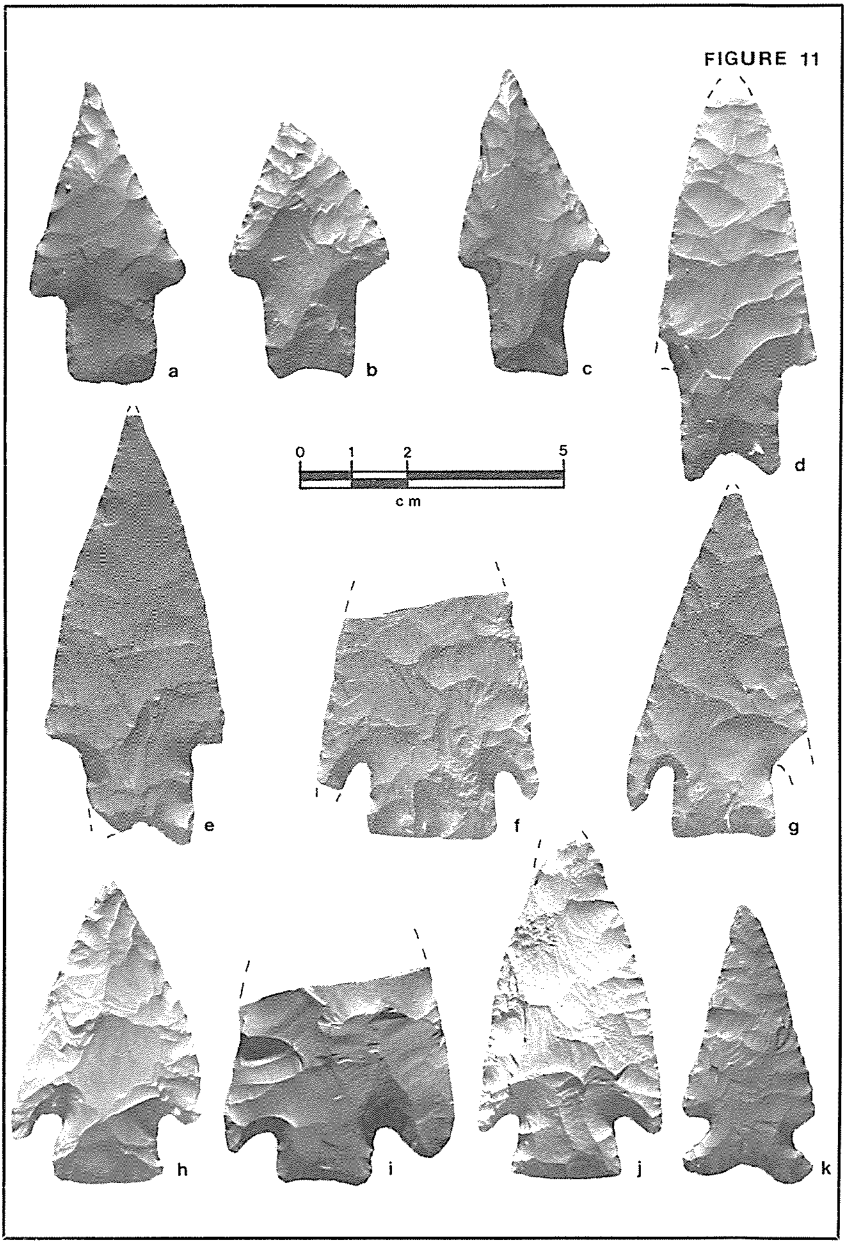

FIGURE 11. *Stage 5 — Lithic reduction sequence.*

SUMMARY AND CONCLUSIONS

The major thrust of this report has been the application of a lithic reduction sequence as an analytical tool in the analysis of a collection of lithic materials from site 41 WM 88 in the North Fork Reservoir area, Williamson County, Texas. The sequence is a synthesis of models utilized by Sharrock (1966), Muto (1971), and Collins (1975) and has been refined to assist archeologists in making judgments in the field regarding site function.

With the exception of a very few artifacts, the collection from 41 WM 88 is made up of materials available in the immediate vicinity. The lithic resource base was in such abundance as to negate any sort of conservative strategies in utilization. Short term tool use is apparent: wear traits such as polish, scratches, and crushing are minimal. The unfinished artifacts throughout the lithic reduction sequence, and the amount of debitage, support the assumption that stone working was carried on at 41 WM 88. The preponderance of projectile points — intact artifacts, fragmented specimens, and some reworked points — indicates that hunting was routine. With this comes the assumption that meat and hide processing were being carried on at the site. Following the criteria set forward by Semenov (1964: 20, 83-142) and Wilmsen (1970: 70-71), the edge angles on many of the implements from 41 WM 88 imply functions of this nature. Plant and fiber processing are inferences which also can be posited due to the steep beveled tools present in the collection. The grinding stones recovered suggest that seeds and nuts as well as other edible plants were being processed and consumed.

The range of projectile point types found indicates that the site was inhabited in more than one particular era or time span. The manufacturing of so many bifaces as well as other tools, and their subsequent discarding, reflects the abundant local raw material and seems to imply that the inhabitants were very mobile, utilizing the chosen resources within their geographical range and not carrying artifacts from place to place.

Subsistence strategies of hunters and gatherers according to Lee (1968: 41) generally tend to rely on the most accessible and dependable resource first, then strategies turn to alternative means of subsistence. To illustrate the above, generalizations of hunters and gatherers and their subsistence strategies have been taken from ethnographic situations over the world. Lee (1968: 41) states that,

> The general view offered here is that gathering activities, for plants and shellfish, should be the most productive of food for hunting and gathering man, followed by fishing, where the source is available. The hunting of mammals is the least reliable source of food and should be generally less important than either gathering or fishing.

This importance or priority is a matter of basic subsistence; it is not particularly a social priority. However, Lee (1968: 41) states that there is a desire "to enjoy the rewards, both social and nutritional, afforded by the killing of game."

The dynamics of environment and prehistoric technology in the North Fork area and central Texas in general are such that it is reasonable to assume that 41 WM 88, and other sites in the area, were inhabited on a seasonal basis. However, no studies along these lines have been conducted in the North Fork area specifically. I am not aware of any studies which address themselves to this question for the central Texas region in general.

Acquiring food in a natural environment is a deliberative and rational process (just as the lithic reduction processes), one in which choices and decision making are definitely involved (see Tindale 1972: 217-268; Clark 1952: 7, and Jochim 1976: 4). Eddy (1973) illustrates this in his study of the Laneport Reservoir District which is now known as Granger Reservoir (see Fig. 1A). Locational strategy studies, as utilized by Eddy (1973) could be well adapted and tested in the North Fork area. Sites are known to exist in varied topographic settings of the North Fork area which would lend themselves to this type of investigation. Although microenvironmental zones (Coe and Flannery 1964) may well be present, three major environmental settings are immediately evident: (1) riverine, (2) floodplain, and (3) upland.

How the lithic technology fits in with all these variables can be viewed better by utilizing the lithic reduction sequence coupled with analysis of use and wear on the lithic artifacts with good context. Such studies combined with the use of adaptations of predictive models of hunter-gatherer subsistence and settlement (see Jochim 1976) can greatly enhance our present knowledge of the processes of prehistoric culture change and development.

The viability of the lithic reduction sequence as it has been applied here to a test case in the North Fork area is effective in that it allows the archeologist to work along a continuum that expands from tangible lithic artifacts to the broadest cultural inference. Other information must be integrated with the technological data in order to achieve explanations of the cultural processes of Archaic peoples and how the populations adapted both socially and technologically to their environments. The ultimate results of such studies of the environment on man's development would allow the archeologist to see the consequent effects on the environment due to the presence of man.

The lithic reduction sequence can be a viable research tool for central Texas as a whole. Since lithic tool kits appear to fluctuate in specialization and intensity of use throughout the central Texas Archaic (Weir 1976: 124-140), then examination of the lithic materials (preferably with good primary context) in terms of this sequence could add to and carry further the existing data base for central Texas.

In summary, the lithic reduction sequence utilized as an in-field indicator of site function gives the archeologist a basis on which to direct further investigation. However, this reduction sequence will not stand alone as an analytical device. It must be integrated with other forms of analysis based on all aspects of current archeological method. Analyses of lithic technology (in terms of a continuum of production and strategy) coupled with studies of environmental, spatial, and socio-cultural relationships would lead to broader cultural inferences and interpretations for the whole of Archaic populations.

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REFERENCES CITED

Birdsell, Joseph E.
1968 Some Predictions for the Pleistocene System Among Recent Hunters and Gatherers. In *Man the Hunter*. Richard Lee and Irven Devore, ed., Aldine Publishing Company, Chicago. pp. 229-240.

Blair, Frank W.
1950 The Biotic Provinces of Texas. *The Texas Journal of Science, Vol. 2, pp. 93-117.*

Bryan, Kirk
1939 Stone Cultures Near Cerro Pedernal and Their Geological Antiquity. Bulletin of the Texas Archeological and Paleontological Society, Vol. 11, pp. 9-46.
1950 Flint Quarries — The Sources of Tools and, at the same time, the factories of the American Indian. *Papers of the Peabody Museum of American Archaeology and Ethnology*, Harvard University, Vol. XVII, No. 3.

Bryant, Vaughn M., Jr., and J. Phil Dering
n.d. Preliminary Overview of the Flora of North Fork Reservoir Area. Unpublished manuscript, Texas A&M Anthropology Laboratory, Texas A&M University, College Station.

Clark, J.G.D.
1952 *Prehistoric Europe: The Economic Basis*. Stanford University Press, Stanford.

Coe, Michael D. and Kent V. Flannery
1964 Microenvironments and Mesoamerican Prehistory. *Science*, Vol. 143, No. 3607, pp. 650-654.

Collins, Michael B.
1975 Lithic Technology as a Means of Processual Inference. In *Lithic Technology Making and Using Stone Tools*. E. Swanson, ed., Mouton Publishers, distributed by Aldine, Chicago, pp. 15-34.

Crabtree, Don E.
1972 An Introduction to Flintworking. *Occasional Papers of the Idaho State University Museum*, No. 28, Pocatello.

Deetz, James
1967 *Invitation to Archeology*. The Natural History Press, Garden City.

Eddy, Frank W.
1973 Salvage Archeology in the Laneport Reservoir District Central Texas. Report submitted to the National Park Service by the Texas Archeological Survey, The University of Texas at Austin.

Fenneman, Nevin M.
1931 *Physiography of the western United States*. McGraw-Hill Book Co. Inc., New York.

Frison, George C.
1968 A Functional Analysis of Certain Chipped Stone Tools. *American Antiquity*, Vol. 33, No. 2: 149-155.

Godfrey, C. L., G. S. McKee, and H. Oakes
1973 *General Soil Map of Texas*. Texas Agricultural Experiment Station, Texas A&M University, in cooperation with the Soil Conservation Service, United States Department of Agriculture.

Holmes, W. H.
1890 A Quarry Workshop of the Flaked-Stone Implement Makers in the District of Columbia. *American Anthropologist*, Vol. 3, pp. 1-26.

Jackson, Marsha F.
1974 Archeological Resources of the North Fork Reservoir Area: Results of the Survey and Testing 1970 Season. Report submitted to the National Park Service by the Texas Archeological Survey, The University of Texas at Austin.

Jochim, Michael A.
1976 *Hunter-Gatherer Subsistence and Settlement: A Predictive Model*, Academic Press, New York.

Johnson, Leroy, Jr.
1967 Toward A Statistical Overview of the Archaic Cultures of Central and Southwestern Texas. *Texas Memorial Museum Bulletin*, No. 12, Austin.

Kelly, J. Charles
1947a The Lehmann Rock Shelter: A Stratified Site of the Toyah, Uvalde, and Round Rock Foci. *Bulletin of the Texas Archeological and Paleonthological Society*, Vol. 18: pp. 115-138.
1947b The Cultural Affiliations and Chronological Position of the Clear Fork Focus. *American Antiquity*, Vol. 13: pp. 97-108.
1959 The Desert Cultures and the Balcones Phase: Archaic Manifestations in the Southwest and Texas. *American Antiquity*, Vol. 24: pp. 276-288.

Kroeber, A. L.
1963 *Anthropology: Culture Patterns and Processes*. First Harbinger Books edition. Harcourt, Brace and World, Inc., New York.

Lee, Richard B.
1968 What Do Hunters Do For a Living, or, How to Make Out on Scarce Resources. In *Man the Hunter*. Richard Lee and Irven Devore, Aldine Publishing Company, Chicago. pp. 30-48.

Maruyama, Magoroh
1963 The Second Cybernetics: Deviation-Amplifying Mutual Causal Processes. *American Scientist*, Vol. 51: pp. 164-179.

McKern, W. C.
1939 The Midwestern Taxanomic Method as an Aid to Archaeological Culture Study. *American Antiquity*, Vol. 4: pp. 301-313.

Muto, Guy R.
1971 A Technological Analysis of the Early Stages in the Manufacture of Lithic Artifacts. Unpublished Master's Thesis, Idaho State University, Pocatello.

Prewitt, Elton R.
1974 Archeological Investigations at the Loeve-Fox Site, Williamson County, Texas. *Research Report* No. 49. Texas Archeological Survey, The University of Texas at Austin.
1976 Late Archaic Occupations at the Loeve-Fox Site: The San Marcos and Twin Sisters Phases. In *The Texas Archaic: A Symposium*. T. R. Hester ed., Center for Archaeological Research, The University of Texas at San Antonio, Special Report No. 2.
n.d. The Rogers Spring Site: 1974 Investigations. Manuscript in press.
press *Research Report* No. 54, Texas Archeological Survey, The University of Texas at Austin.

Rouse, Irving
1960 The Classification of Artifacts in Archaeology. *American Antiquity*, Vol. 25: pp. 313-323.

Sellards, E. H., W. S. Adkins, and F. B. Plummer
1932 The Geology of Texas, Vol. I: Stratigraphy. *University of Texas Bulletin, No. 3232.*

Sememov, S. A.
1964 Prehistoric Technology: An Experimental Study of the Oldest Tools and Artefacts from Traces of Manufacture and Wear. M. W. Thompson, trans. Branes and Noble Books, New York.

Shafer, Harry J. and James E. Corbin
1965 An Appraisal of the Archeolocal Resources of the North Fork, South Fork, and Laneport Reservoirs, Williamson County, Texas. Report submitted to the National Park Service by the Texas Archeological Salvage Project.

Sharrock, Floyd W.
1966 Prehistoric Occupation Patterns in Southwest Wyoming and Cultural Relationships with the Great Basin and Plains Culture Area. *University of Utah Anthropological Papers*, No. 77.

Skinner, S. Alan
1971 Prehistoric Settlement of the DeCordova Bend Reservoir, Central Texas. *Bulletin of the Texas Archeological Society*, Vol. 42: pp. 149-270.

Sorrow, W. M.
1969 Archeological Investigations at the John Ischy Site: A Burnt Rock Midden in Williamson County, Texas. *Papers of the Texas Archeological Salvage Project*, No. 18.
1970 Archeological Investigations at the Barker Site. Texas Archeological Salvage Project, *Research Report*, No. 1.
1973 Test Excavations in the North Fork Reservoir Area. Report submitted to the National Park Service by the Texas Archeological Survey, The University of Texas at Austin.

Sorrow, W. M., H. J. Shafer, and R. E. Ross
1967 Excavations at Stillhouse Hollow Reservoir, *Papers of the Texas Archeological Salvage Project*, No. 11.

Spier, R. F. G.
1970 *From the Hand of Man: Primitive and Preindustrial Technologies.* Houghton Mifflin Company, Boston.

Steward, Julian
1954 Types of Types. *American Anthropologist*, Vol. 56: pp. 54-57.

Suhm, Dee Ann
1960 A Review of Central Texas Archeology. *Bulletin of the Texas Archeological Society*, Vol. 29: pp. 63-108.

Suhm, D. A., A. D. Krieger, and E. B. Jelks
1954 An Introductory Handbook of Texas Archeology. *Bulletin of the Texas Archeological Society*, Volume 25.

Suhm D. A. and E. B. Jelks
1962 Handbooks of Texas Archeology: Type Descriptions. *Texas Memorial Museum Bulletin* No. 4, Austin.

Texas Archeological Research Laboratory
n.d. J. W. Edwards Collection and Notes. Unpublished notes on file at the Texas Archeological Research Laboratory, The University of Texas at Austin.

Taylor, Walter W.
1973 *A Study of Archeology*. Arcturus Books Edition, Fourth Printing. Southern Illinois University Press. Carbondale.

Tindale, Norman B.
1972 The Pitjandjara. In *Hunters and Gatherers Today*, M. G. Bicchieri, ed., Holt, Rinehart and Winston, Inc. New York. pp. 217-268.

Weir, Frank A.
1976 The Central Texas Archaic. Unpublished Ph.D. Dissertation, Washington State University, Pullman.

Willey, G. R. and P. Phillips
1958 *Method and Theory in American Archaeology*. The University of Chicago Press, Chicago.

Wilmsen, Edwin N.
1968 Functional Analysis of Flaked Stone Artifacts. *American Antiquity*, Vol. 33, No. 2: pp. 157-161.
1970 Lithic Analysis and Cultural Inference: A Paleo-Indian Case. *Anthropological Papers of the University of Arizona*, No. 16, The University of Arizona Press, Tuscon.

THE GARZA OCCUPATION AT THE LUBBOCK LAKE SITE

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AND ROBERT STUCKENRATH

ABSTRACT

Recent excavations at the Lubbock Lake site (41 LU 1) by the Lubbock Lake Project, The Museum of Texas Tech University, resulted in the recovery of Garza points in association with hearths. Radiocarbon determinations received on the charcoal dated the occupations to the mid-1600's. These were the first reported radiocarbon dates for this distinctive point type. Four excavation areas yielded evidence of repeated Garza occupation in the form of camping areas and a processing station. In one of the excavation areas, previous work conducted by Green (1962) was correlated with that of the excavations of the Lubbock Lake Project. The dates and the association of Apache-like pottery (micaceous blackware) strongly suggested that Garza points were contemporaneous with the Apache occupation of the area and that perhaps the point type represented a local Apache style.

INTRODUCTION

The Lubbock Lake site (41 LU 1) is a stratified archeological locality on the Llano Estacado. Situated in an old meander bend of Yellowhouse Draw, the site is located on the northern outskirts of the city of Lubbock, Lubbock County, Texas. Although the site has long been recognized as a Paleo-Indian locality (Sellards 1952; Black 1974), the deposits record a fairly continuous aboriginal occupation from Clovis to Historic times. A faunal and geological stratigraphy exists concomitantly with this cultural sequence, providing a three dimensional framework for the interpretation of cultural change in the area.

The Lubbock Lake Project is an on-going, interdisciplinary research program of The Museum of Texas Tech University. Although primarily concerned with the delineation of the Paleo-Indian occupations and changes at the site, most of the cultural time periods and geological substrata have been tested by the project. The site has a minimum extent of 110 acres, and owing to its size and the stratified nature of the deposits, many excavation areas were opened. A variety of cultural activity areas existed synchronically and diachronically, attesting to the differential utilization of the site environs by various cultural groups. Within the later deposits at the site, the most extensively explored cultural occupation was that of the Garza period. This cultural designation is based on a distinctive point type, that of a small, triangular-shaped point with a single, centrally placed, basal notch (Runkles 1964: 107). Several sites yielding Garza points and an associated tool assemblage had been excavated in the area (Holden 1938; Wheat 1955; Word 1963; Runkles 1964; Parsons 1967; Lorrain 1968), and surface collections indicated a distribution from the Llano Estacado into southeastern New Mexico (Runkles 1964: 124). No radiocarbon dates were associated with the material from these sites, but the suggested time period of Garza occupation in the area was late prehistoric (Runkles 1964: 123). Radiocarbon determinations received on charcoal from hearths associated with Garza points at the Lubbock Lake site suggest a protohistoric/historic occupation by this cultural group.

OCCUPATIONAL FEATURES

Garza period occupational features were found at four excavation areas at the site, Area 5, 8, 14, and 15 (Fig. 1). These features represent two different kinds of cultural activity, camping areas and processing stations. Camping areas, where people lived for a short period of time, were located in Area 8, 14, and 15. These areas are characterized by the occurrence of hearths, widespread scatter of lithic tools, unfinished items, and debris, and the absence of bone expediency (butchering) tools. One processing station was partially exposed in Area 5. Secondary butchering and marrow extraction took place in these stations, the kill and primary butchering occurring elsewhere. Processing stations are characterized by the presence of butchered remains of several kinds of game animals, a random bone disposal pattern, marked absence of various major skeletal elements, and the occurrence of bone expediency tools. These two kinds of cultural activity areas are also differentiated by their topographic locations. The camping areas were located in the dry, upland sections away from the main watercourse. Processing stations were located in the lowland areas along the marsh/stream complex. The geologic deposits reflect this topographic difference. The Garza camping areas occurred in substratum $5A_1$, an aeolian/fluvial sand and colluvium deposit; while the processing stations occurred in $5C_1$, the lowland clay facies (Stafford 1977).

