POSSIBLY HUMAN-MODIFIED MAMMOTH TUSK AND BONE FROM THE PLEISTOCENE OF SOUTH TEXAS

Carole A. S. Mandryk[1], Jon A. Baskin[2], Emily O. Matthews[1], and Ronny G. Thomas[2]

Twenty-one species of extinct, large, late Pleistocene mammals have been identified from sand and gravel pits in terrace and valley-fill deposits of the Lower Nueces River of South Texas. A log from the alluvial valley-fill unit that produced most of the fossils has been ^{14}C dated at 13,230 ± 110 YBP. The distal end of a mammoth tusk from this unit exhibits modifications that may not be the result of natural processes and may have been altered by contemporaneous humans. The 185 mm long tusk tip is rounded on the distal end, suggesting possible use as burnisher-billet. The tusk segment also has a curved, rounded, and polished groove 3 cm wide and 1 cm deep transverse to the long axis. The groove may have resulted from being used as a thong stretcher, hide softener, or shaft straightener. Alternatively, the groove may be a natural feature, formed by the stripping of leaves from twigs, an activity noted in living elephants. Sections of a limb bone have marks that may have been caused by butchering activities.

Key Words: Pleistocene; Texas; mammoth; bone modification

INTRODUCTION

The Wright Material Inc. sand and gravel pits along the Nueces River in western Nueces and San Patricio Counties, 50 km east of Corpus Christi, Texas (Fig. 1) have produced a diverse assemblage of late Pleistocene fossils (Baskin 1991; Baskin & Mosqueda 2002). Over the past decade, R. Thomas has been collecting regularly from this locality and has recovered thousands of identifiable vertebrate fossils, including the specimens described in the present paper. Twenty-one species of extinct, large mammals have been identified, including *Mammuthus columbi*, *Mammut americanum*, *Camelops hesternus*, *Bison antiquus*, *Paramylodon harlani*, and *Equus* spp. No indisputable human artifacts have been recovered from these gravel pits. The two mammoth elements described below may have been modified by contemporaneous human activity.

DEDICATION

Shortly after Dr. S. David Webb came to Florida in 1964, he developed an interest in Paleoindian/mammoth interactions (Bullen et al. 1970). One of Dave's main activities for the last 15 years has been the Aucilla River Prehistory Project's investigation of human and animal interaction in the late Pleistocene of Florida of the past 30,000 years (e. g., Dunbar et al. 1989; Dunbar & Webb 1996). This paper is offered in honor of his significant contributions to the study of man and mammoth.

GEOLOGIC SETTING

Four alluvial terrace units and three younger valley-fill units are recognized from late Pleistocene and Holocene sediments in the lower Nueces River Valley, Nueces and San Patricio counties, west of Corpus Christi, Texas, between Odem and Mathis, where the Nueces River is entrenched into the late Pleistocene Beaumont Formation (Cornish & Baskin 1995). The surface elevation of the quarries is approximately 10 meters above sea level, the level of the flood plain (Cornish & Baskin 1995:figs. 1-2). A pump is used to lower the water level and the pits are mined by a dragline. The draglines mine a total of 13 to 16 meters from the surface. The lower one to two meters are under water even during pumping. Mining is halted on encountering a yellow-green clay, interpreted to represent the late Pleistocene Beaumont Formation, or a calcareous-cemented sandstone, of the early

[1] Department of Anthropology, Peabody Museum, Harvard University, Cambridge, MA 02138
[2] Department of Biology, Texas A&M University-Kingsville, Kingsville, TX 78363

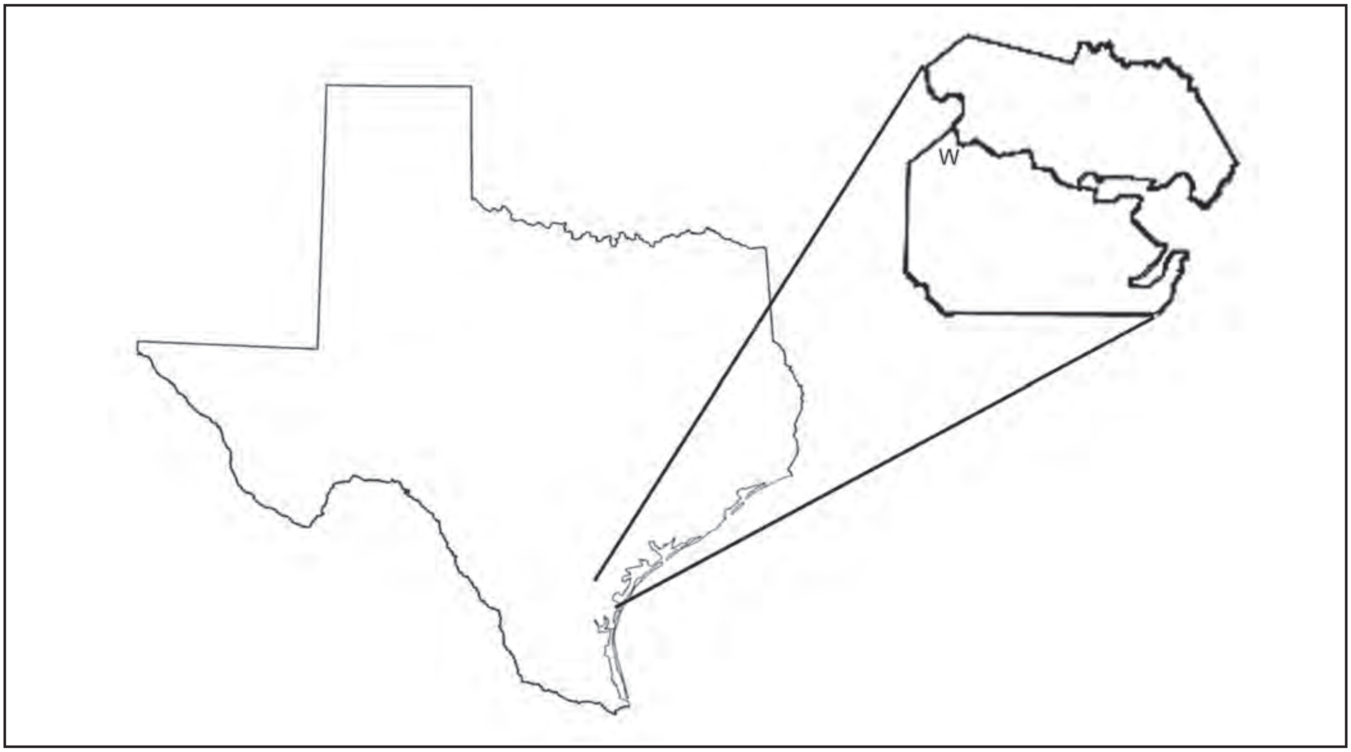

Figure 1. Map of Texas with inset showing location of Wright Materials Inc. Sand and Gravel Quarries (W) in Nueces County.

Pleistocene Lissie Formation or Mio-Pliocene Goliad Formation.

These late Quaternary terraces and valley-fill deposits have produced a mixed assemblage of early Pliocene and late Pleistocene fossil vertebrates. The Cayamon Creek Alloformation is the valley-fill unit beneath the present day floodplain of the Nueces River. It is defined from sections measured at the Wright Materials, Inc. sand and gravel quarries, approximately 4 km north of Bluntzer, Nueces County, Texas (Texas Memorial Museum, University of Texas at Austin [TMM] locality 43059). The unit is subdivided into allomember 1, the lowermost sand and gravel dominated unit; allomember 2, a mud dominated unit; and allomember 3, a fine sand unit. Allomember 1 is by far the thickest of the three. It consists of a lower sandy gravel unit (1a), representing channel fill and point bar deposits, and an upper muddy sand unit (1b), representing overbank deposits. Most of the fossils, including the possibly human-modified specimens, are from Cayamon Creek allomember 1a. Other fossils are from the next oldest unit, the Angelita Terrace. A log recovered from allomember 1a has a radiocarbon age of 13,230 ± 110 YBP (Baskin 1991). The unconformably overlying allomember 2 contains non-marine gastropod shells that were radiocarbon dated at 965 ± 95 BP.