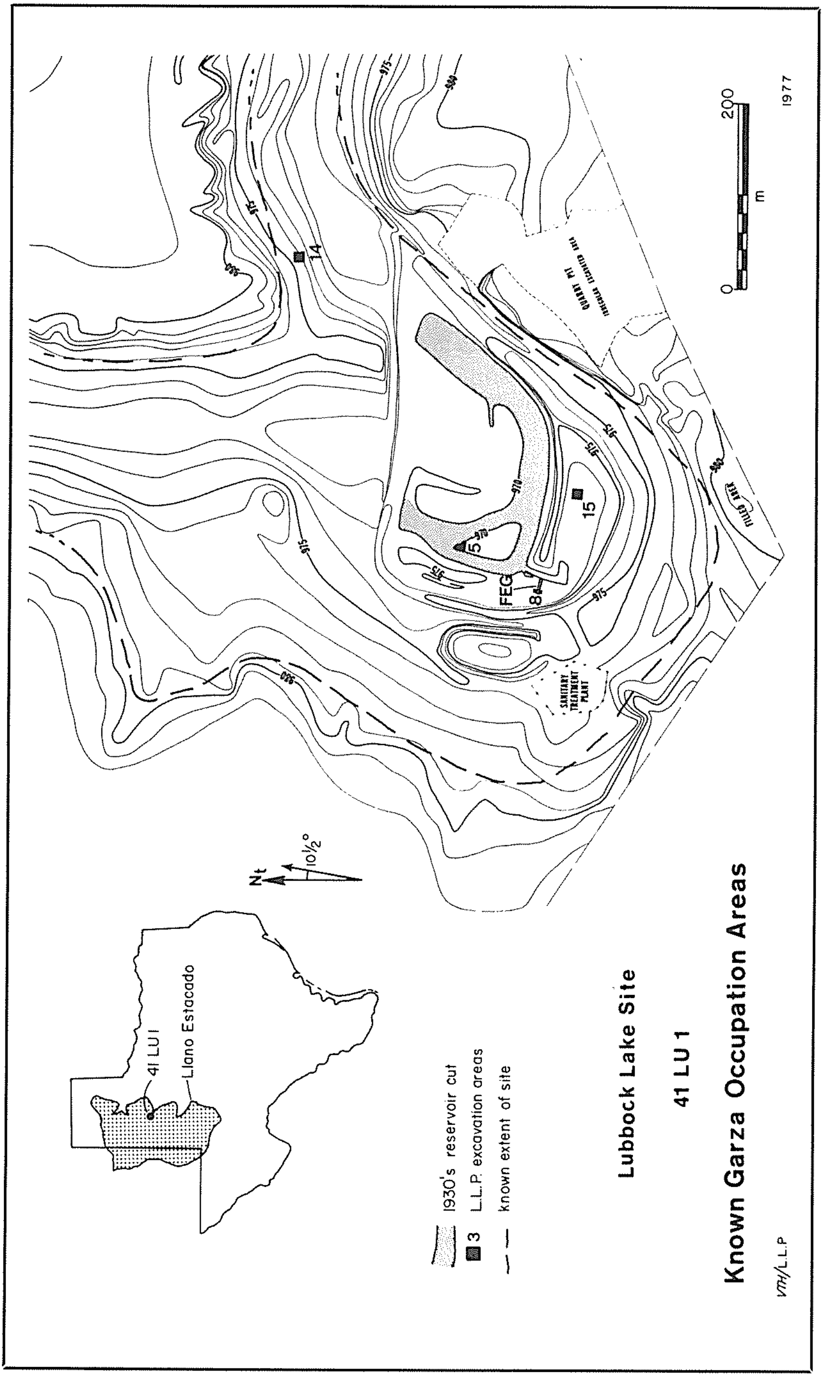

FIGURE 1: *Location of the Lubbock Lake site (41LU1) and Garza period occupations.*

Activity Areas

Area 14-FA14-1 and Area 15-FA15-1

Of the three camping areas located, the two in Area 14 and 15 were found through stratigraphic testing that revealed the presence of hearths. In each of these excavation areas, only the hearth and immediately adjacent occupation surface were excavated, an expeditious technique designed to recover material for radiocarbon dating.

An unlined, basin-shaped hearth, feature FA14-1, was exposed in Area 14. Excavations revealed a lithic scatter beginning 10 cm above the hearth and extending down into it. A unifacially flaked Garza point made of Edwards Plateau chert was recovered *in situ* 10 cm above the hearth. The broken tip exhibits several hinge fractures from impact. A biface corner section of Edwards Plateau chert was recovered and may have been broken in manufacturing since only a few parallel flakes were removed from each side. There is no noticeable wear along the edge of this specimen. Two utilized flakes of Edwards Plateau chert were recovered. One exhibits damage flake scars along both sides, but particularly along the medial edge. The other specimen was broken but retains an edge showing damage flake scars. Seventy-five unmodified flakes were recovered, the most common material being Edwards Plateau chert (59). Other materials used included Tecovas (9) and Alibates (3) cherts, silicified caliche (3), and obsidian (1). Charcoal, submitted to the Radiocarbon Laboratory of the Smithsonian Institution, yielded a date of A.D. 1635 (315 ± 50; SI-2701). The hearth in Area 15 (FA15-1) is more appropriately described as an ash-filled, kettle-shaped pit (Fig. 2). Hearth material, including burned caliche, burned and unburned bone, and charcoal, had been dumped into the pit. One Garza point of Edwards Plateau chert came from the lowest level in the pit. The tip was broken, showing a burin-like break that had occurred on impact. Charcoal from this lowest level yielded a date of A.D. 1665 (285 ± 60; SI-2703).

Area 8-FA8-2, FA8-4

Evidence of repeated, intensive occupation by Garza period peoples came from Area 8, where at least two, and perhaps as many as four, levels of habitation were found. Green (1962) had opened a long trench in this area, dividing it into four excavation units, Block A, B, C, and X. A minimal amount of testing was

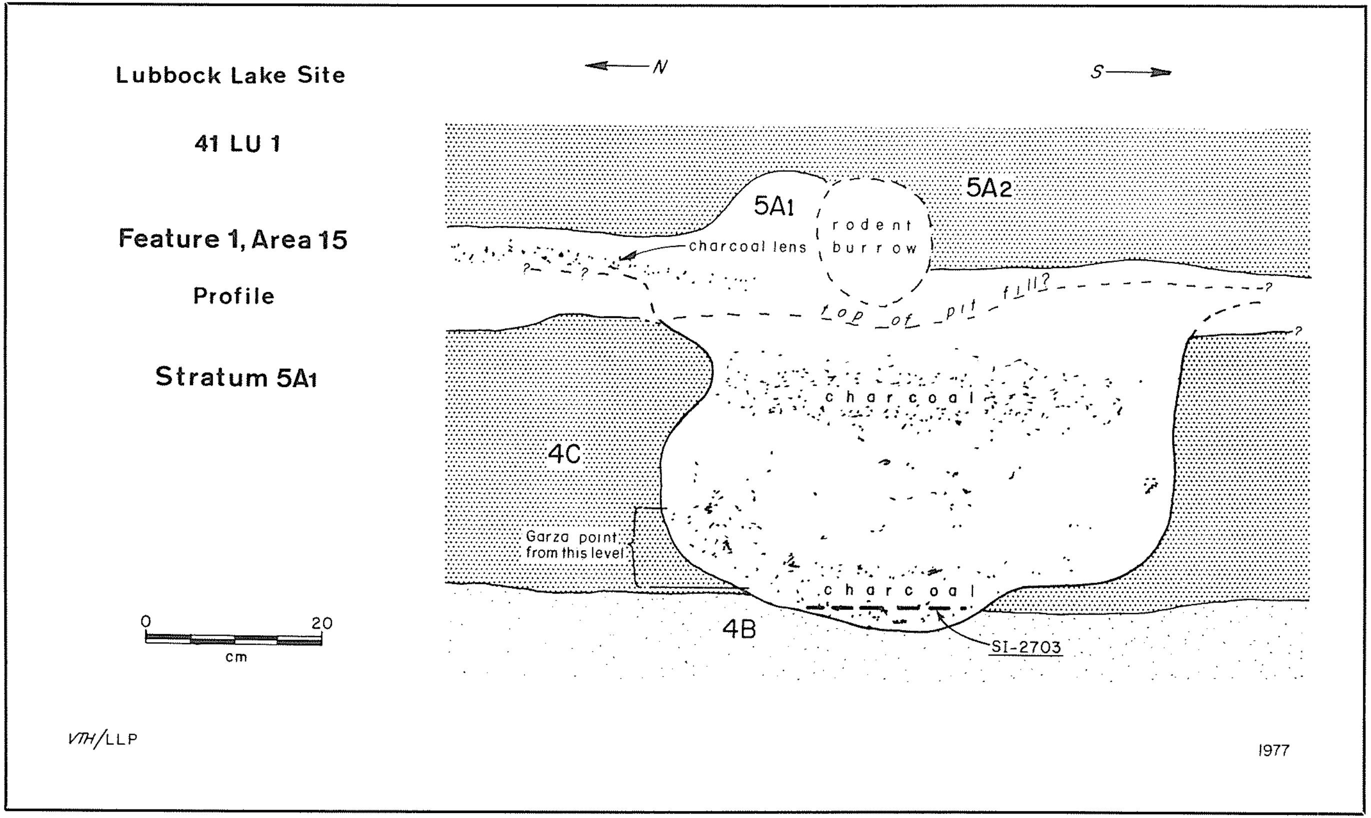

FIGURE 2: *Feature 1, Area 15 — Garza period ash-filled pit.*

conducted in this area by the Lubbock Lake Project to correlate stratigraphy and obtain additional data on the various occupation levels. Green's (1962) stratigraphic sequence in this area was compressed and redefined by Stafford (1977). Within his stratum 6, now designated substratum 5A by the Lubbock Lake Project, Green (1962: 119) exposed two living surfaces, calling the higher one the first occupation level and the other the second occupation level. These levels corresponded to features FA8-2 and FA8-4, respectively, uncovered by the Lubbock Lake Project (Fig. 3). Two other occupation levels were encountered by the project within the 5A deposits, one above and one below the Garza levels. No diagnostic artifacts were recovered, and their cultural affiliations are unknown at present. These features may represent Garza occupations as well since the total deposition of 5A occurred over a short period of time (Stafford 1977).

FA8-2

Green (1962) recovered a variety of tools and exposed several micro-activity areas in both occupation levels. The predominant lithic material source was Edwards Plateau chert; a few other types of material were minimally represented. Three projectile points were recovered from the first occupation level: a broken Garza point made of Tecovas chert (Fig. 4g); a basal tang of a "Lott" point, a locally known, informally named point; and the blade of an indeterminate type (Fig. 4f). "Lott" points were associated with Garza points in the upper two occupation levels at Blue Mountain Rock Shelter (Holden 1938) and at the Pete Creek site (Parsons 1967). Other tools from the first occupation level include an ovate, bifacially flaked, preform of Edwards Plateau chert (Fig. 4c), and six scrapers, all of Edwards Plateau chert and all made on flakes. Three of the scrapers were small, delicate tools perhaps used as finishing implements. Minute damage flake scars can be seen along the working edges. One has retouch along both sides; the second example was broken, but has steep retouch along the two unbroken edges. The third scraper is alternately retouched along the sides. Retouch along the lateral edge is on the dorsal side, while the medial edge retouch occurs on the ventral side (Fig. 4j,k,l). Another scraper exhibits alternate retouch at the distal corners, on the dorsal side at the medial edge, and on the ventral side of the lateral edge (Fig. 4h). A snub-nosed scraper has steep retouch on three sides with heavy damage flake scarring along the edges, particularly the distal end (Fig. 4b). The last scraper was a

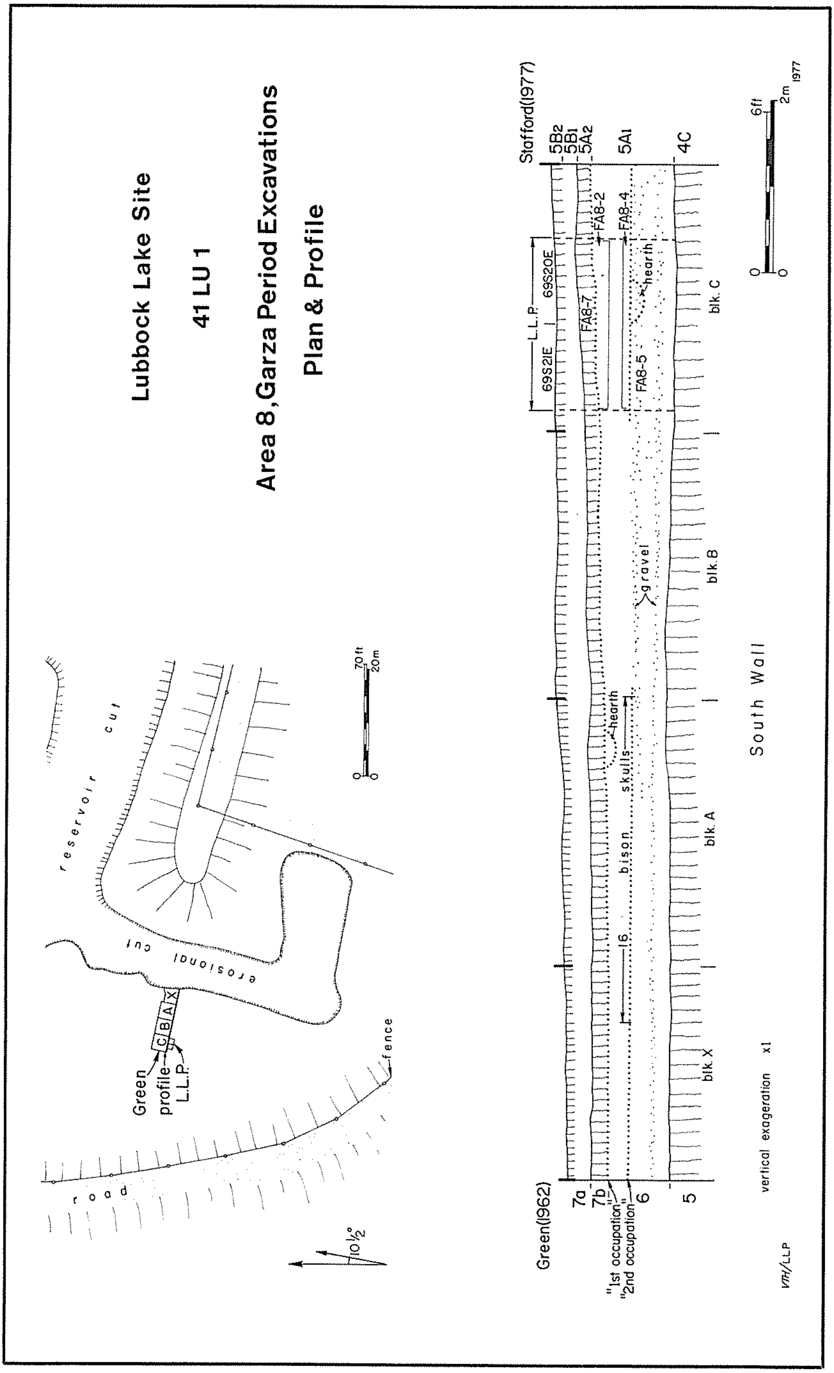

FIGURE 3: *Location and Correlation of excavations and features in Area 8.*

broken section, showing some damage flake scarring superimposed on the retouch of the working edge (Fig. 4i).

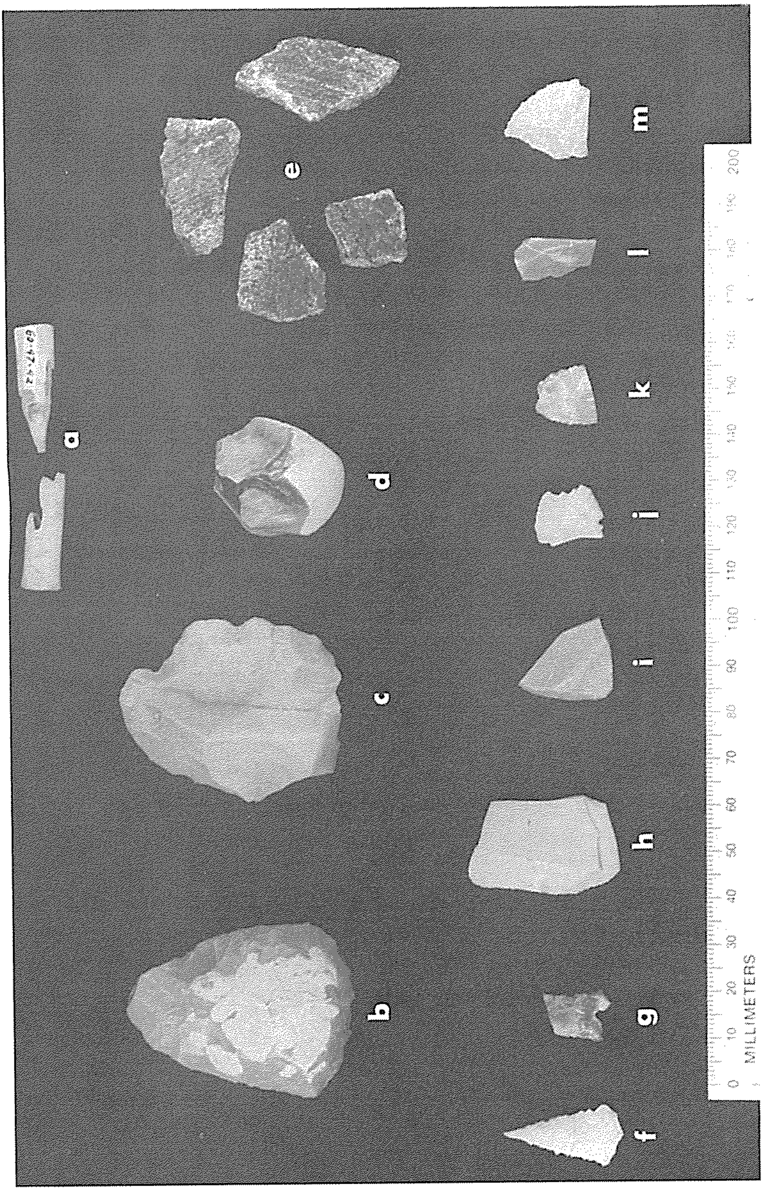

FIGURE 4: *Artifacts from the upper Garza occupation in Area 8.*

Fifteen utilized flakes were recovered, the majority of which were of Edwards Plateau chert. Four of them have either indentations that were used or notches created through damage flake scarring. Of the others, three show damage flake scaring along the lateral edge (one on the ventral side); two exhibit use along the medial edge (one on the ventral side); and two are utilized on the distal end and one at the latero-distal corner. The apex of a triangular-shaped flake has been utilized. The remaining utilized items are broken pieces exhibiting damage flake scars along single edges.

At least one chipping station was exposed, represented by a small cluster of flakes located along the Block A/B line. The majority of unmodified flakes, including retouch and resharpening debitage from the chipping station, were of Edwards Plateau chert. Other materials (Alibates chert, chalcedony, Morrison quartzite, and a white chert of unknown source) were represented by only a few flakes each. A hearth, with several large chunks of burned caliche, was located in Block A (Fig. 3), but a radiocarbon determination was not reported.

In addition to the lithic material, parts of two tubular bone beads were recovered (Fig. 4a). Similar beads were found at other excavated Garza sites (Holden 1938; Wheat 1955; Runkles 1964). Pottery sherds from the level consisted of a thick-walled, brushed, grit-tempered blackware (Fig. 4e). This is an unnamed pottery type that has occurred at other sites (surface collections) in the area and may be of local origin.

Although no Garza points were recovered from the project's testing operations in Area 8, feature FA8-2 was correlated with Green's (1962) first occupation level (Fig. 3). Six additional utilized flakes, a small core, a biface, pottery, and the edge of another chipping station were exposed in a 1 x 2 meter test unit adjacent to Block C. The flaking on the ventral side of the tip of the biface was incomplete, having been broken during manufacturing (Fig. 4m). The material used was Edwards Plateau chert. A unidirectional core was made on a very small nodule of Edwards Plateau chert (Fig. 4d). Two of the utilized flakes (Edwards Plateau chert) were notched along the lateral side, one taking advantage of an indentation and the other creating a shallow notch from damage flake scarring. The other four flakes exhibit a variety of utilization indications. One flake (Edwards Plateau chert) was utilized along the distal end and on the ventral side of the medio-distal corner; while a second flake (Edwards Plateau chert) exhibits wear along the distal end. Two obsidian flakes were utilized, one along the distal and lateral edges, the other along the medial edge on the ventral side.

Two hundred fifty-five flakes of retouch/resharpening debitage were recovered from the partially exposed chipping station. Ranging in size from less than 2 mm to 19 mm, most of the flakes were located *in situ*; the rest were recovered from matrix concentrates. Edwards Plateau chert was the preponderant lithic source (71%), followed distantly by a white chert of unknown source (22%). Other materials (chalcedony, obsidian, and silicified caliche) made up the remainder (7%). The use of five different lithic materials indicates the manufacture or use of a variety of implements (at least five).

Pottery sherds recovered were an unbrushed, thick-walled, grit-tempered blackware. Similar sherds were recovered in surface collections from the area, from the uppermost Garza occupation at Blue Mountain Rock Shelter (Holden 1938), and the Garza occupation at the Floydada Country Club site (Word 1963). These sherds probably represent either a contemporaneous type or unbrushed portions of brushed ware. Neither Wheat (1955) nor Runkles (1964) recovered pottery in association with Garza material.

Food debris scattered across the occupation surface consisted principally of remains from modern bison (*Bison bison*), although pronghorn antelope (*Antilocapra americana*) and wolf (*Canis lupus*) also were represented. Parts of two bison mandibles were recovered during the project's testing efforts. One is the left mandible of a mature animal, aged between 5.5 and 9.5 years (Frison and Reher 1970). The ascending ramus and angle had been removed by pounding action during butchering and the P_2-M_1 removed. The tooth cavity was exposed to the M_3 by incomplete spiral fracturing, removing the symphyseal surface and border area. The breakage was completed by several blows along the border, giving access to the marrow-rich area. The mandible could not be measured for sexing because of this damage. The other mandible is a right one of probably a 3.5 year old. Only the M_3 remained, and it was erupted with the first two cusps in wear and the third cusp unworn (Frison and Reher 1970). The ascending ramus, angle, and border had been removed through pounding action to just posterior to the M_3, probably during butchering. The anterior section had been removed to the M_3, and the mandible could not be measured for sexing.

FA8-4

Several projectile points, all of Edwards Plateau chert, were recovered by Green (1962) in the second (lower) Garza occupation level. Of the five, two are midsections and one is the corner tang of a Harrell point. Two Garza points were located in the second occupation level. One point is a unifacially flaked basal section with the notch bifacially flaked. The other point is incomplete and apparently broke during manufacturing, the two sections being recovered near each other. This Garza point has merely an incipient basal notch, with only a few flakes removed bifacially (Fig. 5a,b). Garza and Harrell points were found in association at the Garza type locality (Runkles 1964), at the upper two occupation levels at Blue Mountain Rock Shelter (Holden 1938), and at the Pete Creek site (Parsons 1967).

The basal section of a thin, bifacially flaked knife, of Edwards Plateau chert, also was recovered. It was apparently broken during manufacture. The base is concave and the edges and base demonstrate some degree of grinding (Fig. 5d).

All of the scrapers and utilized flakes were of Edwards Plateau chert. Two side scrapers were made on flakes. One of these retains the outer cortex of the nodule on the proximal and distal ends. This tool has steep angle retouch along the lateral side with heavy damage flake scarring (Fig. 5f). It was apparently broken during use, and two sections were recovered. The other scraper is a small, delicate tool. Steep angle retouch has created a shallow notch on the lateral side, and tiny damage flakes were removed in the notch area (Fig. 5g). An end scraper has steep retouch that created a shallow scallop edge. Heavy damage flake scarring is exhibited within the "notches" of the scallop (Fig. 5h). The fourth scraper is a keeled, long, and narrow tool, steeply retouched on all sides (Fig. 5e). Damage flakes had been removed around the distal end and adjacent sides, but particularly along the medial edge.