Whether the Pleistocene vertebrates are all contemporaneous with the latest Pleistocene alluvium or are to some degree reworked cannot be easily determined. There is a wide variation in the nature of the preservation. Some of the bones and teeth are darkly stained and appear to be partly mineralized. Other specimens are quite fresh in appearance. The fossils consist mainly of isolated teeth and durable postcranial elements such as astragali, phalanges, and metapodials that indicate that transportation and sorting of specimens has occurred (Hanson 1980). Some of the specimens are water worn, but most are not.

The presence of jaws of *Equus*, *Bison*, *Tapirus*, and *Camelops* and a mammoth skull and associated partial skeleton suggests that some, if not most, of the Pleistocene specimens were not transported very far. *Bison* in the fauna is indicative of a Rancholabrean (late Pleistocene) age. The presence of both *Bison latifrons* and *Bison antiquus* may indicate some degree of mixing for the Rancholabrean fauna, because *B. latifrons* is sometimes considered an early Rancholabrean species (Guthrie 1970). However, *B. latifrons* may have survived into the late Rancholabrean (Pinsof 1991; Wyckoff & Dalquest 1997).

DESCRIPTIONS

Limb Bone

Three sections of limb bone (TMM 43059-100, -101, -102), probably from a single femur, have possible cut marks. The fragmentation of the bone was apparently caused by mining operations, because the breaks are fresh. The ends are missing and the pieces do not articulate. The location, as determined by GPS, is 27º55' N and 97º47' W. The pieces were found in an iron-stained, loosely cemented sand and gravel channel of unit 1a, approximately 14 m below the surface, less than 2 m above an erosional contact with the underlying coarse-grained, calcareous-cemented sand with caliche fragments. The scratches are best developed on the smallest fragment (Fig. 2), a flat piece 30 x 6 cm, which has 22 scratches, 0.5 mm wide over 20 cm of its length. The scratches are more or less parallel to each other. They all terminate on at least one end at a break. The longest one is 9 cm long. Microscopic examination in cross-section of one of the grooves shows a broad 'V-shaped' cut.

Distal tusk

The collecting location of the distal tusk segment (TMM 43059-99), as determined by GPS, is 27º55' N and 97º48' W. It was found in a relatively clean, medium- to coarse-grained, point bar sand of unit 1a, approximately 8 m below the surface of the flood plain. R. Thomas discovered the tusk after noting the exposed fragments of a 15-20 cm portion of tusk that had been destroyed by the dragline. It is not known if these fragments came from the tusk section. If they did, they would double the length of the specimen. The tusk section is approximately 185 mm long and ranges in diameter from 80 mm at the proximal end to 55 mm at the distal end.

The most striking feature is a polished groove set at a slight angle 65-75 mm from the end of the tusk (Figs. 3-4). The groove has an open 'U-shaped' cross-section. At its middle, it is 28 mm wide at the top, 12 mm deep, and sustains an arc of 37 mm. The actual length of the groove is 100 mm, the straight-line distance, 67 mm. The bottom of the groove is more highly polished and shinier than any other surfaces of the tusk. The distribution of the polish is difficult to attribute to natural causes, as it is not on all surfaces and particularly not on protruding surfaces adjacent to recessed polished surfaces (Fig. 4A).

Polish on other surfaces predates possible biological activity indicated by small curving depressions and pitting similar to that seen on bones and considered indicative of post-depositional organic processes, as well as 'split lines' typically seen on weathered bones (Behrensmeyer 1978; Gifford-Gonzalez 1991). The polish also predates exfoliation and flaking of the outer enamel layer. The distal end of the tusk does not taper but is worn relatively flat resulting in a rough textured area lighter in color than adjacent surfaces (Fig. 4C). It could not be determined whether this wear was contemporaneous with, or postdates the polishing along the side of the tusk. The location of the battered area on the projecting tip (Fig. 4B) is consistent with possible use as a hammer stone.