Five utilized flakes were recovered. Three have damage flake scarring along the distal end, one along the medial edge, and one along the lateral edge on the ventral side.

A bone awl was fashioned from a split shaft segment of a long bone, ground and polished to a tip (Fig. 5i). The tip had been broken during use. Awls from split sections of bone were recovered at other excavated Garza localities (Holden 1938; Wheat 1955; Runkles 1964; Parsons 1967).

The most unusual occurrence in this occupation level was the exposing of a cluster of 16 bison skulls (Green 1962), extending

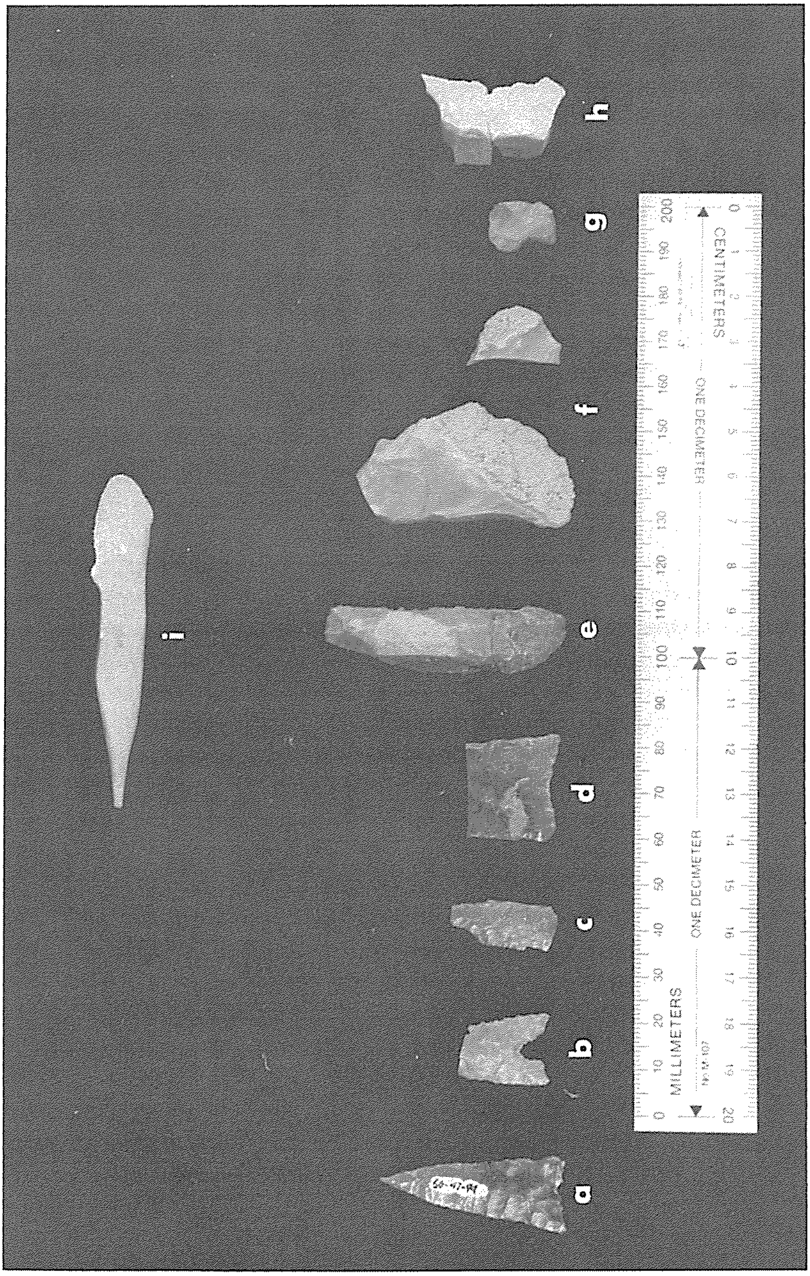

FIGURE 5: *Artifacts from the lower Garza occupation in Area 8.*

from Block A into Block X (Fig. 3). Although Green (1962: 119) suggested that they may have had ritual significance, the feature was not totally isolated; other mundane activities had occurred around the cluster. A butchered wolf skeleton and lithic debris were scattered to the east of the cluster. Two small chipping stations (debris of Edwards Plateau chert) also were located in the area, one south and the other southwest of the cluster. However, no lithic material was recovered from the adjacent Block B to the west of the skulls. Cultural material was located further to the west in Block C (Fig. 3), where another hearth was located. No radiocarbon date was reported. Burned remains of pronghorn antelope, badger (*Taxidea taxus*), and western diamond-back rattlesnake (*Crotalus atrox*) were recovered from the hearth.

Green's (1962) second Garza occupation level was correlated with FA8-4 from the project's test unit. Most of the material from this feature consisted of modern bison remains, concordant with the butchered remains Green (1962) recovered in Block C (Fig. 3). Three resharpening/retouch flakes, each of a different material (Edwards Plateau chert, and a white chert and pink quartzite of unknown sources), constituted the lithic material recovered. A more detailed analysis of the material recovered by Green (1962) and correlation with work done by the Lubbock Lake Project is forthcoming (Kaczor ms.).

Area 5-FA5-6

The one processing station excavated by the project was located in Area 5 and designated feature FA5-6 (Fig. 6). The station represented an area of secondary processing, a distinctive aspect of the animal procurement system. The "schlepp effect" concept (Perkins and Daly 1968), whereby long bones and other major skeletal elements were not as numerous as they should be given the minimum number of individuals (MNI) represented, was operative in these stations. Perkins and Daly (1968: 105) felt that this phenomenon resulted from killing and initially butchering animals away from the locale and bringing back only selected parts. At the Lubbock Lake processing stations, these selected units were then further butchered and the bones processed for marrow. Although modern bison was the principal game animal, remains of pronghorn antelope, wolf, and coyote (*Canis latrans*) also were recovered. Faunal remains were scattered over the surface in a random pattern; however, there was a greater concentration of faunal material and bone expediency tools in the eastern section of the exposed station. This area may then be close to a boundary of the original station. Deposits east of the exposed station were removed by dredging in the 1930's and subsequent erosion. More of the station existed south of the exposed area, demonstrated through testing and profiling operations.

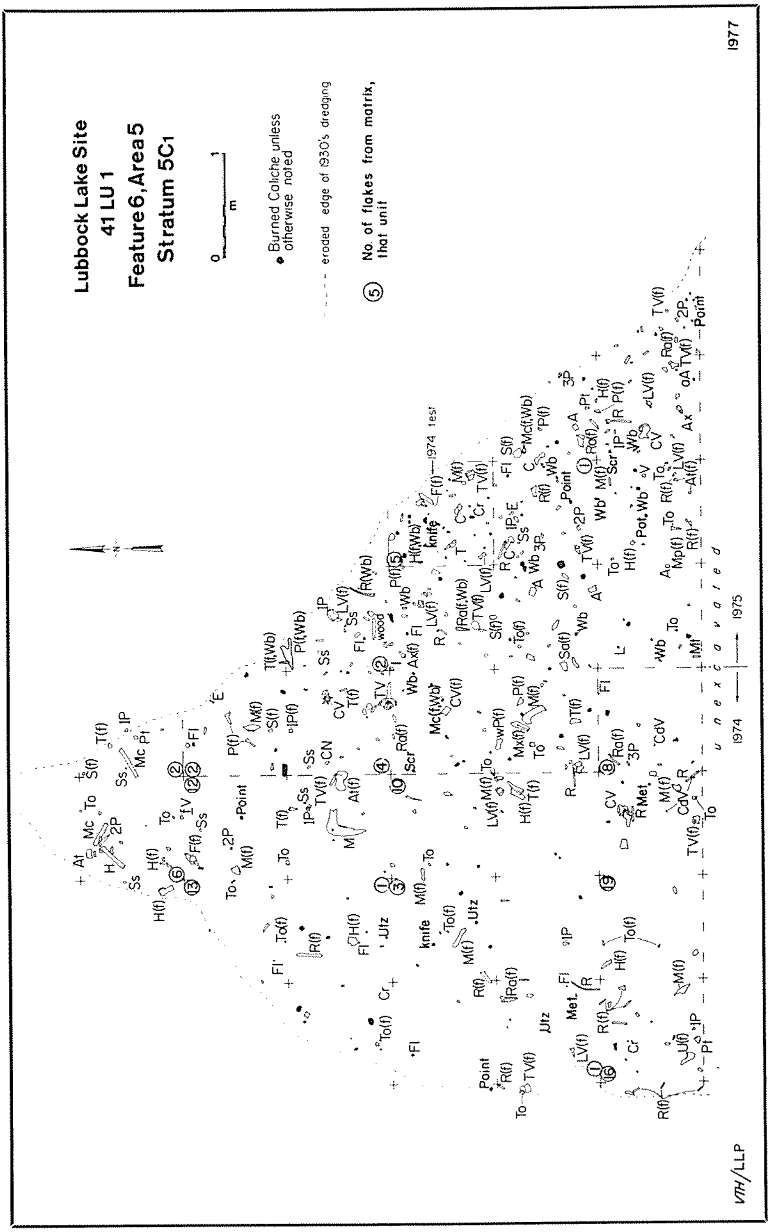

FIGURE 6: *Plan of Feature 6, Area 5 — Garza period processing station.*

Lithic tools and flakes were found throughout the processing station. Parts of four projectile points were recovered. One Garza point of Tecovas chert has the tip broken by impact creating several hinge fractures (Fig. 7a). A Harrell point of chalcedony is represented by a corner tang. A small basal section with a notch (Edwards Plateau chert) is from either a Garza or Harrell point. The fourth point consists of a broken midsection of Edwards Plateau chert. The broken tip of a chalcedony biface was recovered (Fig. 7b). Both edges of this possible knife show slight crushing damage and rounding of points, although wear is heaviest along the lateral edge. A broken unifacially flaked implement, of Edwards Plateau chert, may have also been part of a flake knife. Damage flake scarring is bifacial, and the sinuous edge is worn and rounded. Two scrapers of Edwards Plateau chert were found. One is a large, snub-nosed scraper made on a thick flake (Fig. 7d). Steep angle retouch occurs on the three sides with damage flake scarring concentrated on the distal end. Both edges adjacent to the proximal end, but particularly the lateral side, show edge crushing, perhaps for hafting purposes. The other scraper was made on a blade that had a triangular cross-section (Fig. 7c). The broken midsection of a side scraper was collaterally flaked; damage flake scarring is exhibited along both edges but is more pronounced along the latero-distal one. The material may have been heat-treated as it shows a very crystalline structure, is highly fractured internally, and pitted. Flakes of similarly colored and structured Edwards Plateau chert were recovered in Area 8 from Green's (1962) upper Garza occupation level and FA8-2. A very large chopper made on a cobble of Potter's chert was found lying next to a bison skull. It is unifacially flaked with heavy damage flake scarring along the central distal edge. Ten utilized flakes were found; most of these are of Edwards Plateau chert. Two broken flakes demonstrate damage flake scarring along the working edges. Three others exhibit damage flake scars along the distal, lateral, or medial edges. One has damage flake scarring along the lateral edge on the ventral side; while another has been alternately utilized with damage flake scars along the lateral edge on the dorsal side and along the medial edge of the ventral side. Damage flakes have been removed along the latero-distal edge of a small blade; while another blade of Potter's chert exhibits some damage flake removal along both sides. An indentation along the medial edge of a flake of Alibates chert was utilized; the "notch" also shows damage flake scarring.

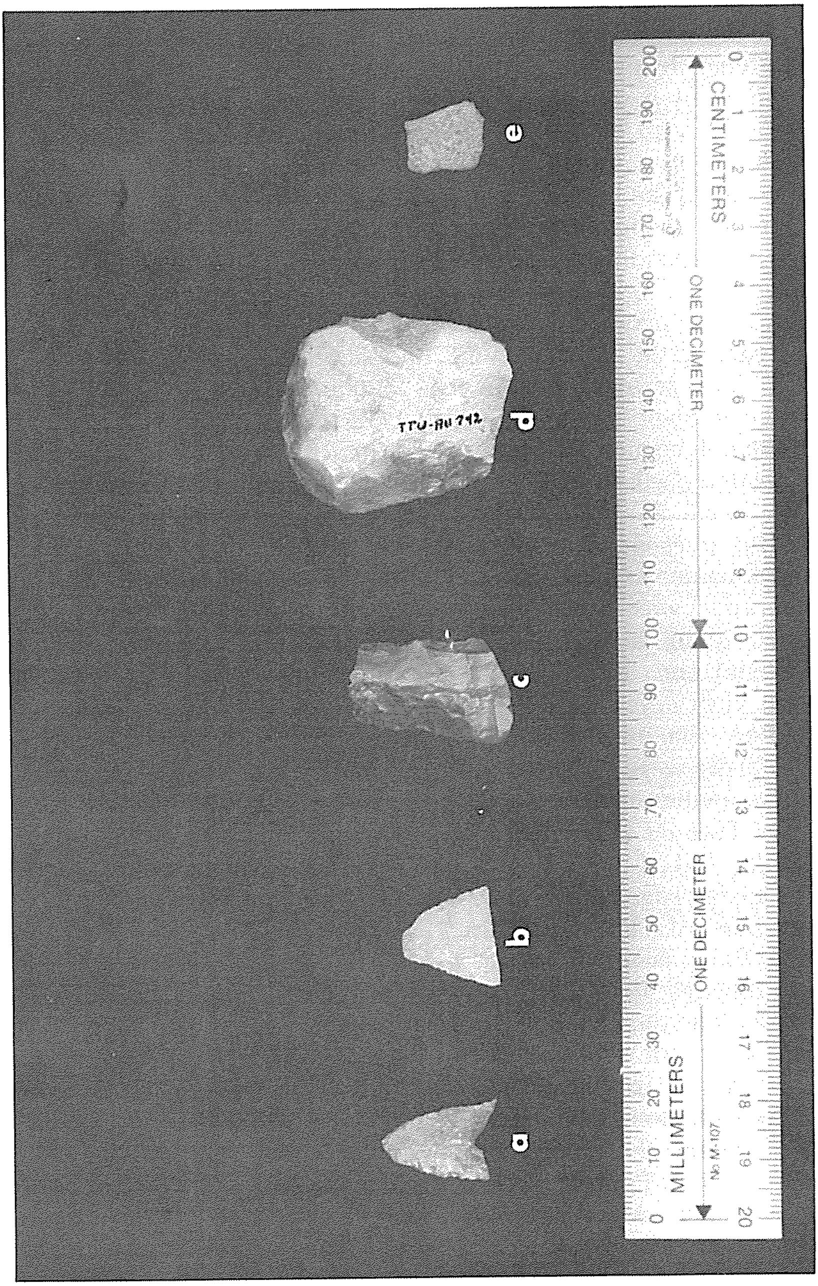

FIGURE 7: Artifacts from Feature 6, Area 5 — *Garza* period processing station.

Two pieces of a broken metate were recovered. One may have been used as a pounding stone for breaking bones open since the broken edge has several large flakes removed and exhibits some crushing damage. One sherd of "Apache" pottery, a thin-walled, mica-tempered blackware, was recovered (Fig. 7e). Similar pottery was recovered from the first Garza occupation level at Blue Mountain Rock Shelter (Holden 1938), in the Garza occupation at the Floydada Country Club site (Word 1963), and the Garza occupation level at Red Bluff Shelter (Lorrain 1968). One hundred forty-five resharpening flakes and other micro-debitage have been recovered to date. Although 10 different kinds of lithic material are represented, Edwards Plateau chert accounts for 73% of the collection. A white chert of unknown source makes up 8%, while chalcedony accounts for 6% and Tecovas chert for 4%. The remaining 9% consists of the other six lithic sources. A variety of colors of Edwards Plateau chert have been encountered, ranging from blue-black to light tan. The variety of lithic sources indicates that a minimum of 10 tools had been used in the station, although tools from only three of the lithic categories were recovered. When the distribution of the resharpening flakes was plotted they clustered in several groups (Fig. 8), possibly indicating work areas. However, not all matrix concentrates have been sorted, and additional resharpening flakes from these concentrates could change the distribution pattern.

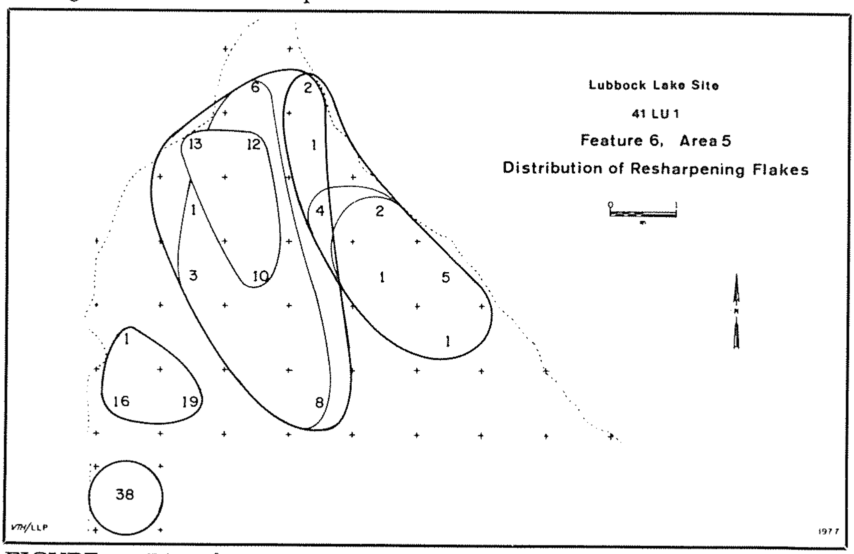

FIGURE 8: *Distribution of resharpening flakes from Feature 6, Area 5 — Garza period processing station.*

Eighteen bone expediency tools were recovered among the scatter of faunal debris. Of these, five were manufactured and 13 were utilized items. Bone expediency tools are implements that were made "on-the-spot," generally from elements of the carcasses being processed. After use, they were left with the rest of the faunal debris. Manufactured tools were shaped before use; utilized items consisted of pieces unmodified before use. Controlled breakage (spiral fracturing) represents a major aspect of the technology, but advantage was also taken of fortuitous breaks. The expediency tools from the Lubbock Lake site, including those of this processing station, were discussed in detail elsewhere (Johnson 1976). All bone tools from the station are of bison, and no one bone was used preferentially. For the purposes of this report, only the manufactured items will be discussed. Two of these are the broken shafts of expediency tools, both demonstrating the removal of a series of thinning flakes along the shaft edge for shaping. A third tool was made from a humerus shaft segment. A number of thinning flakes were removed along the lateral shaft edge. The spirally fractured working edge exhibits damage flake scarring, rounded edges, and heavy wear polish along the ventral side, possibly from use as a scraper. Two choppers were made from the proximal ends of metacarpals. One exhibits damage flake scarring on all three sides of the working edge and wear polish from use. The second is cracked and broken from heavy use. Numerous hinge fractures and heavy wear polish on the discontinuous working edge attest to the battering it received. These and the other expediency tools were restricted to the eastern portion of the exposed station where the faunal debris was more concentrated.

In addition to the possible work areas outlined by the lithic flaking debris, another micro-activity area was exposed in a test unit along the west wall of Area 5. A small pile composed principally of long bones was capped by a bison skull. Numerous resharpening flakes, most of Edwards Plateau chert, were found in the unit. The large chopper was found in association with this bone pile. Although several of the bones show butchering damage, few had been processed for marrow. This bone stacking and lack of marrow processing was in direct contrast to the activities seen in the rest of the processing station.

Judging from a combination of skeletal elements, sexing, and aging, a minimum of six bison were represented in the deposits. Given the extent of the unexcavated deposits and the abundance of material, many more than this number were actually processed. The recovered remains represent four mature animals, a sub-adult, and a fetus. Mandibles that could be aged and sexed (three left ones) were all from females within the 5.5 to 9.5 years age category (Frison and Reher 1970). The fourth adult was a male, based on measurements on the skull recovered from the small bone pile. The sub-adult was five years of age or younger, based on unfused epiphyses and the known closing schedule of these (Koch 1935). Remains of a three-quarter term fetus consist of part of a front leg, a vertebra, and a hyoid found grouped in one of the test units along the eastern edge of Area 5.

No statement on seasonal use of the station can be reasonably formulated at this time. The possibility of "out-of-season" births among bison was always present (McHugh 1958; Wilson 1974), and one three-quarter term fetus does not necessarily indicate a spring use. The mandibles could not be aged accurately enough to determine the time of kill. Additional corroborative data will be necessary before a seasonal determination can be made.

Intensive marrow processing is evident from the extensive bone breakage, to the point of extraction even from phalanges. Marrow processing has obliterated much of the bone damage done during the initial butchering, although occasionally initial damage such as defleshing cut lines on shaft sections or near ends of long bones could be noted. Almost all long bones were represented by proximal and distal ends, and were not as numerous as the M.N.I. would indicate. Shafts were either broken through spiral fracturing or the ends were chopped off. Neither technique was restricted to particular elements; the same type of element was treated both ways. However, there does appear to be a preference in the way the two ends of a long bone were treated. Tibiae, for example, generally had the proximal ends (areas of spongy bone) chopped off, while controlled breakage was used on the distal ends (denser bone). The tooth cavity of mandibles was generally exposed through controlled breakage. Skull sections were recovered, indicating that skulls had been completely disarticulated in the process of removing the brains. Hide preparation may also have taken place in the stations, given the number of lithic and bone scraping implements found and the access to tanning material such as brains.

ENVIRONMENTAL SETTING

Although the inventory list of recovered species is small, it represents a predominantly grasslands fauna. The site environs were restricted by the narrowness of the draw, which was less than 500 meters at its widest point in the site area. Because of this, although different ecological zones may be represented in the assemblage, most animals could easily traverse these zones within their daily activity patterns. Man, in particular, would have utilized the various habitats in the draw and probably crossed them daily. Differential habitat utilization by man can be seen in both economic and spatial dimensions. Different cultural activities had their particular geographic settings even though remains of the same kinds of larger game animals were found in each. On the other hand, some resources, particularly those of the marsh area, were little utilized or perhaps ignored; while grasslands animals, both large and small, were conspicuously consumed.