Figure 2. Fragment of limb a bone (TMM 43059-100) showing scratches. Scale = 5 cm.

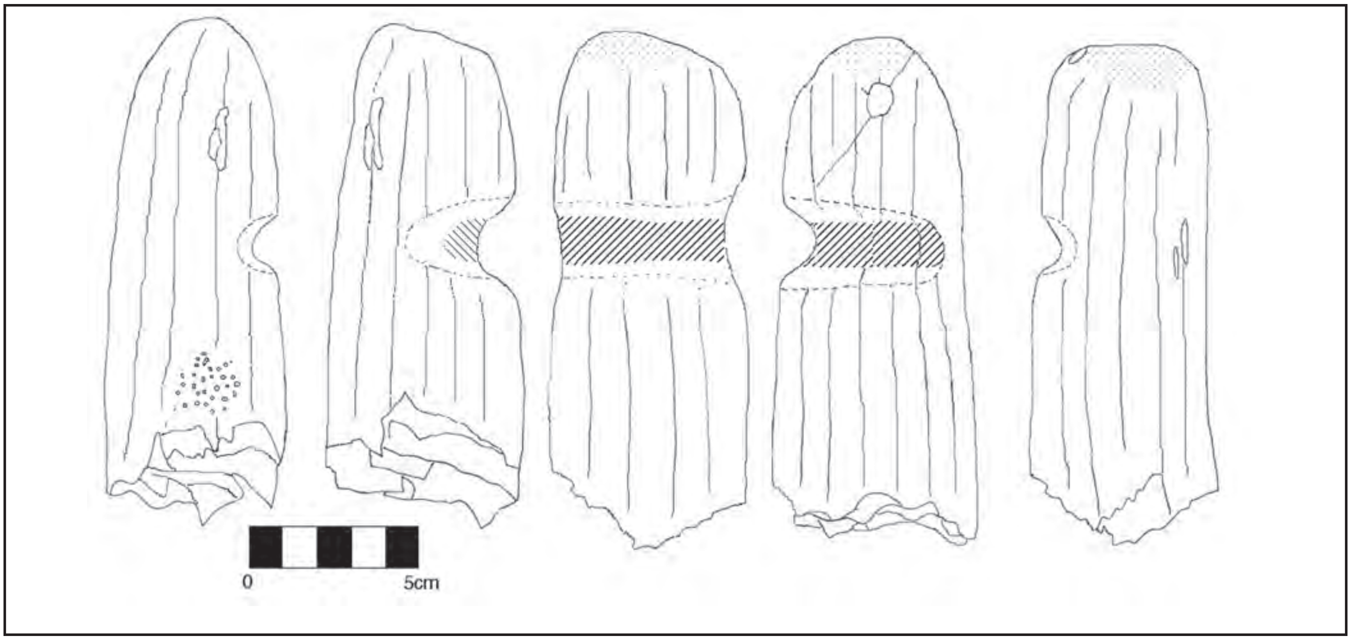

Figure 3. Distal tusk segment (TMM 43059-99), line drawings of five rotated views showing location and extent of groove. Scale = 5 cm.

NATURAL MODIFYING AGENTS

Much work has been done to determine whether natural and/or cultural processes were responsible for certain features found on fossil bones and teeth. Some fossil skeletal elements clearly have been modified by humans (e.g., Semenov 1972; Gaudzinski et al. 2005). Many others are more difficult to attribute to human activity (Haynes 2000) and may have been produced by a variety of natural processes. Natural modifications may occur in fluvial and surficial environments by both biological and physical processes such as trampling, movement in water, and abrasion by blowing sand. Natural processes can result in polished surfaces superficially similar to those produced by cultural use (e.g., Behrensmeyer et al. 1986; Fiorello 1989; Villa et al. 2001). Striations caused by sedimentary abrasion may also be produced during life when tusks are used for such activities as "…digging for tubers and water, scraping soil for salt or stripping bark from trees" (Villa & d'Errico 2001:90). Where carnivore activity is particularly high, the marks left on the bones may be very pronounced and come in the form of "deep furrowing, gouging, and also fracturing" (Haynes 1988:144).

Elephants use their tusks for a variety of different activities, often related to feeding or fighting (Sikes 1971; Haynes 1991; Shoshani 1991). These activities lead to a general wearing down of the dentine, more frequently close to the tip, but nonetheless over the whole of the tusk (Sikes 1971). Haynes (1991) discussed wear facets on the sides of mammoth tusks that have been attributed to scraping. He (1991:fig. 2.11) also described flat facets on the sides at the ends of African elephant tusks. Haynes notes the presence of lateral and medial wear facets, but not terminal wear as is present in the Texas specimen.

Haynes (1988, 1991) described the natural breakage of tusk tips, which can occur many times during the life span of an elephant. The broken ends are continually worn down by everyday activities, which can result in odd-shaped, irregular tusk ends. If the tusk then breaks again, the tusk bit will have an uneven wear pattern on one end and a fresh break on the other. The broken tusk tips illustrated by Haynes (1991:figs. 4.4-4.6) do not result in clean breaks, perpendicular to the main axis. All have tapered distal ends. Human-modified tusks can have a much sharper and straighter termination (Semenov 1970:fig. 73).

Sikes (1971:209) has described how some elephants drape their trunk over a tusk, causing transverse or diagonal grooves on the tusk. These grooves are wider and much closer to the skull than in the Texas specimen. Occasionally, an elephant's tusks will not grow in parallel to one other and will instead cross at the tips (Jayewardene 1994:21). Bending may cause one of the tusks to rub on the other and create wear spots or grooves on the opposite tusk. Because of the continued growth of mammoth tusks, and their curving, "each in an opposing gaining-helix toward one another, such that they arc around and point inward left-and-right... in old age, the arcing tusk-tips of an old bull approach one another and occasionally even cross" (Guthrie 2001:277). In addition to being wider and shallower than the TMM 43059-99 groove, wear spots caused by crossing tusks would have a diagonal orientation. The morphology and orientation of the groove near the tip and at right angles to the length of the TMM 43059-99 tusk argues against any of the above causes.