Most of the animals recovered were mammals, the rest were reptiles. Fish, amphibians, and birds were conspicuously absent. This situation may have been due to a combination of factors both ancient and modern: the cultural activities being explored, unfavorable habitats, and incompletely processed matrix concentrates. Mammals represented include cottontail (*Sylvilgaus* sp.), black-tailed jack rabbit (*Lepus californicus*), black-tailed prairie dog (*Cynomys ludovicianus*), coyote (*Canis latrans*), gray wolf (*Canis lupus*), badger (*Taxidea taxus*), pronghorn antelope (*Antilocapra americana*), and modern bison (*Bison bison*). Reptiles recovered are the pond turtle (*Chrysemys scripta*), ornate box turtle (*Terrapene ornata*), Texas horned lizard (*Phrynosoma cornutum*), and the western diamond-back rattlesnake (*Crotalus atrox*). All of these animals ranged into the region historically, although some were extirpated from the area by encroaching civilization. Open grasslands were indicated by bison, pronghorn antelope, jack rabbit, box turtle, and rattlesnake. Short-grass prairie was inhabited by prairie dogs and their predators, such as badgers and coyotes. Cottontails and other animals, including coyotes and wolves, favored the ecotonal areas of brushy grasslands. The pond turtle was the only member of the riparian community.

Geological evidence documents a dry, upland area surrounding a marsh/stream complex. Based on the faunal communities represented, the reconstruction could be expanded. A mixed-grass prairie existed in the draw, grading into a wet meadow area of the marsh which merged into the spring-fed, small stream coursing through the draw. Trees were scarce to non-existant as no woodland dependent forms were recovered; but a few deciduous trees may have been scattered along the waterway. Hackberry (*Celtis reticulata*) seeds were recovered in the later $5C_2$ deposits overlying the processing station. These trees are known historically to have grown in various draws in the region (Holden 1962), and exist today in Yellowhouse Canyon several miles downstream from the site. Although the present situation of the draw differs, transformations brought about were due to European cultural activities, not by climatic changes. The reconstruction represents an historically modern view of the draw.

DISCUSSION

Garza occupations at the Lubbock Lake site occur sequentially within a given stratigraphic context. Facies changes occur in the deposits, and their correlations are important to both the stratigraphic and cultural chronologies at the site. Since work had been conducted at the site previous to the Lubbock Lake Project excavations, correlation of the various efforts and defined stratigraphic sequences were necessary. Excavations in Area 8 were particularly dependent on these correlations since the project's testing recovered no diagnostic artifacts but uncovered more occupation levels than had been previously recognized. The correlation of the strata and features uncovered by the two excavations, those of Green (1962) and the Lubbock Lake Project, was based on geologic work by Stafford (1977) and recent reprofiling and analysis efforts by Kaczor (ms.). Although designations of substrata differ, both unit description and thickness of deposits match (Fig. 3). When plotted vertically, materials recovered by Green (1962) show a linear distribution along the top (first occupation level) and middle (second occupation level) of substratum $5A_1$. A similar plot of features encountered in substratum 5A in test units by the Lubbock Lake Project show the same distribution for FA8-2 and FA8-4, respectively. In addition, two other features were exposed, FA8-7 in the $5A_2$ soil zone above FA8-2/first occupation level and FA8-5 in the $5A_1$ colluvium immediately below FA8-4/second occupation level (Fig. 3). These features may represent additional Garza period encampments, but no diagnostic artifacts were recovered. Another feature (FA8-1) was encountered in the $5B_1$ deposits above 5A. Since it contained metal, Green (1962) reported that material in this substratum dated from the time of the Singer store occupation (1880's). Additional processing stations were uncovered by the project's excavations in substratum $5C_2$. This substratum is a facies of 5B, and the stations contained the butchered remains of modern bison and modern horse (*Equus caballus*) in association with Washita and Fresno points.

Stratigraphy

The deposition of substrata 5A and 5B over the well-developed 4C soil horizon in Area 8 reflects changes in available moisture and rainfall pattern in the area. Substratum $5A_1$ is a predominantly fluvial deposit with multiple lenses of caliche pebbles in the lower part. These pebble beds are colluvial sediments representing discontinuous sheets of slopewash. The upper part of $5A_1$ is an aeolian and fluvial deposit of very fine to medium silty sands, ranging in color (moist) from brown (7.5YR5/4) to yellowish brown (10YR5/3). A 35 cm thick soil ($5A_2$) developed at the top of the 5A deposits, consisting of fine to medium silty sands and brownish black (10YR4/2 to 10YR5/3) in color. This soil development reflects a change (of short duration) to more stable conditions and growth of vegetation cover. Substratum 5B is a cyclic repeat of 5A, with aeolian sands and stringers of slopewash sediments in the lower ($5B_1$) deposits and an aggrading soil development in the upper ($5B_2$) one. Substrata 5A and 5B are upland facies deposits of sands and soils along the draw slope. The interface with substratum 5C, the lowland marsh deposit in the center of the draw (Stafford 1977). The lowland facies represents the repeated cutting and subsequent infilling of the channel along the interior of the draw. In Area 5, substratum 5C consists of two units. The lower half ($5C_1$) is a brownish-gray (10YR5/1), fine to medium sandy clay. This unit is archeologically equivalent to that of substratum 5A in the upland sequence. The upper unit ($5C_2$) is a dark gray (5Y4/1), very fine to fine silty, sandy clay which is archeologically equivalent to substratum 5B.

Radiocarbon Dates and Cultural Associations

Two radiocarbon determinations now date the Garza period occupation at the Lubbock Lake site to the Historic period. Garza points were originally believed to date prior to A.D. 1500 (Runkles 1964: 123). This assessment was made by Green (1962) based on his work at the Lubbock Lake site and was applied by inference to the Garza type site (Runkles 1964). The two dates of A.D. 1635 (350 ± 50; SI-2701) and A.D. 1665 (285 ± 60; SI-2703) secured by the Lubbock Lake Project suggest that Garza points continued at least into the mid-1600's. The first Europeans entered the region in A.D. 1541 (Holden 1962). At that time, the Lipan Apache were believed to be the principal occupants of the area; their arrival on the Llano Estacado is estimated to be about A.D. 1525 (Gunnerson 1956; Collins 1971). The association of Garza points and Apache peoples is further suggested by the recovery of both Garza points and a micaceous blackware in the processing station, FA5-6. Campbell

(1976) believed this type of pottery to be distinctive of the Plains Apache. Furthermore, Gunnerson (1969) recovered several micaceous wares in New Mexico believed to be Jicarilla Apache, although they date somewhat later in time (about A.D. 1700). Finally, although Apaches on the Llano Estacado may have had horses as early as the mid-1600's through trade in New Mexico (Oliver 1962), no horse remains were recovered from Garza period activity areas at the site. Given these circumstances, the Garza occupation probably represents a protohistoric period (i.e., a period when Europeans had passed through the area but trade goods and horses had not yet been acquired) with a time span of at least 150 years.

Garza points appear to be contemporaneous with the Apache occupation of the area. There are a number of possible working hypotheses. The pottery association suggests that the points may be an Apache type. Whether this point type was indigenous, or brought into the area by the Apaches, or developed by them after their arrival, is uncertain. The known distribution of this type favors the Garza point type being an indigenous form. The type appeared to be largely confined to the Southern High Plains with an extension into the El Paso area (Runkles 1964). A further extension down the Pecos River to the Sheffield area was made by Lorrain (1968). In addition, Heartfield (1975) reported a Garza point from Southwestern Coahuila. In any case, it appeared that this point type may have been utilized for a fairly short time period in the Southern High Plains, from the early 16th century to the mid to late 17th century (Holliday 1977).

Concerning the radiocarbon determinations themselves, the dates fall into a period of known fluctuation in the radiocarbon chronology (Ralph 1971). Such fluctuations were studied and assessed by several different radiocarbon laboratories. Various fluctuation graphs and charts were presented, for example Ralph (1971) and Suess (1970). Fluctuations appeared to be real, but there is some disagreement as to the magnitude of fluctuation within these periods. The radiocarbon dates reported here are uncorrected. According to what is known about the fluctuations, the dates are probably young. Using the MASCA correction table (Ralph 1971: 28), the dates could be as much as 50 years too young. This correction factor would amend the dates, placing them into the late 1500's or early 1600's. However, such a change is not considered significant because this period is still within the known time span of Apaches on the Llano Estacado. Such a correction would, in fact, strengthen the hypothesis of a relationship between Garza points and Apache culture.

Tool Assemblages

Several similarities exist among the tool assemblages recovered from the Lubbock Lake site and other excavated Garza localities, particularly among the collections from camping areas. Garza points were found in association with other point types. At the Lubbock Lake site they were in association with Harrell and "Lott" points. Runkles (1964) recovered Garza, Harrell, and Fresno points from the type locality. Wheat (1955), Word (1963), and Lorrain (1968) reported Garza and Fresno points in association; while Holden (1938) and Parsons (1967) recovered Garza points in association with a variety of other types, including Harrell, Fresno, and "Lott." While size, and perhaps function, varied, morphologically similar, steeply retouched, end scrapers (snub-nosed) were also recovered from all the sites discussed. Wheat (1955) recovered the tip of a bifacially flaked knife from Johnson Creek, similar to the one recovered in the processing station at the Lubbock Lake site. Edwards Plateau chert was the predominantly used lithic source during the Garza period at the Lubbock Lake site. Two-thirds of the lithic items recovered from the Johnson Creek site (Wheat 1955) were of Edwards Plateau chert. While a variety of materials were represented in the Blue Mountain Rock Shelter (Holden 1938), Edwards Plateau chert was dominant. However, at the Pete Creek site (Parsons 1967), both Edwards Plateau and Tecovas cherts were used extensively. Tubular bone beads were recovered from the Lubbock Lake site, Blue Mountain Rock Shelter (Holden 1938), Johnson Creek site (Wheat 1955), and the Garza type locality (Runkles 1964). Micaceous pottery was found at the Lubbock Lake site, Blue Mountain Rock Shelter (Holden 1938), Floydada Country Club site (Word 1963), and Red Bluff Shelter (Lorrain 1968). Curiously, no pottery was recovered from the Garza or Johnson Creek localities (Runkles 1964; Wheat 1955), from the lower two Garza occupation levels at Blue Mountain Rock Shelter (Holden 1938), or from Green's (1962) lower Garza occupation level at the Lubbock Lake site.

The one major difference of note concerns the variety of cultural activities represented by the camping areas of the several sites and the processing station at the Lubbock Lake site. The main distinction between the two assemblages is the presence of bone expediency tools in the processing station. The variance of settlement and procurement activities at the site is concordant with a differential utilization of the site environs and resources. Spatially, the activity areas were located in different topographic settings, the processing station in the lowlands of the marsh/stream complex and the camps along the dry, upland areas. Some of the animal communities in the draw were ignored, while major dependence was placed on one or two forms (i.e., bison and antelope) from another. Small game items such as rabbits found in the camping areas were used as subsidiary sources.

The Garza occupation at the Lubbock Lake site represents a repeated occurrence both temporally and spatially. Different cultural activities took place during the occupation in distinctive locales. The radiocarbon determinations received on charcoal from a hearth and ash-filled pit date the occupation to the Historic period. However, because of the absence of European trade goods and modern horse remains, the term Protohistoric for the period is suggested. Circumstantial evidence is presented for a series of working hypotheses regarding the cultural relationships between Garza points and Apache peoples. Continued research, both at the Lubbock Lake site and elsewhere, will be needed to test these hypotheses, to identify historic aboriginal groups in the area and their associated point types, and to trace the migrations of these groups into and out of the region.

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References Cited

Black, Craig C. (ed.)
1974 The History and Prehistory of the Lubbock Lake Site. *The Museum Journal*, The West Texas Museum Association Vol. 15, pp. 1-160, Lubbock.

Campbell, Robert G.
1976 The Panhandle Aspect of the Chaquaqua Plateau. *Graduate Studies Texas Tech University*, No. 11, pp. 1-118.

Collins, Michael B.
1971 A Review of Llano Estacado Archaeology and Ethnohistory. *Plains Anthropologist*, Vol. 16, No. 52, pp. 85-104.

Frison, George C. and Charles A. Reher
1970 Age Determination of Buffalo by Teeth Eruption and Wear. *Plains Anthropologist*, Vol. 15, No. 50, part 2, pp. 46-50.

Green, F. E.
1962 The Lubbock Reservoir Site. *The Museum Journal*, The West Texas Museum Association, Vol. 6, pp. 83-123, Lubbock.

Gunnerson, D. A.
1956 The Southern Athabascans: Their Arrival in the Southwest. *El Palacio*, Vol. 63, pp. 346-365.

Gunnerson, J. W.
1969 Apache Archaeology in Northeastern New Mexico. American Antiquity, Vol. 34, No. 1, pp. 23-39.

Heartfield, Lorraine
1975 Archeological Investigations of Four Sites in Southwestern Coahuila, Mexico. *Bulletin of the Texas Archeological Society*, Vol. 46, pp. 127-177.

Holden, W. C.
1938 Blue Mountain Rock Shelter. *Bulletin of the Texas Archeological and Paleontological Society*, Vol. 10, pp. 208-221.
1962a The Land. In: L. L. Graves (ed.), *A History of Lubbock*, The West Texas Museum Association, pp. 1-16, Lubbock.
1962b Indians, Spaniards, and Anglos. In: L. L. Graves (ed.), *A History of Lubbock*, The West Texas Museum Association, pp. 17-44, Lubbock.

Holliday, Vance T.
1977 Cultural Chronology of the Lubbock Lake Site. Unpublished master's thesis, Texas Tech University.

Johnson, Eileen
1976 Investigations into the Zooarchaeology of the Lubbock Lake Site. Unpublished doctoral dissertation, Texas Tech University.

Kaczor, Michael J.
ms. A Correlative Study of the West Texas Museum Excavations at the Lubbock Lake Site, 1959-1961. Unpublished master's thesis, Texas Tech University.

Koch, Walter
1935 The Age Order of Epiphyseal Union in the Skeleton of the European Bison (*Bos Bonasus L.*). *Anatomical Record*, Vol. 61, pp. 371-376.

Lorrain, Dessamae
1968 Excavations at Red Bluff Shelter (Sotol Site) Crockett County, Texas (X41CX8). *Transactions of the Fourth Regional Archaeological Symposium for Southeastern New Mexico and Western Texas*, pp. 18-39.
McHugh, Tom
1958 Social Behavior of the American Buffalo (*Bison bison bison*). *Zoologica*, Vol. 43, pp. 1-40.
Oliver, Symmes C.
1962 Ecology and Cultural Continuity of Contributing Factors in the Social Organization of the Plains Indians. *University of California Publications in American Archaeology and Ethnology*, Vol. 48, No. 1, pp. 1-90.
Parsons, Mark L.
1967 Archeological Investigations in Crosby and Dickens Counties, Texas During the Winter, 1966-1967. State Building Commission Archeological Program, Report No. 7, pp. 1-108.
Perkins, Dexter and Patricia Daly
1968 A Hunter's Village in Neolithic Turkey. *Scientific American*, Vol. 219, No. 5, pp. 96-106.
Ralph, E. K.
1971 Carbon 14 Dating. In: H. N. Michael and E. K. Ralph (eds.), *Dating Techniques for the Archaeologist*. M.I.T. Press, Cambridge, Massachusetts.
Runkles, Frank A.
1964 The Garza Site, a Neo-American Campsite Near Post, Texas. *Bulletin of the Texas Archeological Society*, Vol. 35, pp. 101-126.
Sellards, E. H.
1952 *Early Man in America: A Study in Prehistory*. University of Texas Press, Austin.
Stafford, Thomas W. Jr.
1977 Late Quaternary Alluvial Stratigraphy of Yellowhouse Draw, Lubbock, Texas. In: Eileen Johnson and Thomas W. Stafford Jr., Cultural Adaptation to Ecological Change on the Llano Estacado. Preliminary Report of the 1976 Field Season of the Lubbock Lake Project. Report to the National Science Foundation. Edited by M. Elizabeth King.
Suess, H. E.
1970 Bristlecone Pine Calibration of the Radiocarbon Time Scale 5200 B.C. to the Present. In: I. U. Olsson (ed.), *Radiocarbon Variations and Absolute Chronology*. Wiley, New York.
Wheat, Joe Ben
1955 Two Archaeological Sites Near Lubbock, Texas. *Panhandle-Plains Historical Review*, Vol. 28, pp. 71-77.
Wilson, Michael
1974 The Casper Local Fauna and Its Fossil Bison. In: George C. Frison (ed.), *The Casper Site: A Hell Gap Bison Kill on the High Plains*, pp. 125-172. Academic Press, Inc., New York.
Word, James H.
1963 Floydada Country Club Site. *Bulletin of the South Plains Archaeological Society*, Vol. 1, pp. 37-63.

PREHISTORIC RITUAL SKULL BURIALS AT THE CRENSHAW SITE (3 MI 6), SOUTHWEST ARKANSAS

MARY LUCAS POWELL

ABSTRACT

One hundred and eight loose human teeth representing 16 adult individuals were recovered from an antler pile and ash bed at Crenshaw, a Coles Creek-Mid Caddo ceremonial center in southwest Arkansas. A cluster of eight skulls was excavated from a plaza area north of these features. Seventeenth century ethnographic accounts describe a ceremony involving ritual burial of heads taken by the Hasinai Caddo of East Texas in raids against enemy villages. Osteological analysis suggests that the Crenshaw remains represent such trophies of war.

The Crenshaw site is a large ceremonial center in southwest Arkansas, dating from the Coles Creek to Mid-Caddo periods (ca. 900 A. D. to 1400 A. D.) (Hoffman 1970). It is located near the Great Bend of the Red River, about 20 miles northeast of Texarkana, and includes six mounds, at least five cemeteries and 20 acres of discontinuous midden around and under the mounds. A number of isolated skulls have been excavated from the open area south of the mounds, known as "The Plaza of the Skulls".

In 1969 Dr. Frank Schambach of the Arkansas Archeological Survey conducted excavations in the off-mound area south of Mound D. Two highly unusual features were discovered. The first (Feature 1) was a rectangular mass of deer antler approximately 4 by 4 meters and some 40 centimeters thick, composed of 2420 antlers from white-tailed deer. No skeletal material or artifacts were found in this feature; however, human teeth and bits of cranial bone were scattered around the southeast perimeter.

The second feature (Feature 6) was a bed of ash roughly 8 by 9 meters and 30 centimeters thick, which Schambach identified as a temple floor (Schambach n.d.). The ash contained a large number of loose human teeth and cranial fragments scattered apparently at random. An isolated human mandible was recovered from a small pit (Feature 8A) at the northern edge of the bed.

Both features have been radiocarbon dated from wood charcoal to around 1000 A. D. (see Chart below). The artifact assemblage from the ash bed corresponds to the Millers Crossing Phase, the earliest Caddo Phase identified in western Arkansas (Schambach n.d.). The two features are aligned horizontally in a precisely adjacent manner, with no overlapping of their lateral margins; this alignment offers further support that they were contemporaneous.

Radiocarbon Dates from Wood Charcoal

Sample Number	*Date*
TX 1351	A. D. 1000 ± 50
TX 1352	A. D. 1010 ± 50
TX 1353	A. D. 1100 ± 50
TX 1360	A. D. 980 ± 60
TX 1356	A. D. 990 ± 60

The human teeth scattered around the antler pit represent a minimum of six adult individuals, identified by six left maxillary canines. Their distribution coincides with the locations of clusters of human cranial fragments in five out of the six cases. Of the 35 teeth from this area, only four (11%) are mandibular, an unexpectedly low proportion. The 73 teeth from the ash bed represent at least ten adult individuals, identified by ten left maxillary first molars. They were evenly distributed within the horizontal boundaries of the ash bed, but concentrated more heavily in the central vertical level. Thirty-three teeth (45%) came from this level, as compared with 24 teeth (33%) from the upper level and 16 teeth (22%) from the lower level. Again, only 13 (18%) of the teeth are mandibular. There were no mandibular teeth at all in the lower level, directly beneath the heaviest concentration of artifacts and teeth in the ash bed.

The absence of postcranial skeletal material cannot be attributed to differential bone preservation, as a great quantity of small animal bone was recovered by screening the ash. It seems more probable that a number of human skulls were separated from their bodies and brought to this spot to serve some purpose in connection with the antler pile and ash bed.

A group of eight skulls had been donated to the Arkansas Archeological Survey in 1968 by the landowner, Lon Rayburn. He had exposed these in the midden-free area 40 meters north of the ash bed, known as "The Plaza of the Skulls". He reported that over the past few years he had found some 30 skulls, placed singly or in groups in pits without postcranial material or artifacts, in this portion of the site. Isolated skulls are not uncommon at Caddo sites; they have been discovered at Spiro (Brown 1966), Belcher (Webb 1959), and Ferguson (Rose and Powell n.d.), to name only a few. At the end of the 17th Century, the Spanish priests Espinosa and Casanas observed a ceremony of the Hasinai Caddo in East Texas which involved the ritual burial of the "heads of victims taken by the Hasinai" in raids against enemy settlements (Griffith 1954: 132). It is not out of the question that a similar ceremony was performed by the Caddo who inhabited the Crenshaw site several centuries earlier. In view of the evidence, it seems perhaps the most reasonable explanation for these bodiless skulls.

Espinosa refers to these war trophies alternately as "heads" and "skulls". Examination of the eight skulls revealed certain features which indicate that these, at least, were buried as "heads," i.e., with the flesh still covering the bone. In all eight, the mandibles were in normal articulation with the crania, both at the temporomandibular joints and at the occlusal edges of the anterior teeth. Such articulation would be unlikely in skulls buried without their connecting tissue. A more striking feature is the presence of the first cervical vertebra in articulation with the occipital condyles of four of the eight skulls. A fifth skull preserved its articulation with both the first and second cervical vertebrae. Fragments of the hyoid bone were recovered from the dirt beneath the mandibles of two skulls. The three skulls apparently lacking these associated bones were the most badly crushed of the eight, and it is possible that fragments of vertebrae and hyoid were present but unidentified. These cervical vertebrae would not normally preserve their close articulation with the condyles at the base of the skull in the absence of connecting tissue, nor would the hyoid maintain its position below the mandible. They would not necessarily be dislodged during decapitation, due to their close proximity to the base of the skull and the thickness of the surrounding musculature.

None of the skulls bore marks which could be interpreted as fleshing cuts or scrapes. Several showed signs of gnawing by rodents, but this is common for buried skeletal material from western Arkansas and does not necessarily indicate exposure of the bone before burial.