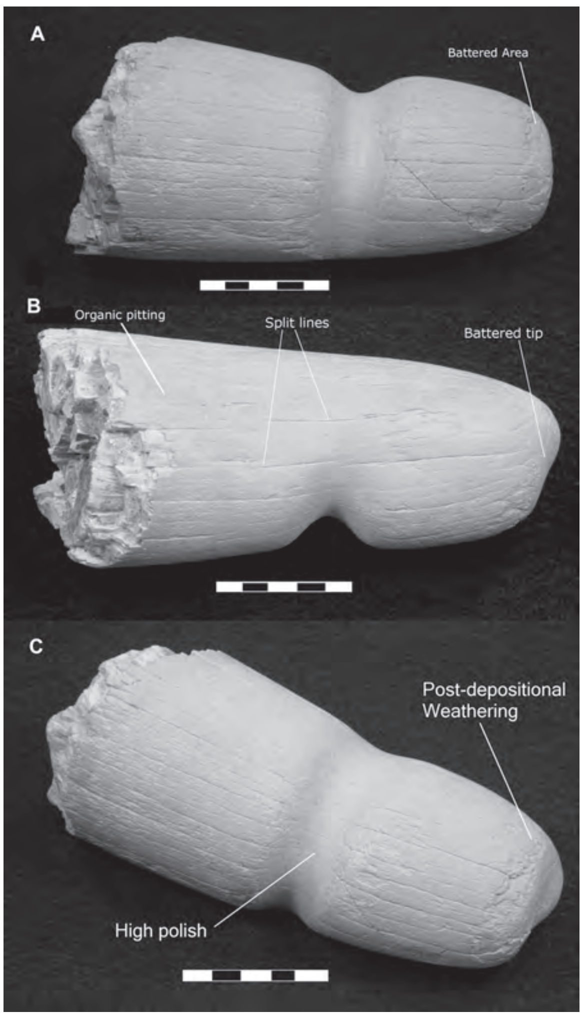

Figure 4. Distal tusk segment (TMM 43059-99), photographs in (A) ?dorsal view showing polishing in groove and shape of distal end; (B) ?lateral view showing pitting, polishing in groove, and shape of distal end; and (C) oblique view showing polishing in groove and shape of distal end. Scales = 5 cm

Andrew Hemmings (pers. comm.) suggested the groove was used by the mammoth to strip leaves from twigs. Shoshani (1991) discussed modifications related to feeding that produce transverse grooves and wear on the tusks of living elephants. Deep grooves can form near the tips from 'plucking' vegetation between the tusk and the trunk. Shoshani and Kamiya (1992) noted grooves of various sizes and depths in upper and lower tusks of extant and extinct proboscideans. They noted the presence of a groove 14 mm long and 7 mm deep on the side of a lower tusk of an early Miocene gomphothere from Japan.

A *Rhynchotherium* mandible with both lower tusks from a private collection has a naturally formed groove similar to the one on the Texas specimen. It is from the late Pliocene (late Blancan) Macasphalt Shell Pit of Sarasota County, Florida. A cast (UF 204873) of the specimen is in the collection of the Florida Museum of Natural History. The groove is oriented vertically on the outside of the lower right tusk. The tusk is about 30 cm long. The groove is about 5 cm from the end. It differs in morphology from the Texas specimen in that it is 'V-shaped', rather than 'U-shaped' in cross-section.

CULTURAL MODIFYING AGENTS

The marks on the limb bone and the features of the tusk, particularly the groove, may be the result of human activity, although there is no direct evidence of a human presence with these fossils, because no stone artifacts or human remains have been recovered from the gravel pits. If contemporaneous humans worked the tusk and long bone, these individuals likely would have been Paleoindians of the Clovis culture. Pre-Clovis sites with butchered mammoths have also been reported (Overstreet & Kolb 2002). Additionally, mammoth bones and tusks from death sites have been utilized for raw material (Leshchinskiy 2001; Vasil'ev 2001). Alroy (2001) noted that corrected carbon dating methods place the first appearance of Clovis people at 13,500 BP (Fiedel 1999) and the youngest well-dated, extinct megafauna at 12,260 BP (Whitley & Dorn 1993). Aslan and Behrensmeyer (1996) estimated that contemporary fluvial channel deposits from Wyoming represent time-averagin over an interval of 10^1-10^4 years. Given this time interval, it is possible that at least part of Cayamon Creek allomember 1 was coeval with Clovis people. Although rare relative to other cultural artifacts, Clovis points are known from 128 of Texas' 254 counties, including San Patricio County, directly north of the Nueces River from Nueces County (Chandler 1982; Meltzer & Bever 1995). Hester (1995) noted that although no mammoth kill or butchering sites have been found in South Texas, Clovis points that are found in the region suggest that earliest occupation began around 11,200 BP.

Perhaps the most commonly identified evidence of the co-occurrence humans and mammoths are butcher marks. The patterning of the grooves on the long-bone fragments (Fig. 2) is consistent with previously identified butcher marks. The grooves are shallow, unlike the deep furrows and gouges on the bones left by carnivores (Haynes 1988). Likewise, the grooves do not resemble rodent-gnawings, which have been identified on other bones from the Nueces gravel pits. While ancient scratches and grooves are often interpreted as being caused by butchering activities of humans, trampling by large mammals can cause scratches and other features that are similar to cut marks and butcher marks (Behrensmeyer et al. 1986; Fiorillo 1989). However, in experimental studies of the effects of trampling, Olsen and Shipman (1988) found that, regardless of the gravel size, the scratches were fine and shallow and could be distinguished from those caused by blades. Haynes (1991), however, was unable to produce "butcher marks" by butchering recent elephants with stone tools. Olsen and Shipman (1994) note that defleshing marks often appear in clusters, indicating repeated strokes were needed to remove the muscle, as is perhaps indicated by the numerous parallel grooves on the Nueces River long bone.

After a tool is abandoned, markings produced by natural causes are more likely to be left on bone/antler/ivory tools than on stone tools, increasing the likelihood cultural evidence will be obscured, and making analysis and interpretation more difficult. This may be one reason research on artifacts made of bone/antler/ivory is rare compared to lithic analyses. Most of the work that has been done focuses on refined, shaped, carved and polished items such as awls, needles, and projectile points. Studies often include experimental manufacture of artifacts, with special attention to the sequence of shaping and polishing, and may include subsequent analysis of microwear observed after use in different activities. Discussion in the literature of utilized objects or utilitarian artifacts — e.g., the bone/antler/ivory equivalent of a "utilized flake" — is much more restricted (Thomas 1998). However, skeletal materials have long been part of the modern human toolkit, dating back to at least 70,000 YBP (Henshilwood et al. 2001), if not significantly earlier (d'Errico & Blackwell 2003) and we need to better understand the processes that shape them.

Bone modification studies have attempted to differentiate microwear polish caused by human utilization from surface modifications resulting from taphonomic processes and other natural causes. At a macro level, the distribution of surface modifications, including the "presence, location and mode of occurrence of striations, and features such as polish, degree of abrasion, micro-pitting, [and] root marks" (Villa & d'Errico 2001:81), is informative. If observed modifications are due to cultural utilization, "…a clear differentiation should be visible between where the polish ends and the unpolished surface begins" (Miller 2002). Use-wear can be expected to be restricted to specific constrained areas of an artifact, not distributed randomly.

Saunders et al. (1990, 1991) described and illustrated culturally modified mammoth tusks from Blackwater Draw Locality No. 1, New Mexico. It was from here that bones of mammoth, bison, and other extinct mammals were first found in association with Clovis artifacts (Boldurian & Cotter 1999). Saunders et al. (1991) interpreted one skeletal artifact to be an ivory burnisher-billet. The 74 mm long section of tusk "was rounded though blunted on each end" (Saunders et al. 1991:360). A billet is a non-stone object used as a hammer, primarily to detach flakes from lithic material. A burnisher is an instrument used to flatten, smooth, or polish a surface with hand pressure.

TMM 43059-99 more closely resembles mammoth-ivory billets from the Pleistocene of the Czech Republic illustrated by Saunders et al. (1991:fig.2). The tip of the Nueces tusk is convex-rounded and worn smooth, suggesting use as a burnisher. There are also rougher patches caused by more profound pitting that could also be from human use. The greatest frequency of pitting occurs on the outer edge of the most protrusive edge (Fig. 4B). Should this have been used as a billet, this area would be the most effective in exerting the pressure necessary for flaking. There appear to be a higher frequency of cracks in this general area as well.

A semi-fabricate is a cut and chopped (whittled) mammoth tusk. The proximal end of the Nueces River tusk resembles that of the semi-fabricates illustrated by Saunders et al. (1990), except that, in the present case, the proximal end is a recent artifact of excavation by a dragline. As described by Saunders et al. (1991) and Newcomer (1977), an effective way to section osseous material is to saw or cut a groove around the circumference with a graver or unretouched flake and then break a portion off by striking with a billet. Khlopatchevs (2001) analysis of Upper Paleolithic mammoth tusk processing found that "cut, sawed or gouged grooves functioned as....striking platform[s]" (Khlopatchev 2001:446). Whereas bone or antler may only require striking with a billet, sectioning of mammoth ivory may have required use of an anvil as well as a hammer stone, i.e., the force of "two blows performed simultaneously on the outer surface in different directions" (Khlopatchev 2001:446).