Six of the skulls were sexed as male and two as female. These decisions were based upon standard features of cranial morphology listed by Bass (1971) and Krogman (1973), including the supraorbital ridges and margins, prominence of the forehead and parietal regions, the shape of the orbits and the chin. General indicators of robusticity such as the mastoid process and crest, the external occipital protruberance and nucchal area, the temporal lines, lateral diameter of the mandible head and its thickness at M_2 were also considered. These eight individuals fell within the ranges of size and robusticity observed in Caddo populations from Ferguson, Hedges, Copeland Ridge and other sites in western Arkansas (Hynds and Powell n.d.; Rose and Powell n.d.).

Age estimations were based upon dental eruption, attrition and degree of closure of the cranial sutures (Krogman 1973). One skull was aged at 17 to 25 years, because of incomplete eruption of the third molars and light wear on the erupted teeth. Another was placed in the 40 to 45 years old category because of advanced attrition, numerous resorbed sockets and the almost complete ectocranial obliteration of the coronal, sagittal and lambdoid sutures. Of the remaining six, two were aged at 20 to 30 years and four were aged at 30 to 40 years. The majority of the molars from the antler pile and ash bed showed similar attrition and would be placed in the last two age categories.

The inclusion of two female skulls among a group of probable war tropies is not inconsistent with the practice of warfare among the Indians of this area, as observed by early European chroniclers. The Hasinai customarily returned from battle with the heads and scalps of both male and female enemies. Joutel reported of them that "of the 48 persons (taken in a Hasinai raid) they gave quarter only to some young children" and that the war party returned to their village "loaded with heads . . ." (Swanton 1942: 186). The selection of the most robust male skull to crown the cluster of eight was surely deliberate, in view of this interpretation.

Only one of the skulls showed any notable pathology: the parietals and upper occitipal area of the top skull were thickened to 1½ times their normal size. This condition was accompanied by extensive osteoporotic pitting of the cortex in these parts. Taken together, these pathological changes suggest a fairly severe degree of anemia (Jane Buikstra 1976, personal communication).

Dental pathologies were also minimal among these eight individuals. Forty-five caries were observed in a total of 228 teeth, for a mean rate of 5.6 caries per individual and 0.2 caries per tooth. Only one individual had no caries at all. The molars offered the preferred site for carious involvement, due to their greater surface area and complexity. These rates are similar to those observed for other populations from western Arkansas, dating from the Mid to Late Caddo periods (Hynds and Powell n.d.; Rose and Powell n.d.). Two individuals exhibited alveolar abscesses, and the oldest of the group had lost five teeth who sockets had been completely resorbed. Calculus was common in all individuals except one, the youngest of the eight, but it generally appeared as stains rather than as three-dimensional deposits.

Three anomalous traits were observed in these eight skulls: Carabelli's cusp, congenital absence of the third molar and exostoses of the external auditory canal. The first two traits are under strict genetic control and do not appear responsive to environmental stimuli (Goose and Lee 1971; Brekhus, Oliver and Montelius 1944). Clinical studies of the exostoses of the external auditory canal indicate that they are more frequent among groups of closely related persons than among random members of a population. Environmental pressures seem to exert some influence on their actual expression, however (Hrdlicka 1935).

The accessory tubercules on the mesiolingual aspect of the maxillary molars known as Carabelli's cusps appeared in two of the eight dentitions, an incidence rate of 25 per cent. Rates of incidence for these discrete traits among other western Arkansas populations range between 43% and 27% for the two Coles Creek period populations represented at Mounds C and F at Crenshaw, to 14% for the Hedges and 19% for the Copeland Ridge populations, two Late Caddo sites on the Ouachita River. The trait was observed on eight of the 37 undamaged maxillary molars from the antler pile and ash bed at Crenshaw, a rate of 22 per cent. These rates may be skewed by the admittedly small sample sizes, but they do appear to confirm the findings of recent dental researchers that this trait is *not* so uncommon among Mongoloid populations as was once believed, provided that *all* levels of its expression are scored: the pit, the groove and the cuspule, as well as the complete cusp (Kraus 1959: 123).

The rates of incidence for the two other traits appeared to be unusually high for this group of eight skulls, when compared with most of the other western Arkansas populations mentioned earlier in this paper. Observations of these discrete traits meet the requirements for a binomial distribution, in that each trait can be scored simply as present or absent (Thomas 1976). Rates of incidence for these two traits were calculated for the populations represented at the Hedges, Copeland Ridge and Ferguson sites and for Mounds C and F at Crenshaw. Using these rates for comparison, probabilities for obtaining the seemingly high rates observed in the eight skulls were calculated using the binomial density function (Thomas 1976).

Three of the eight skulls showed congenital absence of at least one third molar, for an incidence rate of 37.5 per cent. In one case, the left lateral maxillary incisor was also absent. Both of these features are considered to be related expressions of the same genetic factors (Brekhus, Oliver and Montelius 1944). Combining the populations of the Hedges and Copeland Ridge sites, the incidence observed for this trait was nine per cent. The probability for obtaining a sample with an incidence of three out of eight cases, or 37.5%, from such a population is 0.0215, a very low probability. A similarly low probability exists for obtaining this 37.5% incidence rate from a population such as the Coles Creek period sample from Mound F at Crenshaw. The incidence for the Hedges sample alone was somewhat higher, and the probability for obtaining the rate observed in the eight skulls rose to 0.0755. At the 0.05 level of significance, therefore, the sample of eight skulls does not differ *for this one trait* from the population represented at the Hedges site.

Four of the eight skulls displayed exostoses or bony outgrowths in the external auditory canals, an incidence rate of 50 per cent. This condition is clinically noted to be more prevalent in males, and if expressed in females is more frequently unilateral than bilateral (Hrdlicka 1935). The Crenshaw sample reflected this sexual distribution. Combining the Caddo samples from the Hedges and Ferguson sites with the two Coles Creek period samples from Mounds C and F at Crenshaw, the probability for obtaining a sample with an incidence rate of 50% was calculated to be 0.0046, an extremely small probability. Once again, however, the Hedges sample alone provided a higher rate or incidence, 40%, and therefore the probability for obtaining a sample of eight with an incidence rate only 10% higher was calculated to be 0.2322, or nearly one in four chances.

The results of these comparisons appear to indicate that the population represented by the eight skulls was more similar to a population such as that represented at the Hedges site than to other populations in western Arkansas, on the basis of these two discrete traits. However, the small sample size, as well as the chronological discontinuity between these two sites, makes any conclusions based upon these observations extremely tentative.

SUMMARY

One hundred and eight loose human teeth were recovered from Feature 1, an antler pile, and Feature 6, an ash bed, at the Crenshaw site. These represent a total of 16 adult individuals who were apparently decapitated and their skulls brought to the site to serve some purpose related to these two features. A group of eight skulls excavated from the "Plaza of the Skulls" at the same site, representing six males and two females, probably suffered the same fate. Osteological analysis indicated that these skulls were buried while still covered with flesh. Ethnographic accounts of the Hasinai Caddo of East Texas at the end of the 17th Century indicate that these skulls may represent war trophies. Comparisons based on binomial probability of the eight skulls with skeletal material from other western Arkansas sites suggest a closer biological affinity with populations from the Ouchita River Valley than with the Coles Creek period populations represented at the Crenshaw site, on the basis of two non-metric traits. However, the samples are too small to draw any meaningful conclusions regarding biological distance between these populations. Such studies must await the recovery of large, well-documented skeletal series from this area, if questions of cultural affinity are to be answered from the skeletal record.

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REFERENCES CITED

Bass, W. M.
1971 *Human Osteology: A Laboratory and Field Manual of the Human Skeleton.* Missouri Archaeological Society, Columbia.

Brekhus, P. J., C. P. Oliver and G. Montelius
1944 A Study of the Pattern and Combinations of Congenitally Missing Teeth in Man. *Journal of Dental Research*, Vol. 23, pp. 117-131.

Brown, J. A.
1966 *Spiro Studies:* Volume 2, The Graves and Their Contents. University of Oklahoma Research Institute, Norman.

Goose, D. H. and G. T. R. Lee
1971 The Mode of Inheritance of Carabelli's Cusp. *Human Biology*, Vol. 43, pp. 64-69.

Griffith, W. J.
1954 *The Hasinai Indians of East Texas as Seen by Europeans 1687-1772.* Middle American Research Institute, Tulane University, New Orleans.

Hoffman, M. P.
1970 Archaeological and Historical Assessment of the Red River Basin in Arkansas. In: Archeological and Historical Resources of the Red River Basin, edited by Hester A. Davis. *Arkansas Archeological Survey Research Series*, No. 1, Fayetteville.

Hrdlicka, A.
1935 Ear Exostoses. *Smithsonian Miscellaneous Collections*, Vol. 93, No. 6, pp. 1-100.

Hynds, B. and M. L. Powell
n.d. Skeletal Analysis of 69 Burials from Arkansas. Paper read at the Caddo Conference, March 1975, Texas A&M University, College Station.

Kraus, B. S.
1959 Occurrence of the Carabelli Trait in Southwest Ethnic Groups. *American Journal of Physical Anthropology*, Vol. 17, No. 2, pp. 117-124.

Krogman, W. M.
1973 *The Human Skeleton in Forensic Medicine.* C. C. Thomas, Springfield, Illinois.

Rose, J. C. and M. L. Powell
n.d. Analysis of Human Skeletal Material from the Ferguson Site. Manuscript on file with the Arkansas Archeological Survey, Southern Arkansas University, Magnolia.

Schambach, F. F.
n.d. Deer Ceremonialism in Early Caddo Culture: Evidence from the Crenshaw Site in Southwest Arkansas. Arkansas Archeological Survey, Southern Arkansas University, Magnolia.

Swanton, J. R.
1942 Source Material on the History and Ethnology of the Caddo Indians. *Bureau of American Ethnology, Bulletin* No. 132.

Thomas, D. H.
1976 *Figuring Anthropology.* Holt, Rinehart and Winston, New York.

Webb, C. H.
1959 The Belcher Mound: A Stratified Caddoan Site in Caddo Parish, Louisiana. *Memoirs of the Society for American Archeology*, Salt Lake City.

NEUTRON ACTIVATION ANALYSIS OF WEST TEXAS CERAMICS: A STATISTICAL EVALUATION

CAROLYN EKLAND

ABSTRACT

A neutron activation study of west Texas Jornada Mogollon ceramics was statistically evaluated to see if the neutron activation technique is useful for distinguishing between ceramics manufactured by different cultural groups in separate geographical areas. The results of this study indicate that ceramics from a settled village site at Hueco Tanks show less variation in their element composition than ceramics collected from a number of widely dispersed, intermittently occupied sites in the Guadalupe Mountains area. The analysis further indicates that ceramics manufactured in widely separated geographical environments are generally distinct in their total element composition. The results of the statistical tests suggest that the elements most useful for showing these distinctions are the major constituents of clays.

INTRODUCTION

Neutron activation analysis is an analytical technique which is used to identify and measure the abundances of elements found in various geologic materials. Archeologists have recently found that knowledge of the element composition of artifacts can be useful for solving problems of a cultural nature such as locating the place of origin for artifacts or for establishing the existence of prehistoric contact between groups in separate geographical areas. Gordus *et al.* (1967) and Gordus *et al.* (1971) used neutron activation to locate the source of obsidian artifacts found in Hopewell burial mounds, and Allen *et al.* (1975) used the technique to identify the source material of steatite or soapstone bowls from sites in the eastern United States. Sabloff (1971) used data from neutron activation of Fine Orange and other pottery types to infer trade networks or movements of people between a number of Terminal Classic and Early Postclassic Maya sites, and Bennyhoff and Heizer (1965) used neutron activation of ceramics to suggest trade between the sites of Cuicuilco and Teotihuacan in the Valley of Mexico.

In neutron activation analysis a small sample is extracted from an artifact and placed in a nuclear reactor where it is bombarded with free neutrons. During the irradiation process some of the elements in the sample will absorb neutrons to form radioactive isotopes. Because these radioactive isotopes are unstable they will decay to the stable form over a period of time, emitting gamma rays during the disintegration process. The gamma ray emissions from the decaying isotopes exhibit characteristic energy levels and rates of decay which allow the investigator to identify the isotopes and, thereby, the stable elements from which they were produced. Quantitative measurements can be obtained by counting the gamma ray emissions from each of the elements detected in the sample and comparing these with emissions from standards irradiated under the same conditions (Meyers and Denier 1972: 4-7).

Due to individual differences in the elements' absorption of neutrons, and variations in the rate of decay for the resulting isotopes, different irradiation periods and counting schedules are employed in the analysis. Different elements and their respective amounts will be detected in each of the counts.

PROBLEM

Neutron activation studies have revealed that samples of material from the same geologic source or area are not always homogeneous in their element composition (Bowman *et al.* 1973); however, the element composition of source materials will often exhibit greater variation between different geographical regions than will materials extracted from within any one local (Allen *et al.* 1975). The analysis reported in this paper uses the results of a neutron activation study of west Texas ceramics to assess the relative homogeneity of element composition both within and between sherd populations drawn from two separate geographical areas. The analysis was further attempted to determine whether some inferences could be made as to the possible manufacturing origins for some of the pottery types in the sample. The actual neutron activation study which provides the basis for the statistical analysis reported in this paper was not conducted by the author; however, a description of the sample analyzed and a short discussion of the results is essential to understanding the statistical evaluation which follows.

Twenty-six sherds from the west Texas area were selected for the neutron activation study. The sample included 16 sherds which were randomly selected from a large sherd population collected by George Kegley from a Mogollon pithouse village at Hueco Tanks State Park in El Paso County (Figure 1); 10 sherds were selected from a sample collected from nine intermittently occupied sites in the Guadalupe Mountains National Park along the Hudspeth-Culberson County border by members of the 1970 Texas

Archeological Society field school (Figures 1 and 2). One of the sherds in the Guadalupe Mountains sample had no actual site provenience and was included as a random specimen. It is suspected that the sites in the Guadalupe Mountains area were occupied either by small transient Mogollon groups or by other cultural groups who were interacting with the Mogollon settlements further to the west (Harry J. Shafer, personal communication).

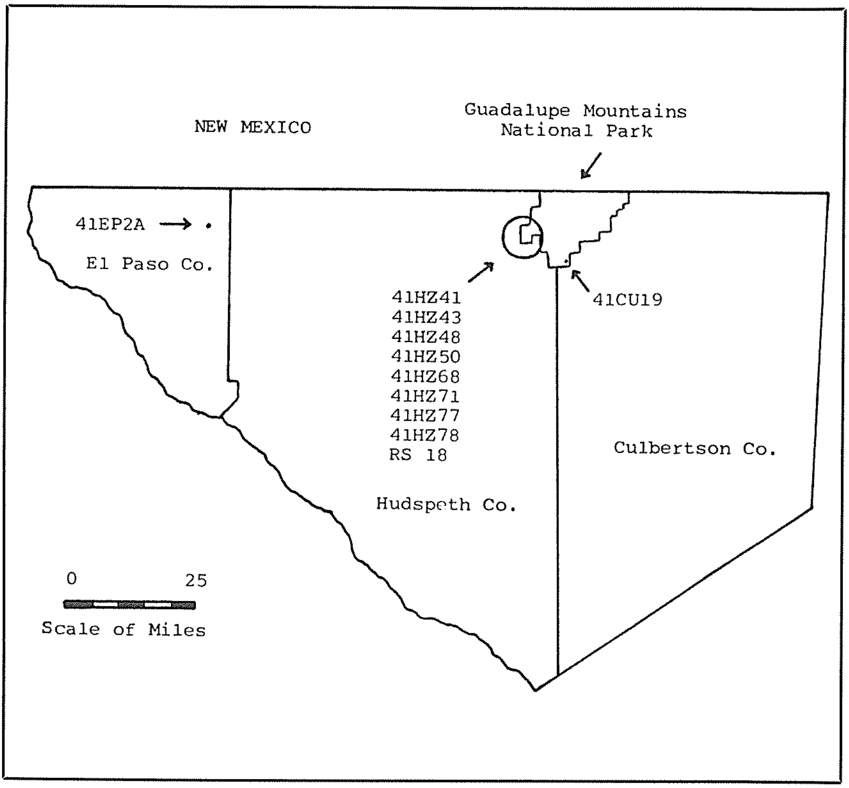

FIGURE 1. *Map of West Texas Area Showing the Locations of Hueco Tanks State Park and Guadalupe Mountains National Park*

The 26 sherds used in the analysis represent several types of pottery generally associated with the Jornada Mogollon ceramic assemblage. Of the 16 sherds from the settled village, 12 were El Paso Brown, two were Chupadero Black on White, and two were Mimbres Classic Black on White. Of the 10 samples from the Guadalupe Mountains area, eight were El Paso Brown, one was Chupadero Black on White, and one was an unclassified specimen resembling the El Paso Brown ware in paste composition but with an orange slip. The following are the general type descriptions for the ceramics used in the analysis:

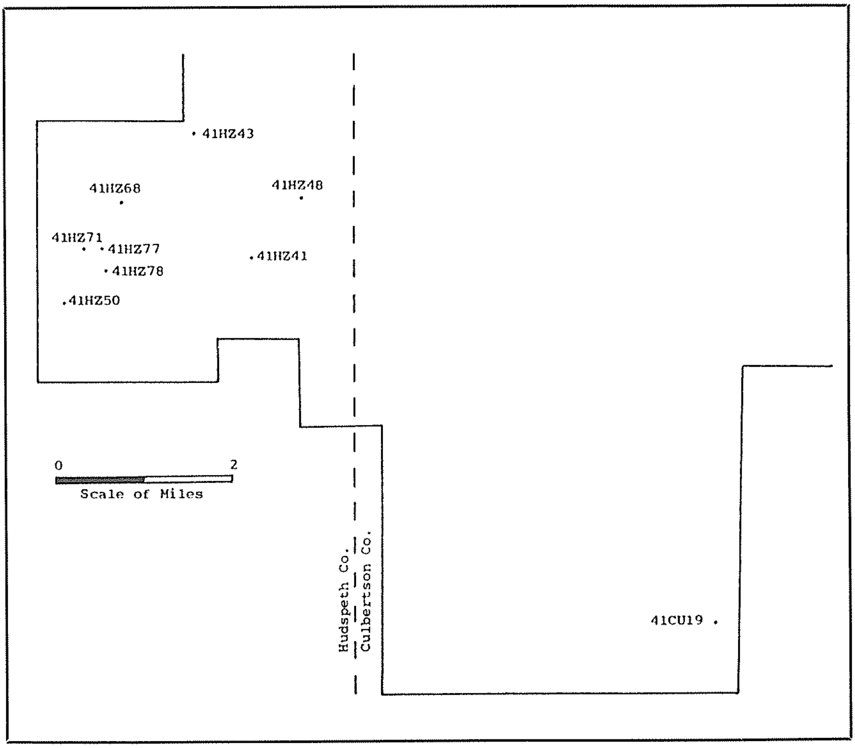

FIGURE 2. *Map of Southwest Corner of Guadalupe Mountains National Park Showing the Site Locations for Ceramics Used in the Project.*

El Paso Brown — A coiled, undecorated ware with a soft granular and friable paste. Paste color is generally a medium brown with surfaces often discolored by firing clouds. Tempering materials vary depending on the local but frequently include feldspars, gypsum, sand, or some combination of these (Runyan and Hendrick 1973: 21-22).

Chupadero Black on White — A coiled, well-fired ware with a fine textured paste. The paste color is uniform and ranges from light to dark grey. Vessels are generally slipped white or grey-white and painted with a black mineral paint. Temper varies with the area of manufacture often consisting of quartz sand, basalt, or basalt with crushed sherds (Runyan and Hendrick 1973: 37-38).

Mimbres Classic Black on White — A coiled ware with a relatively fine, porous, and friable paste. Paste colors range from light grey to grey-black. Interiors of vessels are slipped a heavy white and decorated with black mineral paint. The characteristic temper is a fine to medium quartz sand (Runyan and Hendrick 1973: 36).

Orangeware — An unclassified specimen with method of manufacture and paste characteristics closely resembling pottery of the El Paso Brown type. Unlike the El Paso Brown, however, the specimen features an orange slip.

Clay samples were not available from either locality. Admittedly it would be desirable to have the element composition of the local clays for comparison.

The ceramics were analyzed through neutron activation by Rebecca Wright (Ms.) at Texas A&M University. Two samples from each of the 26 sherds were prepared and used in the analysis. One sample from each sherd was irradiated for 30 seconds and the gamma ray emissions counted for five minutes; the second group was irradiated for 14 hours and the gamma ray emissions counted for 60 minutes.

This method of analysis identified 16 different elements in the ceramics as a whole; however, not all of the 16 elements were detected in each sherd. The short irradiation and count revealed the presence and amounts of aluminum, calcium, chlorine, potassium, magnesium, manganese, sodium, and vanadium; with the exception of chlorine these elements were detected in all of the pottery samples analyzed. The longer irradiation and count yielded the presence and amounts of arsenic, gold, bromine, cadmium, cerium, potassium, lanthanum, sodium, antimony, and samarium; the presence of these elements was considerably more variable for only lanthanum, sodium, and samarium were detected in all of the ceramics. The quantitative analysis also indicated that the majority of the long-run elements were present in considerably smaller concentrations than those detected in the short count.

As was mentioned earlier, the following analysis was conducted to evaluate the potential of neutron activation analysis as a means for assessing the relative homogeneity of element composition both within and between two ceramic populations and to determine whether any inferences could be made as to the manufacturing origins for some of the ceramic types. The two populations selected for the study were drawn from widely separated geographical environments, each occupied by cultural groups differing in their degree of sedentism. Provided that the assumption that artifacts manufactured from materials in one particular local will show similarities in element composition is true, it is hypothesized that due to differences in selected clay sources, the sherds from the settled village will show less variation in element composition than will the samples collected from the more widely dispersed, intermittently occupied sites. It is further believed that if the two geologic environments are sufficiently different this will be reflected in the clay sources, the end result being that each group of ceramics will exhibit differences in total element composition.

The black on white ceramic types collected from both the settled village and Guadalupe Mountains area are not believed to be native to the region and are suspected to be imports (Harry J. Shafer, personal communication). If this is true, the analysis should indicate that the element composition of their clays is distinct from the other ceramics used in the analysis.

STATISTICAL ANALYSIS

A recent neutron activation study of ceramics has revealed that often times clays from different areas of the world do not exhibit distinct differences in their element composition, especially if single elements or only a very few elements are considered (Harbottle 1970: 29). For this reason it was decided that a statistical method which could incorporate the data for as many elements as possible was necessary for testing the hypotheses proposed in this paper. A factor analysis was selected as the statistical technique which would provide the kinds of information most useful for the project.

The first part of the project involved recording on computer cards the amounts of such element detected in each sherd. A factor analysis (Nie *et al.* 1975) was then used to reduce these data to a smaller set of variables called factors; each of these factors represents a distinct pattern of variation which is shared by certain elements in the clays. Only nine of the sixteen elements were selected for the analysis as they were present in the majority of the samples. Due to missing data for some of these nine elements, the factor analysis ignored the one Chupadero Black on White sherd from the Guadalupe Mountains area, reducing the data set to 25 cases.

The factor analysis produced three factors which accounted for 80.8% of the variation in the data. The factor matrix, shown in Table 1, indicates that there are three independent patterns of interrelated elements in the clays of the ceramics; strong loadings, which are underlined in the matrix, show which individual elements are characteristic of each factor. The strong positive loadings for Factor I indicate that there is an element pattern in the clays which lanthanum, sodium, and samarium are involved in;

the absolute amounts of the loadings measure how closely each element is related to this pattern, that is, the higher the loading the closer the relationship between the element and the pattern.

TABLE 1. ROTATED FACTOR MATRIX

	Factor I	Factor II	Factor III
Aluminum	.01	.87	.42
Calcium	-.22	.00	.74
Potassium	-.23	.24	.74
Magnesium	.18	.39	.61
Manganese	.06	.67	.18
Vanadium	.01	.79	-.02
Lanthanum	.99	.03	-.17
Sodium	.83	.05	-.04
Samarium	.94	.02	-.12

TABLE 1. ROTATED FACTOR MATRIX

Three factor scores for each of the 25 sherds were also obtained and can be seen in Table 2. These scores measure the relative importance of each sherd to the particular factor; a high positive score indicates that the sherd contains a high proportion of those elements characteristic of the factor and a high negative value indicates that the particular sherd is deficient in the elements characteristic of the factor.

To test the hypothesis that the ceramics from the settled village would show less variation in element composition than would those from the sites in the Guadalupe Mountains area, the variance of the factor scores for each of the sherd samples were calculated and compared; factor scores, rather than the actual amounts of each element detected in each sherd, could be used for this as the meaningful variation in the original data is not lost when factor scores are computed (Rummel 1967: 451). Two measures of the variance for the settled village ceramics were calculated for each set of factor scores, one for all 16 of the sherds and one for only the brownware; if the black on white ceramics were imports to the site and thus manufactured from clays of a different element composition it was suspected that this would be reflected in the variance. One measure of the variance was calculated for the sherds from the Guadalupe Mountains region, again for each group of factor scores; the orangeware specimen was included with the brownware due to similarities in the paste composition.

TABLE 2. FACTOR SCORES FOR SHERDS

	Factor I	Factor II	Factor III
Settled Village			
El Paso Brown			
1	-.14	.80	-.06
2	1.28	.70	.37
3	3.39	-.39	.37
4	.40	.57	.12
5	-1.79	.51	-.08
6	.77	-.11	.44
7	-1.01	.30	.20
8	-.65	-.13	.16
9	-.23	-.47	-.02
10	-.41	.29	-.33
11	1.25	.49	-.29
12	-.29	.43	-.08
Chupadero Black on White			
13	-.93	-1.27	2.90
14	-.56	2.38	-.00
Mimbres Classic Black on White			
15	-.33	-.59	1.68
16	-.69	.07	-.30
Scattered Sites			
El Paso Brown			
17	.15	-.14	-.29
18	-.12	.30	.54
19	.32	2.30	.53
20	.61	-.86	-.96
21	-.76	-1.28	-.70
22	.25	-1.13	-.69
23	.54	-.94	-1.19
24	-.15	-.97	-1.29
Orangeware			
25	-.90	-.88	-1.02
Variance			
Settled Village			
All Ceramics	1.39	.60	.65
Brownware	1.65	.16	.06
Guadalupe Mountains	.25	1.14	.42

TABLE 2. FACTOR SCORES FOR INDIVIDUAL SHERDS

The variance of the factor scores for both groups of sherds from the settled village and for the brownware from the Guadalupe Mountains sites can be seen at the bottom of Table 2. For the factors that loaded heavily for the elements in the short count, Factors II and III, the variance of the factor scores for the settled village brownware was lower than that of the Guadalupe Mountains sample; this indicates that the composition of the elements characteristic of these factors was more homogeneous. This difference in the variance was expected as it seems likely that the ceramics from the village would have been manufactured from one or a few good clay sources located close to the village while those from the Guadalupe Mountains area would have been manufactured from a number of different sources.

For the factor that loaded heavily for the elements detected in the longer irradiation and count the situation was reversed, that is, the settled village sample showed a considerably higher variance than did the Guadalupe Mountains group due to some extremely high and low concentrations of lanthanum, sodium, and samarium in some of the sherds. This was not expected and may be directly related to the characteristics of the clay samples used in the actual neutron activation study. Earlier studies have indicated that ceramics are not homogeneous and that small samples will differ to some degree from the body as a whole (Perlman and Asaro 1971: 188). It has been further determined that elements that occur in very small amounts will not be dispersed in a statistically satisfactory number of particles if the pottery is not well homogenized (Perlman and Asaro 1971: 184). Both lanthanum and samarium, which contributed the most heavily to the factor, were found in considerably smaller amounts than most of the other elements. If the ceramics were not well homogenized these elements would not be well dispersed in the clays, the end result being that either high or low concentrations could be present depending on where the actual sample was extracted from the sherd. Taking the size of the two populations into consideration, sixteen for the settled village as opposed to nine for the scattered sites, the greater variation exhibited by the settled village ceramics does not seem unreasonable for there would be an increased possibility that more extremes would appear in a larger population.

When the variance of the factor scores for all the settled village ceramics were compared with the variance for only the brownware, there was an increase in the variance for the elements important in Factors II and III; once again this occurred because certain pieces of the black on white ceramics contained larger amounts of some of the elements especially calcium, potassium, manganese, and vanadium. However, the variance for elements characteristic of Factor I decreased because the amounts of these elements in the black on white pieces were closer to the average, the extremes being found in the brownware population.

While the results of this rather simple analysis should not be considered conclusive due to the small size of the sample and the possibility of measurement errors in the neutron activation study itself, it would appear that the settled village ceramics showed less variation in element composition than did those from the Guadalupe Mountains area. In this instance the elements from the short count were the most useful for assessing the relative homogeneity for the two populations of ceramics as they were present in large amounts and were found in all of the samples. The elements detected in the longer count appeared to be relatively useless for this kind of analysis for two reasons: first, not all of the elements were found in all of the pottery samples analyzed; and second, those that were detected in all of the samples were present in such small concentrations that they would be susceptible to extreme variation from sample to sample if the clays were not well homogenized.

Each of the three sets of factor scores were then plotted against each other on scattergrams to see if the scattered site sample would separate out from the settled village ceramics. Both Factor II and III exhibited some separation when plotted against Factor I; however, the most distinct separation occurred between Factor II and III (Figure 3). Both Factor II and III exhibited heavy loadings for some of the major elements found in clays including aluminum, calcium, potassium, and magnesium (Shepard 1971: 6-10 and 374-377).

The scattergram plot revealed two general clusters, one for the settled village ceramics and one for the dispersed settlement sample (Figure 3). One sherd from the scattered site population (18) clustered with the settled village, and one (19) fell outside both the dispersed settlement and settled village populations; in both cases these ceramics contained greater concentrations of the major clay elements than did the rest of the scattered site sample. Three of the four black on white pottery pieces also failed to cluster with the settled village sample; this suggests that although the ceramics were found at the settled village they were manufactured from a different clay source than the brownware, lending support to the hypothesis that they are not indigenous to the site.

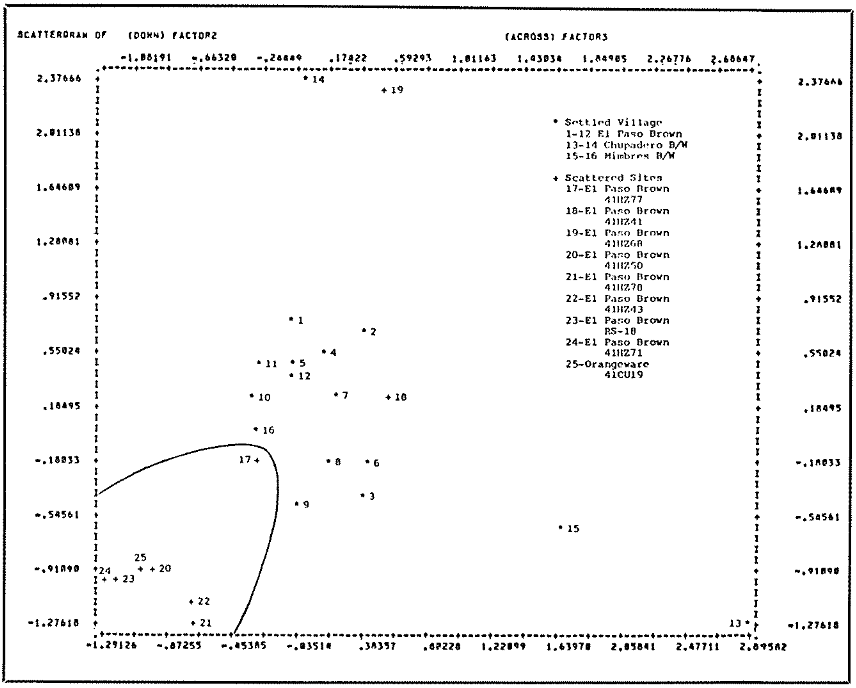

FIGURE 3. *Scattergram of Factor II and Factor III.*

Although the separation of the two ceramic populations is not perfect, the scattergram plot indicates that the Guadalupe Mountains sample is generally distinct from the settled village ceramics in element composition and that it is the major constituents of clay that best reflect this difference.

CONCLUSIONS

Although neutron activation analysis has generally been addressed to problems of ceramic origins, this statistical evaluation has indicated that the results are also useful for distinguishing between populations of ceramics drawn from sites occupied by cultural groups differing in their degree of sedentism. It has further indicated that the results of neutron activation studies can be successfully used to differentiate between ceramic populations manufactured in separate geographical environments. The statistical tests suggest that when dealing with problems of this nature it is best to focus on elements found in the greatest abundances in ceramics, especially the major constituents of clays.

The minor trace elements detected in considerably smaller amounts proved to be useless for either accurately assessing ceramic homogeneity within populations or for distinguishing between populations from different geographical areas; this is most likely related to the actual characteristics of the ceramics themselves for if pottery is not well homogenized the amounts of these elements could exhibit wide variation depending on where the sample was extracted from the sherd. However, the detection of these trace elements would likely be of critical importance to the investigator dealing with ceramic origins for they would most likely reflect slight differences in various geologic surroundings.

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REFERENCES CITED

Allen, R. O., A. H. Luckenbach, and C. G. Holland
1975 The Applications of Instrumental Neutron Activation Analysis to a Study of Prehistoric Steatite Artifacts and Source Materials. *Archaeometry*, Vol. 17, part 1, pp. 69-83.

Bennyhoff, J. A. and R. F. Heizer
1965 Neutron Activation Analysis of Some Cuicuilco and Teotihuacan Pottery: Archaeological Interpretations of Results. *American Antiquity*, Vol. 30, No. 3, pp. 348-349.

Bowman, H. R., F. Asaro, and I. Perlman
1973 Composition Variations in Obsidian Sources and the Archaeological Implications. *Archaeometry*, Vol. 15, Part 1, pp. 123-127.
Gordus, A. A., W. C. Fink, M. E. Hill, J. C. Purdy, and R. T. Wilcox
1967 Identification of the Geologic Origins of Archaeological Artifacts: An Automated Method of Na and Mn Neutron Activation Analysis. *Archaeometry*, Vol. 10, pp. 87-96.
Gordus, Adon A., James B. Griffin, and Gary A. Wright
1971 Activation Analysis Identification of the Geologic Origins of Prehistoric Obsidian Artifacts. *Science and Archaeology*, Fourth Symposium on Archaeological Chemistry, Atlantic City, 1968. ed. by Robert H. Brill, pp. 222-234, MIT Press.
Harbottle, G.
1970 Neutron Activation Analysis of Potsherds from Knossos and Mycenae. *Archaeometry*, Vol. 12, Part 1, pp. 23-34.
Meyers, Thomas and Mark Denier
1972 LONGTERM and SPEKSCAN: Neutron Activation Analysis Computer Programs. *The University of Michigan Museum of Anthropology Technical Reports*, No. 2, Ann Arbor.
Nie, Norman H., C. Hadlai Hull, Jean G. Jenkins, Karin Steinbrenner, and Dale H. Bent
1975 *Statistical Package for the Social Sciences*. McGraw-Hill, New York.
Perlman, I. and Frank Asaro
1971 Pottery Analysis by Neutron Activation. *Science and Archaeology*, Fourth Symposium on Archaeological Chemistry, Atlantic City, 1968. ed. by Robert H. Brill, pp. 182-194, MIT Press.
Rummel, R. J.
1967 Understanding Factor Analysis. *The Journal of Conflict Resolution*. Vol. 11, No. 4, pp. 444-480.
Runyan, John W. and John A. Hendrick
1973 Pottery Types of the SWFAS Area. *Transactions of the Eighth Regional Archaeological Symposium for Southeastern New Mexico and Western Texas*, pp. 19-45, Publication of the Lea County Archaeological Society, Inc., Hobbs, New Mexico.
Sabloff, Jeremy A.
1971 Comments on the Archaeological Background and Implications of the Neutron Activation Analysis of Fine Paste Pottery. *Science and Archaeology*, Fourth Symposium on Archaeological Chemistry, Atlantic City, 1968, ed. by Robert H. Brill, pp. 180-181, MIT Press.
Shepard, Anna O.
1971 Ceramics for the Archaeologist. *Carnigie Institution of Washington, Publication 609*, (Seventh Printing), Washington, D.C.
Wright, Rebecca
Ms. Neutron Activation Analysis on Pottery. Unpublished manuscript in the files of the Department of Anthropology, Texas A&M University, College Station, Texas.

NOTES

A POLYCHROME VESSEL FROM GOLIAD COUNTY, SOUTHERN TEXAS

ANNE A. FOX AND W. S. FITZPATRICK

ABSTRACT

A polychrome, bone tempered vessel embellished with a trailed and punctated motif is described. The vessel bears characteristics of both Goliad and Rockport wares and the implications of these mixed attributes as to the origin of the potter are discussed.

In 1974 W. S. Fitzpatrick of Corpus Christi, Texas, sent a collection of ceramic sherds to Dr. Thomas R. Hester of The University of Texas at San Antonio for analysis. The sherds had been found some years previously on the south bank of the San Antonio River two or three miles upstream from Mission Rosario. Since the decoration on the vessel represented by the sherds appears to be unlike that reported from other sites in the area, the vessel will be documented fully here for the information of others who are interested in ceramics from south Texas aboriginal and mission sites.

DESCRIPTION

The collection consists of 64 sherds from a single vessel (see Fig. 1). No information is available on whether there was other artifactual material present on the site. It has been possible to restore enough of the vessel to reconstruct the original shape and to estimate its dimensions (Fig. 2). The following data have been obtained from examination of the sherds:

Shape: small, wide-mouthed jar with globular body and rounded bottom

Method of manufacture: coiled construction

Approximate height: 19 cm

Diameter at rim: 14.5 cm.

Maximum diameter of body: 18 cm

Wall thickness: neck, 4 cm; base, 5 to 6 cm

Rim: flat, with closely spaced notches, giving a serrated appearance (Fig. 1)

Paste texture: very fine, 1/8 to 1/16 mm

Temper: tiny flecks of white and gray bone

Finish: exterior, smoothed with fine, vertical striations on neck; interior, crudely smoothed with overlapping coils visible on neck, numerous fingernail impressions lumpy areas, and random striations.

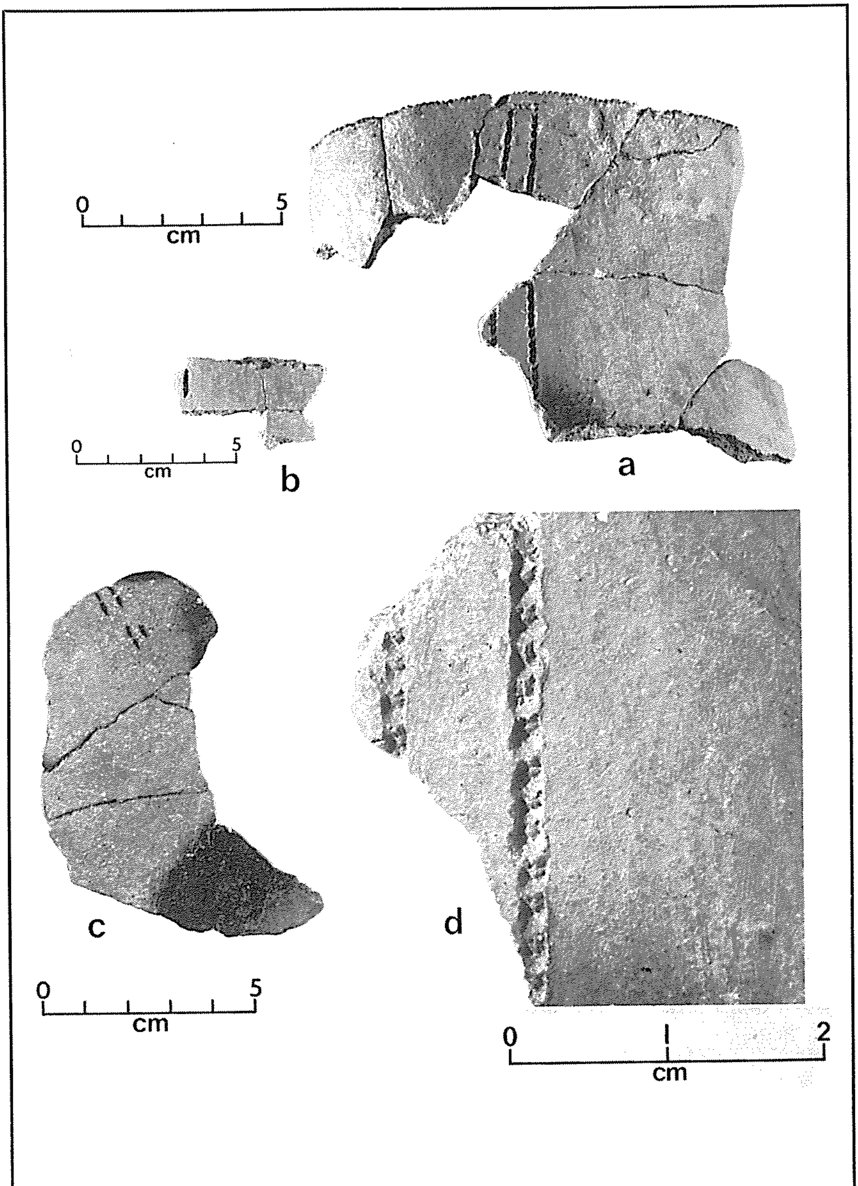
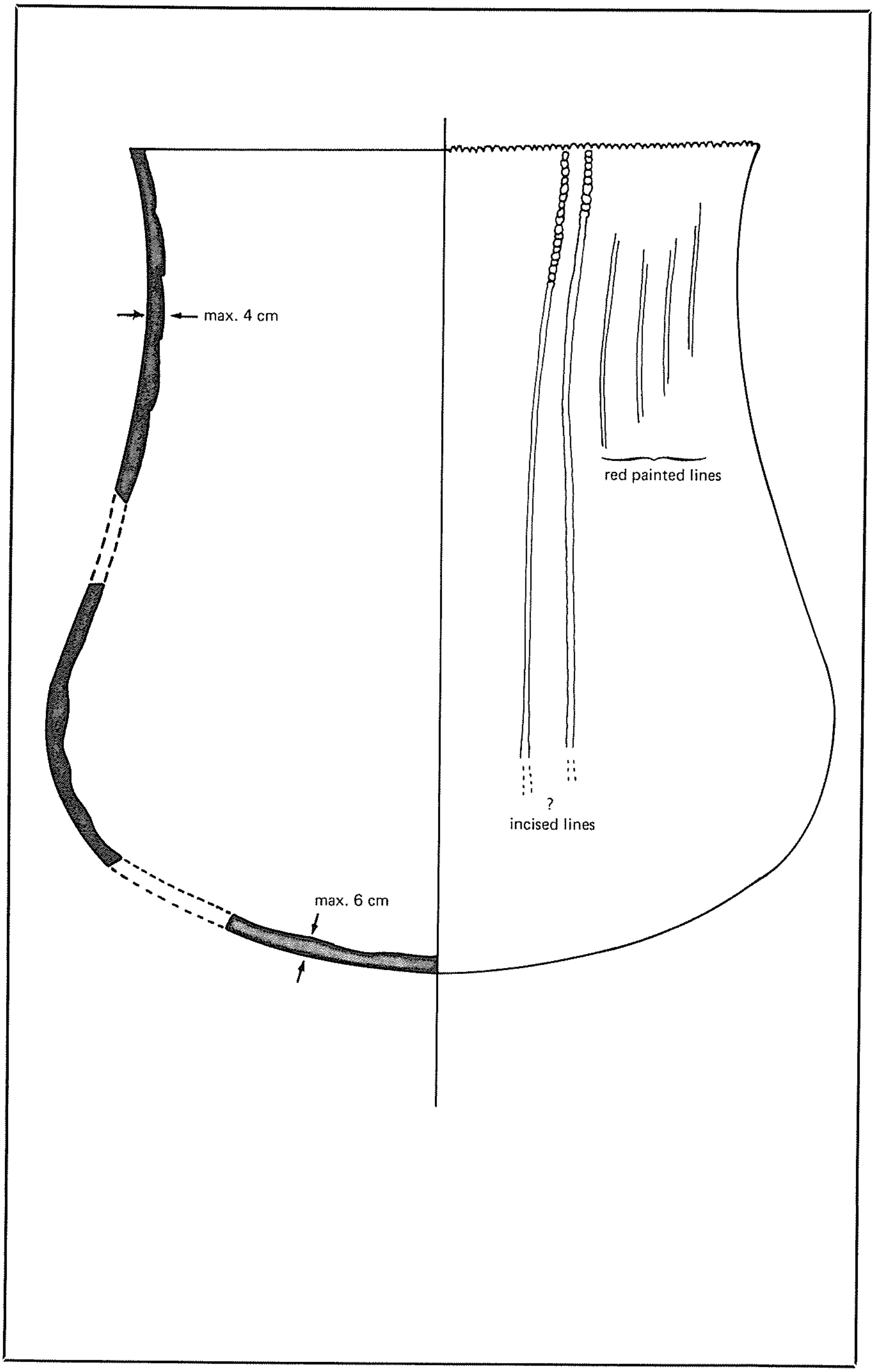


FIGURE 1. *Sherds of Vessel from Goliad County.* a, portion of neck showing incised decoration and notched rim; b, body sherd with asphaltum on exterior; c, basal sherd with incised lines; d, enlargement of incised decoration (approximately 4 times actual size). Note varying scales.


max. 4 cm
red painted lines
?
incised lines
max. 6 cm

Color: exterior, reddish-brown (5YR 6/4) to pinkish-gray (5YR 6/2) with dark gray fire clouds on body and base; interior, uniformly reddish-brown; core of most sherds is dark to light gray.