This process is a reasonable approximation of how the main feature on the Nueces tusk section was formed, with the exception that the groove was not continued around the circumference of the tusk. Instead, after the groove extended halfway, the tusk was utilized in some fashion that caused polish to develop on the interior surfaces of the grooved depression. Saunders et al. (1991) argue that the Blackwater Draw semi-fabricate was cut when the ivory was still fresh because the tusk had not yet separated along the 'concentric lines of Owen.' These lines, more properly termed Schreger lines, are the surfaces of contact between the progressive cones of dentine that are formed during ontogenetic development of tusks in Elephantidae (Palombo & Villa 2001). The fact that no separation of the Schreger lines is evident on the Nueces tusk groove may indicate it was formed when the ivory was still fresh. However, while "it is easier to work bones which are still fresh, ivory can be worked in a fossil or sub-fossil state" (Scheer 2001:457). Experiments have demonstrated that "fossil ivory of mammoth, softened in water, is carvable like wood" (Hahn et al. 1995, cited in Scheer 2001:457). It remains to be demonstrated whether fossil ivory would present as cohesively as fresh ivory if separation alongthe Schreger lines due to weathering has not occurred prior to fossilization.

Though the polish on the tusk segment resembles what one might expect from tumbling in high energy environment, and sand is visible in some cracks, the polish within the groove it is also similar to the patterning d'Errico et al. (1984) found to be caused by polishing with sand. Tyzzer (1958) found sand to be an effective grinding agent when sprinkled on a piece of leather that was wrapped around bone or antler and then pulled back and forth. D'Errico et al. (1984) found that worked or worn bone surfaces exhibited consistent variations in the shape and distribution of striae left by different techniques, including polishing with sand and deerskin, and sandstone. The culturally derived marks were distinguishable from those derived by natural causes, where the directions of resulting striae were purely random. Furthermore, these variations in surficial patterning are distinguishable under magnification levels of as little as 10X.

The size, shape, position, and polish of the groove on TMM 43059-99 suggest that it is human-made, caused by some sort of rubbing activity. The groove possibly could have been used to support a handle for the burnisher, so that greater and more controlled pressure using two hands could be applied. Haynes and Hemmings (1968) described an unusual artifact manufactured from a mammoth leg bone from the Murray Springs, Arizona, Clovis site. The object has a 25-30 mm circular hole with beveled edges bored through one end. They interpreted it to be a shaft wrench, based on similarities to artifacts recovered from Upper Paleolithic, European sites. Though the form of the tool is completely different, the diameter is similar to that of the half circle groove of TMM 43059-99, suggesting a possible similar usage.

A more likely explanation for the groove is that the tusk was used for softening skins, either during the tanning process or after strips of skin or sinew were cut for thongs, laces, harnesses, etc. According to accounts of Native American hide-tanning techniques, one way of softening a hide after the application of brains was to wrap it around a wooden pole that had been driven into the ground or braced by the feet, then pulling it back and forth, manipulating and stretching it in order to separate the fibers (Mandryk 1983). Semenov (1970:fig. 103) illustrated thong stretchers (albeit with wider grooves than TMM 43059-99) with wear often limited to one side of the object and often to only one portion of the bone.

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The slashed and punctured bones of a woolly mammoth suggest that humans lived in the far northern reaches of Siberia earlier than scientists had previously thought, a new study finds. Before the surprising discovery, researchers thought that humans lived in the freezing Siberian Arctic no earlier than about 30,000 to 35,000 years ago.Â The researchers also found a Pleistocene wolf humerus (arm bone) that had been injured by a "sharp implement with a conical tip," Pitulko said in the statement. The bone, also discovered in Arctic Siberia, dates to about 47,000 years ago, they found.Â The hunters who butchered the mammoth and wolf were far from the Bering Land Bridge, which lay exposed at that time.