Surface treatment: double incised vertical lines containing punctations from rim to near base, barely visible red lines parallel to incised lines, traces of asphaltum in no particular pattern, probably accidental or the result of crack mending (Fig. 1,b).

DISCUSSION

In general, this vessel fits the description by Mounger (1959: 164-165) for the bone tempered Goliad wares, in all details except decoration. Its shape, size and proportions are similar to those of vessels she describes from Mission Espiritu Santo seven miles downstream from the site where the vessel was found (*ibid.*: 166). However, the surface treatment appears to be unique. Campbell (1962: 334) in his summary of Mounger's type descriptions, indicates that Goliad Red-on-buff often bears broad, vertical, widely spaced lines in a dull red paint. The red lines barely visible on the vessel in question are neither broad nor widely spaced. The incised decoration, apparently made while the clay was still quite wet, was accomplished by alternately pulling and jabbing a stick or reed 1.5 mm in diameter along the surface of the vessel, probably from the rim down the neck and onto the body. Also present are short pairs of similar lines on the body of the vessel (Fig. 1). There is not enough of the vessel present to determine the pattern, but the design appears to repeat three or four times around the vessel. This type of trailed and punctated design has not been reported previously on any type of Texas ware. However, Gilmore illustrates sherds of Goliad Black-on-buff with a single line of punctations extending downward from the rim from Mission Rosario (1975: 117 and Fig. 35, E and G), and Campbell (1962: 332) indicates that punctations are occasionally found on Rockport Black-on-gray vessels.

The rim treatment in this case is unusual, not in form but in the execution of the notching. A tradition of rim notching is well known on Rockport wares (Suhm and Jelks 1962: 135, 136L), but the notches on this vessel are much closer together than any the senior author has seen.

It appears that we have in this one small jar an unusual blending of Goliad and Rockport traditions. Since there exists no information about other materials from the site, we can only speculate on the possible origins of vessel and potter. There are indications in the collections of sherds from the Goliad missions that Goliad ware was occasionally decorated in a manner reminiscent of Rockport Black-on-gray (Campbell 1962: 334). It appears that in the case of the Fitzpatrick vessel, the vertical lines of punctations and rim notching may have been inspired by similar, though not identical, designs the potter may have known from his or her own experience, or observed on Rockport wares brought into the missions. The workmanship of the vessel, the thin walls and fine textured paste, are suggestive more of Rockport wares than of the thicker walls and coarser paste of Goliad wares, implying perhaps a neophyte coastal potter working with local clays but in his own tradition.

The location of the site on which the sherds was found is near the trail from Mission Rosario to its ranch upstream (Forrestal 1931: 17). Goliad ware sherds have been found on a number of other sites in Goliad and Karnes Counties. The Scarborough Site (Calhoun 1966) contained two restorable jars of Goliad Plain accompanied by chert tools in a campsite about 20 miles east of Mission Rosario on a tributary of the San Antonio River. Another site containing sherds of Goliad Plain plus typical Mexican made ware used in the missions, was located approximately the same distance upstream on the west bank of the San Antonio River (*ibid.*). Undoubtedly many more such temporary campsites exist along streams in southern Texas, where mission Indians stopped in their travels between missions and on visits to other aboriginal groups in the area.

In conclusion it was suggested that this small, well-made and carefully decorated jar was made by an Indian in one of the Goliad missions who had either been taught in or exposed to the coastal pottery traditions (a phenomenon which probably also occurred in the Goliad County area in late prehistoric times; cf. Hester and Parker 1970: 21). It was probably accidentally broken during a trip up the San Antonio River, perhaps to the Rosario ranch or to the ranches or missions near San Antonio.

References Cited

Calhoun, C. A.

1966 A Small Campsite near Kenedy, Texas. *Newsletter of the Houston Archeological Society*, No. 18.

Campbell, T. N.

1962 Origins of Pottery Types from the Coastal Bend Region of Texas. *Bulletin of the Texas Archeological Society*, Vol. 32.

Forrestal, Rev. P. P., translator
1931 The Solis Diary of 1767. *Preliminary Studies of the Texas Catholic Historical Society*, Vol. 1, No. 6.

Hester, T. R. and R. C. Parker
1970 The Berclair Site: A Late Prehistoric Component in Goliad County, Southern Texas. *Bulletin of the Texas Archeological Society*, Vol. 40, pp. 1-24.

A PAINTED PEBBLE FROM A SITE ON THE NUECES RIVER, SOUTHERN TEXAS

THOMAS R. HESTER

ABSTRACT

A painted pebble from an archeological site on the Nueces River, Zavala County, Texas, is documented. It represents the only known occurrence of this artifact form in southern Texas. Comparative studies indicate considerable similarity with the painted pebbles of the lower Pecos region.

As a part of the 1975 Field Course in Archeology of The University of Texas at San Antonio, an archeological reconnaissance was conducted on the Mangum Ranch (owned by Belton K. Johnson) near La Pryor in Zavala County (Fig. 1). The eastern edge of the ranch lies along the Nueces River; on a series of eroded terraces west of the present river channel, a number of prehistoric archeological sites were recorded.

At one site, M-2 (41 ZV 183), the author discovered a painted pebble recently exposed by gullying action that had cut through buried deposits. In addition to the painted pebble, a limited surface collection at this large terrace occupation site produced a series of Archaic period chipped stone artifacts, including dart points (*Marshall*, "Early Corner Notched," *Matamoros*), a *Clear Fork* tool, preforms, cores, flakes and flake-blades, and a hammerstone made on a cobble very similar to the painted example reported here.

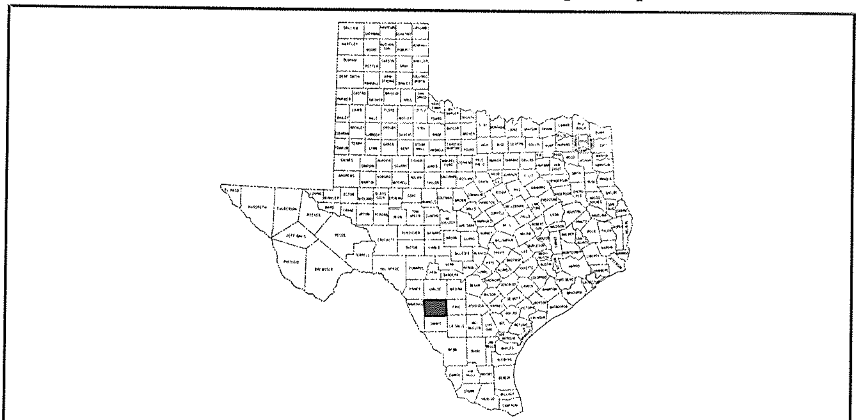


FIGURE 1. *Location of Zavala County, Southern Texas.* The location of the county is shown as a darkened rectangle.

The painted pebble is illustrated in Fig. 2. It is made on an oval, biconvex pebble of cherty limestone, gray-white in color. The designs are in red and are painted (or at least survive) on one face. Length of the specimen is 78 cm, maximum width is 59.5 cm, maximum thickness is 22 cm, and it weighs 149.4 g.

The motifs, as shown in Figs. 2 and 3, consist of bilaterally symmetrical pairs of curved and intertwined lines (the lines average 2 mm in width). Linear and oval appendages are found on the right side, and may have been present on the left, but that area is badly eroded. There also appear to have been lines running up the center of the pebble between, or perhaps connecting, the pair of curved double lines. Again erosion has removed all but minor traces of these lines. An artist's rendering of the motifs (Fig. 3) clearly depicts a tri-lobed motif in the lower left portion of the pebble; if a similar motif was present on the opposite side, it has been eroded away.

Specimens of this kind have not previously been reported from southern Texas sites. Typically, southern Texas prehistoric sites have not yielded any perishable cultural materials (other than faunal debris and occasional artifacts of bone). The nearest reported specimen comes from Kincaid Rockshelter, near Sabinal in Uvalde County. T. N. Campbell (personal communication, February 1977) describes the specimen as being larger than the artifact from 41 ZV 183, with the painting barely visible. Campbell also notes that the Kincaid specimen has closely parallel, partly overlapping lines at one end "and looks a bit like certain specimens said to have come from the lowest levels of Fate Bell and Eagle Cave."

In the lower Pecos region of southwest Texas, numerous painted pebbles have been found in Archaic contexts in dry rockshelter deposits (cf. Davenport and Chelf 1941; Parsons 1965a, b; Collins 1969).* The most comprehensive study is that of Davenport and Chelf. They note (p. 3) that the dominant paint used on lower Pecos specimens is black, with red the second most common color. They describe most of the red paints as "ferrous pigments," derived from ochre or hematite. While the residue on the painted pebble from 41 ZV 183 has not been analyzed, I would guess that it has an ochre base. Although the designs on the Zavala County specimen are rather faint, comparison shows them to be somewhat similar, though by no means identical, to those found on several lower

*Occasional painted pebbles are also found in central and west central Texas (cf. Field 1956; Jelks 1962; Shafer 1971).

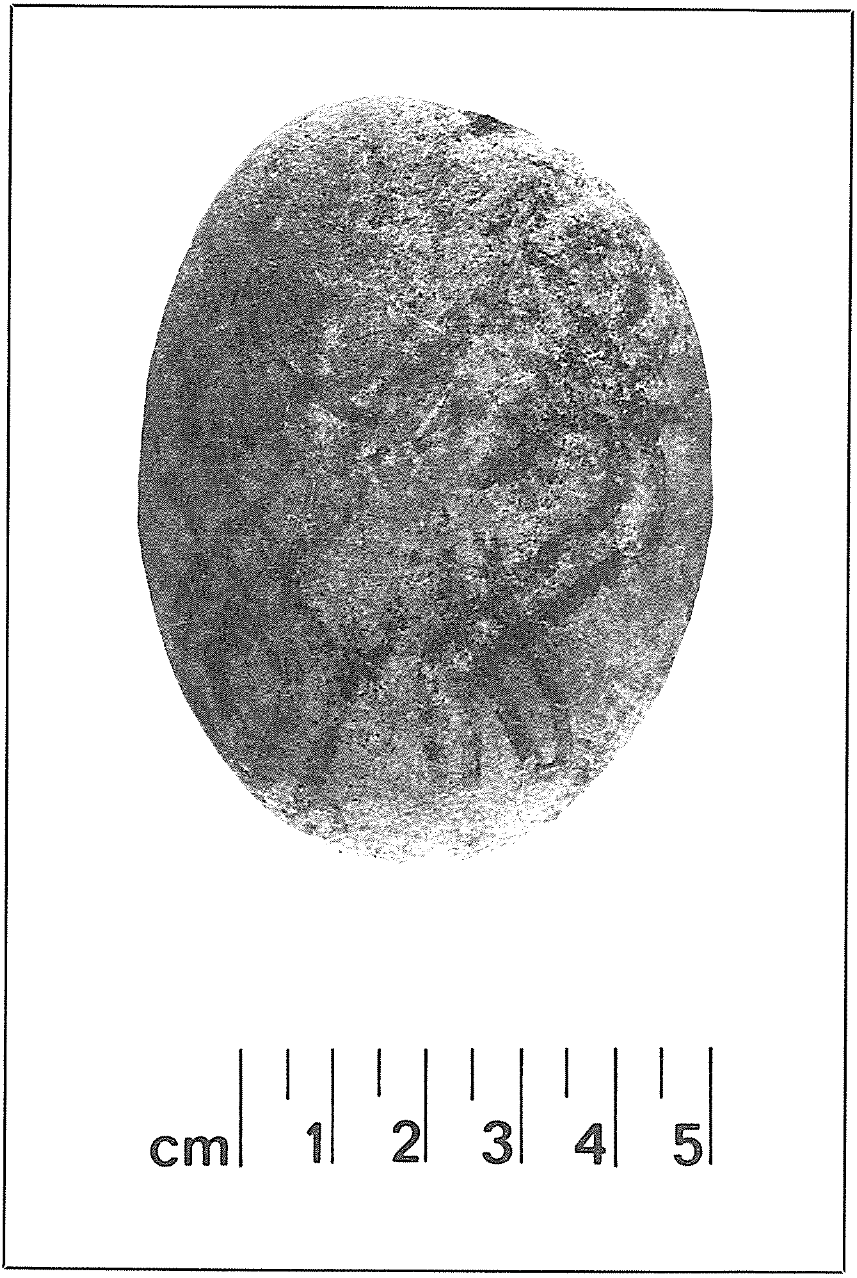


FIGURE 2. *Painted Pebble from 41 ZV 183.*

Pecos painted pebbles (cf. Davenport and Chelf 1941: Pls. VIII, 1; XIII, 3).

While it is beyond the scope of this brief note to explore the meaning or interpretation of painted pebbles it has been suggested that they represent anthropomorphic figures, probably females (cf. Davenport and Chelf 1941: 5-6; Parsons 1965a: 154; Parsons ms.: 39). A thorough review of this interpretation, and other theories, is found in Shafer (1975: 11-13).

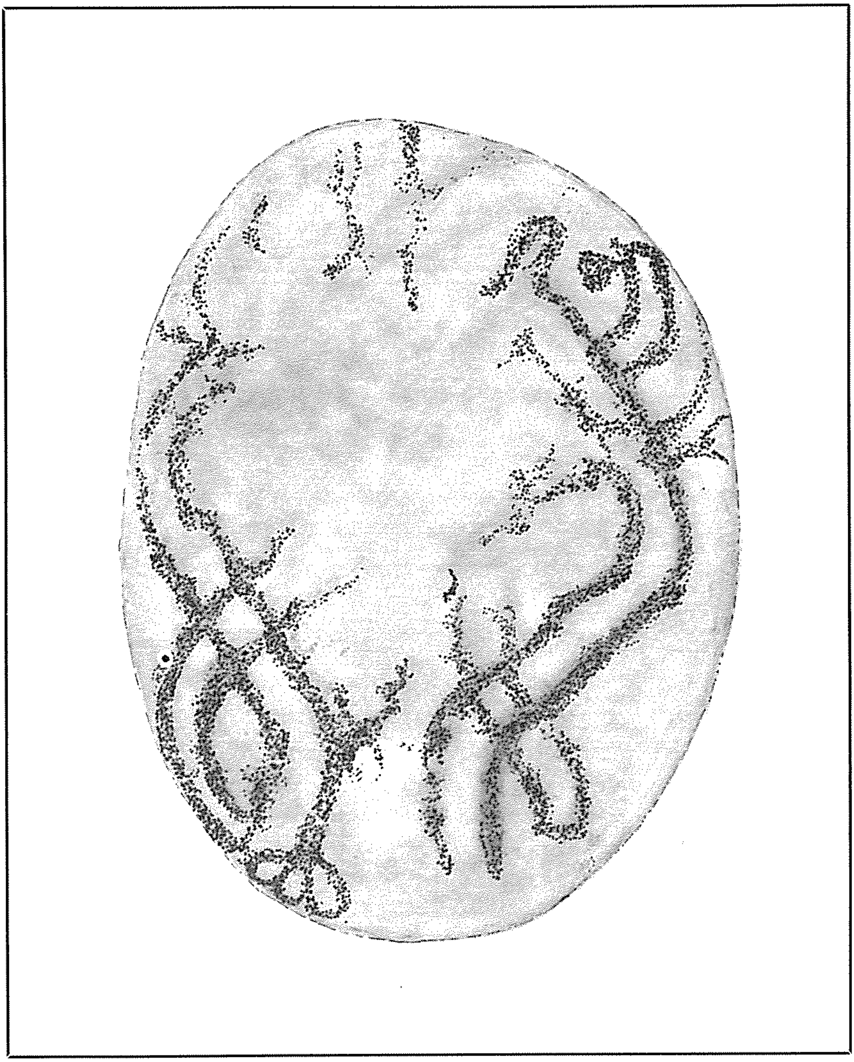


FIGURE 3. *Artist's Sketch of Painted Pebble from 41 ZV 183.*

The significant aspect of the painted pebble from 41 ZV 183 is not its mere occurrence. Rather, it sheds new light on the material culture of the prehistoric populations of the southern Texas coastal plain. Most often, archeologists working in this area have to deal solely with chipped and ground stone tools which have survived the ravages of time. Yet we know from ethnohistoric accounts (cf. Ruecking 1955) that the native populations had an extensive cultural inventory consisting of artifacts fashioned of wood, plant fibers, and other perishables. Ornaments made of shell have been briefly reported from some sites (cf. Hester 1971), but other forms of "art" have not been documented until this time. I should also point out in closing that a pictograph site was documented by the 1974 UTSA Field Course in Archaeology along the Rio Grande in Webb County (author's notes, on file at the UTSA Center for Archaeological Research). It is hoped that this important site can be published in the near future.

References Cited

Collins, M. B.
1969 Test Excavations at Amistad International Reservoir, Fall, 1967. *Papers of the Texas Archeological Salvage Project*, No. 16.

Davenport, J. W. and C. Chelf
1941 Painted Pebbles of the Lower Pecos and Big Bend Regions of Texas. *Witte Memorial Museum, Bulletin* No. 5.

Field, A.
1956 Archeological Investigations in Lampasas, Burnet, Llano and San Saba Counties, Texas. *Bulletin of the Texas Archeological Society*, Vol. 27, pp. 161-184.

Hester, T. R.
1971 Marine Shells from Archeological Sites in Southwestern Texas. *Texas Journal of Science*, Vol. 22, No. 1, pp. 87-88.

Jelks, E. B.
1962 The Kyle Site: A Stratified Central Texas Aspect Site in Hill County, Texas. *Archaeology Series*, No. 5, Department of Anthropology, University of Texas, Austin.

Parsons, M. L.
1965a Painted and Engraved Pebbles. In: The Archeology of Eagle Cave (R. E. Ross). *Papers of the Texas Archeological Salvage Project*, No. 7.
1965b 1963 Test Excavations at Fate Bell Shelter, Amistad Reservoir, Val Verde County, Texas. *Miscellaneous Papers, Texas Archeological Salvage Project*, No. 4.
ms. Painted Pebbles: A Stylistic and Chronological Analysis. Unpublished manuscript.

Ruecking, F., Jr.
1955 The Coahuiltecan Indians of Southern Texas and Northeastern Mexico. Unpublished MA thesis, The University of Texas at Austin.
Shafer, H. J.
1971 Investigations into South Plains Prehistory, West Central Texas. *Papers of the Texas Archeological Salvage Project*, No. 20.
1975 Functional Interpretations of the Lower Pecos Archaic Art. Paper presented at the conference "Prehistory of Northeast Mexico and Texas," Monterrey, N. L., Mexico.

WATER SEPARATION PROCEDURES AT THE 1976 TEXAS ARCHEOLOGICAL SOCIETY FIELD SCHOOL: AN APPRAISAL OF RESULTS

JOHN E. KELLER AND BRUCE B. FULLEM

ABSTRACT

An apparatus for flotation separation used at the Texas Archeological Society Musk Hog Canyon field school is described. The methods used in processing the matrix samples from archeological contexts and the results of the experiment are presented.

INTRODUCTION

During the 1976 Texas Archeological Society field school at Musk Hog Canyon, the authors carried out water separation experiments with some of the excavated samples. Our investigations were oriented toward several related, but nevertheless separate, goals: the collection of a floral sample and an evaluation of the methods by which this can be accomplished. In addition, we wished to evaluate the feasibility of conducting an extensive flotation operation for the archeological work to be conducted along the right-of-way of IH 10 in western Crockett County.

The basic principle behind the water separation technique, that lighter-than-water materials such as plant remains can be separated by floating from soil and other heavier-than-water site constituents, is well understood. In fact, descriptions of the techniques and equipment are abundant in recent archeological literature (Jarman *et al.* 1972; Struever 1968; Davis and Wesolowsky 1976; Limp 1974; Watson 1976).

APPARATUS

The ultimate design of our equipment had more to do with available materials and resultant construction requirements than with any preconceived plan. The basic component of our apparatus (Figure 1) is an open fiberglass tank measuring approximately 60 inches (152.5 centimeters) by 21 inches (53.5 centimeters). A central baffle of fiberglass and plywood (metal or plastic would be equally effective) serves to separate this tank into two approximately equal chambers. The first of these, the "flot chamber" (A) is connected to the water supply by means of an external garden hose fitting (B) and a controllable gate valve (C). The interior of the chamber contains an appropriate amount of pipe and an upward directed showerhead (D) through which the chamber is filled and the water agitated. A removable wooden stand (E) which serves to support a fine mesh screen "flot box" (F) completes the first chamber arrangements. The "flot chamber" is connected with the second or collection chamber (H) by means of a fiberglass covered spillway (G), which allows for removal of the floating or light fraction by moving water. The spillway is directed into a small-mesh, #20, gramametric screen (I), which collects the sample and allows for water run off. Drainage from the collection chamber is provided by a number of strategically placed holes (J).

During the course of our experimentation, we noted that the amount of agitation seemed rather important in sample collection. This was in substantial agreement with the literature on the subject and as a result, we added a further variation to the apparatus. Since agitation can be accomplished by forced air and water, we decided that a second hose with a controllable nozzle might provide sufficient water movement. Accordingly, a second hose was connected to the water source and this was used to inject a forceful jet of air and water into the "flot chamber". This injection resulted in a marked increase in agitation and the associated frothing producing an observable increase in the size of the sample collected.

An ample supply of water is obviously necessary for the proper operation of the device. Our water source was the Pecos River from which water was taken by means of a three-horsepower centrifugal pump with a fine mesh gauze covered intake. This arrangement supplied ample quantities of filtered water at sufficient pressure to allow operation of the showerhead and agitation nozzle simultaneously.

Flotation samples were removed during the course of the excavation by means of trowel and placed directly into cloth sacks. Each sample contained approximately 12 quarts and was brought to the flotation tank for processing within 24 hours.

METHODS

Our first goal in using the flotation device was to evaluate its performance and to determine what alterations were needed.

The flotation procedure was varied to accommodate the various field objectives (ex. whether or not carbon samples were to be taken). In all, six variations were tried using various combinations of air, water, and kerosene.

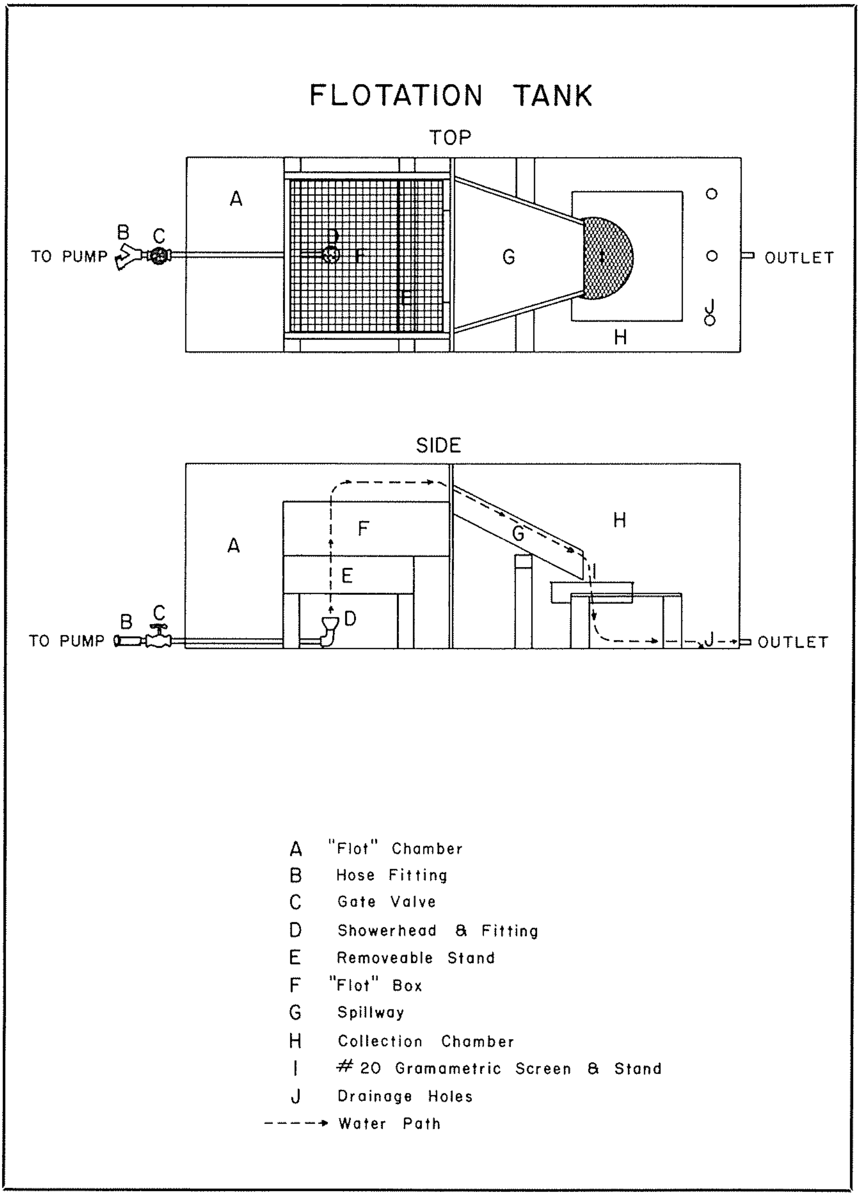


FIGURE 1. *Apparatus for flotation separation for archeological matrix.*

1) WATER
2) WATER & AIR
3) WATER & KEROSENE
4) WATER, KEROSENE & AIR
5) WATER & SOAK KEROSENE
6) WATER, SOAK KEROSENE & AIR

In cases where carbon 14 material is to be retrieved, the process is restricted to water only with two possible alternatives.

In west Texas during the summer, there is no reason to attempt drying of the soil anymore than it is naturally. This being the case, it was decided to handle the soil as little as possible and therefore, it was not dry screened. This did not seem to cause any difficulty in processing the samples. It should be added that our samples were kept to a six quart size. This was accomplished by dividing the original samples and running them twice, so an evaluation could be made of the various methods. With the use of water only, a sample was poured in slowly while the operator stirred the soil and water. This in connection with the below-surface shower head produced considerable agitation and the flow of water and dirt allowed sufficient overflow to carry all floating or nearly floating material down the spillway.

The second alternative also used no chemical additives thus allowing C^{14} samples to be taken. Attempting to duplicate the effect described by Jarman *et al.* (1972), the second hose with the agitation nozzle was used. By injecting a jet stream of water into the tank with the end of the hose several inches above the surface, a tremendous amount of air is added as well. This produces not only a greater in and out flow of water, but a vigorous bubbling action accompanied by a froth. The occurrence of a froth without chemical additives is particularly useful when C^{14} samples are desired.

When C^{14} samples are not to be recovered, the use of a collector has been recommended (Jarman *et al.* 1972). Two methods of application were utilized and both were tried with and without the air and froth action. This provided four additional variations to evaluate. First, the collector (kerosene) was added in the amount of less than one-half cup and then the soil was added as before. This is considerably more kerosene than Jarman *et al.* (*ibid.*) used, but our machine has a constant flow of water which carries off much of the kerosene. The second technique was to presoak the sample in herosene for five minutes while still in the sack, thus allowing a much greater time for the collector to work. Both of these techniques are potentially harmful to the environment and adequate kerosene disposal methods should be employed.

All of these methods worked quickly, but the bubbling action was the fastest and seemed most efficient. A sample could be run and the tank purged to avoid contamination in ten minutes. If samples were from the same feature and purging was not necessary, samples could be run in less than two minutes.

RESULTS

It is not possible to assume equal light fraction contents for all samples. Therefore, comparisons between samples are not valid. However, the samples were divided in half, permitting two methods on each sample and by this means, comparisons can be made between two parts of the same sample.

Without the forced air, the light fraction from the water-only method out-weighed the kerosene methods in 75 percent of the cases. When forced air was used, the water and kerosene method proved to be most effective. In comparing samples run with and without the forced air, it was found that the air increased the weight of the light fraction.

After our return to Austin, we ran two more samples to check the results with a different water source. The density of water from the Pecos River (perhaps due to salinity) (Lange and Carty 1975) is significantly greater than water from less arid regions and this could change the effectiveness of the collector. These check samples were divided into thirds and each of the three methods with air were employed. The results are given in ratio form — water: soak kerosene: kerosene - 1:1.25; 1.50 and 1:1.29: 1.29.

The results indicate that the largest returns are given when forced air and a small amount of kerosene are used. If C^{14} samples are to be taken, then the use of forced air and water is recommended. It is also possible and practical to process a large number of samples with a realistic hope of gaining useful information. While no quantitative statements can be made about the types of material recovered, as this was not the purpose of this experiment, there were botanical remains identified and they include seeds of *Juglans*, *Celtis*, *Quercus*, cactus and *Acacia*.

REFERENCES CITED

Davis, E. Mott and W. B. Wesolowsky
1976 The Izam: A Simple Water Separation Device. *Journal of Field Archaeology*, Vol. 2, No. 3, pp. 271-273.

Jarman, H. N., A. J. Legge and J. A. Charles
1972 Retrieval of Plant Remains from Archaeological Sites by Froth Flotation. In *Papers in Economic Prehistory* (edited by E. S. Legge), Cambridge University Press, Cambridge, England, pp. 39-48.

Lange, F. W. and F. M. Carty
1975 Salt Water Application of the Flotation Technique. *Journal of Field Archaeology*, Vol. 2, No. 1 & 2, pp. 119-123.

Limp, F. W.
1974 Water Separation and Flotation Processes. *Journal of Field Archaeology*, Vol. 1, pp. 337-342.

Munson, P. J., P. W. Parmalee and R. A. Yarnell
1971 Subsistence Ecology of Scovell, a Terminal Middle Woodland Village. *American Anthropologist*, Vol. 36, No. 4, pp. 410-431.

Struever, Stuart
1968 Flotation Techniques for the Recovery of Small-Scale Archaeological Remains. *American Anthropologist*, Vol. 33, No. 3, pp. 353-362.

Watson, Patty Jo
1976 In Pursuit of Prehistoric Subsistence: A comparative account of some contemporary flotation techniques. *Mid-Continental Journal of Archaeology*, Vol. 1, No. 1, pp. 77-100.

In Memoriam
David Espy

David Espy, a longtime resident of Corpus Christi and a co-founder of the Coastal Bend Archeological Society, died on March 27, 1977.

Dave was "Mr. Fix-It" at a half-score of TAS Field Schools. No camp task was too menial for him — and who can forget his stringing wire and building sheds to provide a more commodious campsite for all of us amateur and professional archeologists.

Generosity, selflessness, warmth, and friendship characterized Dave. He seemed ageless, treating all who shared his avid interest in archeology alike. He taught the young, seeing them as peers; surveyed sites with the experienced, viewing them and himself as students in a remarkably fertile field.

Dave Espy was mentor, colleague, sharer, and friend. We will miss him.

The Members
Coastal Bend Archeological Society

IN MEMORIUM

JAMES M. MALONE
1923-1977

The archeological community of Texas was indeed saddened by the news of the death of Jim Malone. At the time of his death Jim was Assistant State Archeologist with the Texas Historical Commission, a position he had held since 1971.

A native of West Texas, Jim received a B.A. degree in economics from The University of Texas in 1948. He attended the University of Chicago to pursue graduate studies in economics in 1949. After three years in the United States Air Force, he served seventeen years with the United States Diplomatic Service. He returned to Austin in the mid-1960's to continue his graduate studies and received a M.A. degree in anthropology in 1969. Jim joined the staff of the State Archeologist's Office in 1968 as a research archeologist.

His recent research projects have included an intensive study of historic Texas stoneware pottery kilns and lime kilns along with a cooperative project for long range preservation of Indian pictographs. In carrying out his duties as Assistant State Archeologist he worked closely with various agencies and local archeological and historical societies in the preservation of Texas' cultural heritage.

He maintained active membership in various professional organizations including the Society for American Archaeology, Texas Archeological Society, Council of Texas Archeologists, and the Society of Professional Archaeology. Jim also maintained conservation-related interests outside his profession. For example, he was a member of the Audobon Society, the Garden Club and the Creation of Wild Basin Park.

In Jim's short professional career in archeology, he made significant and lasting contributions represented by various publications, public lectures and documents. His concern for the cultural heritage of Texas and his intense dedication toward the conservation goals for these resources was an inspiration to those who knew and worked with him.

Bibliography of James M. Malone

1969 Report on the Excavation and Analysis of A Prehistoric Site in Liberty County, Texas: The Price Daniel Site (41 LB 3). M.A. thesis, The University of Texas, Austin.

1970 Archeological Reconnaissance in Miller Creek Reservoir area, by James M. Malone and Alton K. Briggs. *Archeological Survey Report* 6, Texas State Historical Survey Committee and Texas Water Development Board, Austin.

1970 An Archeological survey of the Texarkana Reservoir Enlargement area: Report on the first season, by Alton K. Briggs and James M. Malone. *Archeological Survey Report* 7, Texas Historical Survey Committee and Texas Water Development Board, Austin.

1970 Archeological Reconnaissance in the Mackenzie Reservoir Area of Tule Canyon. *Archeological Survey Report* 8, Texas Historical Survey Committee and Texas Water Development Board, Austin.

1972 Archeological reconnaissance at proposed Mineola Reservoir. *Archeological Survey Report* 10, Texas Historical Survey Committee and Texas Water Development Board, Austin.

ACKNOWLEDGEMENTS

I wish to thank Curtis D. Tunnell and Alton K. Briggs for providing information on the accomplishments and careers of James Malone.

Harry J. Shafer
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BOOK REVIEWS

"Archeological Investigations at Proposed Big Pine Lake, 1974-1975, Lamar and Red River Counties, Texas." by Robert J. Mallouf. Texas Historical Commission, Archeological Survey Report 18. $10.00.

This handsomely designed and massive report presents the results of one season's investigations within the proposed Big Pine Lake located east of Paris, Texas and near the western edge of the Early Caddoan geographical area. The study was sponsored by the U. S. Army Corps of Engineers in Tulsa, Oklahoma and was done in order to meet the needs of a Phase II study which involved extensive testing. This is a followup to a Phase I reconnaissance investigation conducted in 1972 by Robert D. Hyatt then of the Archaeology Research Program at Southern Methodist University. The reconnaissance recorded 110 sites and recommended that 19 be tested in order to evaluate their significance and to test a settlement model that was then proposed.

The present study is a good example of the long range planning that can be incorporated into construction plans when archeologists and land modification planners work in concert. The purpose of the Phase II study was to provide a complete cultural resources inventory, to determine depth and areal extent of tested sites, to evaluate site significance, to test the proposed settlement model, and to make recommendations for additional investigations and mitigation measures to be conducted before construction is completed.

After a few introductory remarks, the report presents a description of the environmental setting of the project area. Environmental zones are refined from those used in the reconnaissance report and are used later in describing site distributions. A brief discussion of the ethnohistory and archeological background of the area is followed by a two page description of methodology. The next section describes the sources and kinds of stone types found at the sites. The following 370 pages are primarily site descriptions that include discussions and preliminary interpretations of cultural stratigraphy, features and material culture. The A. C. Mackin site, a prehistoric Caddoan mound site and the Neely site complex, an Early Ceramic and Early Caddoan village, make up almost 300 of these pages. A brief description of the seven minimally tested sites, Mackin and Neely were extensively tested, and a short description of the previously unrecorded sites (9) are included in this section. Throughout the report, artifacts receive extensive attention although lithic debris and heat altered rock are only discussed for the Mackin and Neely sites. The summary section contains a thorough discussion of the chronological and typological affiliations of the sites and also proposes several settlement models for the different horizons recognized in the project area. Suggestions are made about further investigations, an interpretive center, mitigation procedures and estimated costs. Three appendices are included. These are a soil analysis and interpretation of four sites, a vegetational survey, and the specimen proveniences for the Mackin and Neely sites.

The report is profusely illustrated with a total of 166 figures. Many of these figures are maps and diagrams which have more artistic flare than the usual run of the mill archeological site map. Several well executed artifact drawings of ceramics and of the bipolar reduction sequence are included. Unfortunately some of the artifacts were photographed and the lighting did not bring out flake scar patterns as do the line drawings. The only other drawback with the illustrations is that several of the site maps have field information that is unnecessary on published maps since the information is not used in the body of the report. Nevertheless the report is tastefully and extensively illustrated.

The report provides a valuable synthesis of the understanding of prehistoric occupation in the Big Pine Creek area of the Red River drainage and will be an important reference for Caddoan archeologists working in this area for years to come. It presents problems that future investigators can use to guide research. The most important new perspective that the study offers is the systematic evaluation of sources of raw material used for chipped stone tools. This has been a descriptive facet of lithic studies in Oklahoma for many years but this report presents the first recent attempt to determine if such information can be gathered from sites in east Texas. The answer is affirmative as shown early in the monograph and I hope that other researchers will follow the lead of Mallouf and Larry Banks of the Corps of Engineers in incorporating source studies into field research. An area of further development would be to present the morphological and technological aspects of the lithic debris as they cross-cut the various raw material types. This would provide another means of evaluating variations in the movement of raw materials and should lead to a better understanding of trade patterns.

One of the important discoveries of this research is that the project area, which is a minor tributary of the Red River, was abandoned by the prehistoric Caddoan inhabitants sometime between A. D. 1275 and 1350. This is a period of change throughout the Caddoan area, much of Texas and the Southwest. The Cooper Lake area just to the south was abandoned at this time and elsewhere in the Neches, Sabine, and Cypress Creek watersheds there appear to be corresponding settlement pattern shifts. Early Caddoan sites tend to be located along major drainages while the smaller but more numerous late prehistoric Caddoan sites are located near the headwaters of smaller tributaries. A somewhat different pattern is apparent in parts of the Red River basin where large sites remain present along the major drainage and in some cases smaller hamlets sites are located at the headwaters of minor tributaries as represented by the Bossier Focus. The Big Pine Lake information when combined with data from the region should allow a better explanation of changes in the natural and cultural environments.

A concern for public interest in archeology is shown through the development of plans for an interpretive center involving the A. C. Mackin mound site. This interest is to be expected from the Texas Historical Commission which has a responsibility for site preservation and is encouraging to see on the part of the Corps of Engineers. This is one way that archeologists can present the results of their investigations to the public. Similar interpretive approaches need to be encouraged as projects elsewhere develop.

The report suffers from a lack of organization in that several sections do not integrate well with the conclusions. This is particularly true of the raw material section but is also true of the environmental description which is presented without any explanation of why it is described or how it is expected to be used later in the report. Overall the report flows from data gathering and description to summary and conclusions without explaining the rationale behind why the reported data were gathered or why they are presented as they are. In part it seems that this format is a reflection of a strategy that attempted to "... maximize data recovery within limits imposed by time and budgeting ... (pg. 39)" but it also seems that it is a reflection that an explicit research design did not guide the study. At least I was unable to find a developed statement of the "whys" that guided the methodology that is described in the report. This is not to say that the conclusions of the study are meaningless, for they are important, but it is to indicate my belief that a comprehensive research design should have allowed the researchers to have further maximized data recovery for the satisfaction of the needs of the Corps of Engineers and of Caddoan archeologists.

The reviewer is unclear about the reliability of the site evaluation of the seven minimally tested sites. In most cases one or two test pits and an unstated number of shovel tests were used to evaluate site depth, area, and significance. It is impossible, except in the case of site X41LR48 (Fig. 154), to know the location of the shovel tests and be able to determine their relationship to the delimitation of site areas as presented in Table 18. No explanation is provided about why single test pits rather than other forms of site sampling such as plowing/surface collection, systematic or random test pitting, or other subsurface evaluation approaches were not used.

The sampling approach used also raises the question of the reliability of the results from one or two test pits. An examination of the artifact assemblages from the tested sites shows that the samples are small in number (ranging from 12 to 39 pieces including stone tools and pottery) or appear to be biased (as in the case of the Emerson site where the entire assemblage consists of 382 pieces of pottery). Unfortunately lithic debris from these sites is not reported and cannot be used to augment assemblages for comparative purposes. Although no formal statistical comparison of these assemblages is made in the report, it is hard to believe that the reported information is sufficient to adequately evaluate models of settlement, chronology, or lifeway or to determine which of the tested sites is significant. In retrospect I wonder if Mallouf remains convinced that a sufficient number of sites and sufficient amount of testing per site has been done. While it is true that the Federal guidelines for determining site significance are very general, it behooves us to refine our evaluation tools beyond these limits if we are going to make our archeology relevant to the public. The problem of site evaluation is not unique to this report and contract archeologists need to become ever increasingly sensitive to this as a problem wherever they are working.

The Big Pine Lake report shows how masses of information can be derived from a limited amount of field investigation, unfortunately the masses could have been more thoroughly integrated. The report is long and contains a wealth of information that will be used for many years to come. The report presents important data from an early Caddoan mound center which is located on a minor tributary of the Red River along with the results of the testing of nine other prehistoric sites spanning the period from Late Paleo-Indian to the end of the Early Caddoan period. The study shows by example the value of the analysis of stone resource areas. The absence of a formal research design and of a discussion of site evaluation techniques is unfortunate but the report still concludes by offering statements about prehistoric settlement/subsistence patterns in the area. This can, and I hope will, be used by future investigators to expand our understanding of prehistory on the western fringe of the Caddoan area.

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Excavations at the Harris County Boys' School: Analysis of Galveston Bay Area Mortuary Practices. Special Publication No. 3, The Texas Archeological Society, Austin. 1976. 112 pp. $8.50

Special Publication No. 3 of the Texas Archeological Society provides a useful synopsis of the prehistoric mortuary practices in the Galveston Bay area. The report also describes, in considerable detail, the research conducted at an aboriginal cemetery (41HR80) on the grounds of the Harris County Boys' School and correlates some stratigraphic testing of a midden area (41HR80) which is immediately adjacent to the cemetery. Lawrence E. Aten supervised most of the field work at the Boys' School Cemetery and is the report's principal author. Charles Chandler collaborated with Aten in a chapter on the description and analysis of recovered artifactual materials, and Al Wesolowsky and Robert Malina contributed a short chapter on the recovered human skeletal remains and that skeletal materials' implication for aboriginal demography.

The Boys' School Cemetery is located on Mud Lake near the western edge of Galveston Bay and was first reported in 1968 by Richard Gramley, whose brief excavations encountered 12 burials. Aten later excavated the site on four separate occasions between May 1969 and April 1972 for a total of 30 working days.

The entire collection of skeletal materials from the Boys' School Cemetery represents 32 individuals of which 29 were found *in situ*. Most of the interments were of the flexed variety; and, as a whole, the cemetery does not seem to be age or sex specific. The ages of the deceased individuals are interpreted to vary from less than 6 months to more than 40 years of age, and of 23 individuals classified as adults, 19 were also classified as to sex, representing 12 males and seven females.

Grave goods were present with some of the burials but were certainly not abundant. Associated variously with 12 of the 29 documented burials were beads, fishhooks, awls, bone projectile points, dice, flageolets, red ochre and shells. Additionally, one infant appears to have been buried in a ceramic vessel. Aten (p. 61, 96) notes that there appears to be a correlation between the grave goods and the sex of the interment that might suggest a sexual division of labor, but cautions that the limited data makes such assumption tenuous.

In addition to the human interments, the site contained a considerable amount of midden refuse. In analyzing the data, particularly the lithic and ceramic technologies and some of the stratigraphic components, Aten (p. 51, 56-57) makes the convincing case that burials are relatively later than most of the midden refuse. He believes that the bulk of occupation was preceramic and probably extended through the Clear Lake Period with regular habitation of the site ending around A. D. 600. He believes the graves were excavated from the present ground surface through Clear Lake and perhaps Mayes Island Period materials, and that the cemetery dates in some portion of the Turtle Bay Period, roughly in the time span of A. D. 600 to A. D. 950.

A significant portion of the report is devoted to the description of cemeteries and mortuary data in the Galveston Bay area other than the Boys' School material. Much of this material is a result of Aten's review of old field notes and from his own research into the area. Some of the data is in print for the first time and provides a wider archeological spectrum for understanding the Boys' School material. Aten specifically reviews information from the Caplen Cemetery, Jamaica Beach Cemetery, isolated burial localities, nongrave occurrences of human skeletal remains and speculates on the nonoccurrence of burials.

The Boys' School Cemetery report stands as an important reference in understanding the mortuary practices and prehistory of the north Texas coast. Much of the data is appearing in print for the first time, and a number of stimulating hypotheses of cultural dynamics can be generated from the presented data. Because of the technical nature of much of the presented data it should be noted that the report may not be suitable for casual reading.

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