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ANALYSIS OF PALEOINDIAN BONEBEDS AT THE CLOVIS SITE: NEW DATA FROM OLD EXCAVATIONS

Eileen Johnson and Vance T. Holliday

ABSTRACT

Excavations at the Clovis site in 1949 and 1956 produced sizeable archaeological and zooarchaeological collections from two largely unreported Paleoindian bonebeds. Jelinek's (1956) work in the Brown Sand Wedge yielded bison and mammoth remains. Evans' (1949) work in the Carbonaceous Silt yielded bison remains and the type collection of projectile points for the "Portales Complex." Neither bonebed was analyzed or radiocarbon dated until now. Radiocarbon assays on organic-rich sediments yielded ages of ca. 10,800 yr BP for the Jelinek bonebed and ca. 9000 yr BP and ca. 8700 yr BP for the Evans bonebed, the first and only dates associated with their respective excavations. Human, carnivore, and environmental agencies modified the bonebeds; neither was affected by fluvial action. The bison material in the Jelinek bonebed is separable from the mammoth remains. The mammoth remains may represent bone quarrying. People scavenged the bison bone at some point for marrow. At least two events formed and disturbed the Evans bonebed. Direct evidence on the bones of butchering or other human activities are lacking. Mixing of the bonebed and extensive reworking of the projectile points for use as butchering tools have contributed to the confused typology of the "Portales Complex."

Keywords: Clovis site, hunter-gatherer subsistence; bonebeds; Southern High Plains; Paleoindian

INTRODUCTION

The Llano Estacado ("Stockaded Plains" [Bolton 1990:243] or Southern High Plains) in northwest Texas and eastern New Mexico is a vast, level plateau covering approximately 130,000 km² and comprising the southernmost portion of the High Plains physiographic section (Fenneman 1931; Hunt 1974) (Fig. 1). The region has been a key area for the investigation of the peopling of the New World since 1933 (e.g., Howard 1935a, 1935b) and contains a remarkably high concentration of well-known Paleoindian sites (e.g., Clovis, Lubbock Lake, Miami, Midland, Plainview) that have yielded significant data on Paleoindian artifact styles and technology, subsistence, chronology, and environments. Much of the 1930s, 1940s, and 1950s research was never published. Most of the collections and field documentation, however, still are available and reexamination of the material has proven quite fruitful (Boldurian 1990; Hill et al. 1995; Hofman et al. 1989; Holliday et al. 1994; Johnson 1989, 1991a).

The Paleoindian bonebeds excavated at the Clovis site in the 1940s and 1950s are one such case. Clovis is in an ancient basin 2 km north of and draining into upper Blackwater Draw, one of a number of dry valleys or "draws" that are northwest-southeast trending tributaries of rivers on the Rolling Plains to the east (Fig. 1). Also called Blackwater No. 1 Locality (Sellards 1952:29) or Blackwater Locality No. 1 (Hester 1972), Clovis is one of the best known sites in the region (e.g., Sellards 1952; Wormington 1957; Hester 1972). The site was a gravel quarry from the 1930s to 1960s, resulting in the discovery and destruction of many Paleoindian activity areas (Hester 1972). Clovis documents multiple, sequential Paleoindian...

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Figure 1. Map of the Southern High Plains with locations of Paleoindian sites.
Paleoindian Bonebeds at the Clovis Site

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dian occupations and provides the basis for models of Paleoindian chronologies and paleoenvironments on the Great Plains (Sellards 1952; Sellards and Evans 1960; Wonyming 1957; Hester 1972; Wendoff 1961; Wendoff and Hester 1975; C. V. Haynes 1995). Much of the research at Clovis was carried out under less than ideal conditions, however, and large amounts of data were never organized, correlated, or even recovered (Hester 1972).

Since its discovery in 1933 (e.g., Howard 1935a, 1935b), research at the Clovis site has focused on the analysis of projectile points and some tools (e.g., C. V. Haynes 1995; Hester 1972; Sellards 1952; Wheat 1972). Only limited attention has been given to the old collections (Hughes 1984; Lundelius 1972; Saunders et al. 1990, 1991; Saunders and Daeschler 1994; Stevens 1973).

The Evans and Jelinek collections represent the largest archaeological assemblages and largest zooarchaeological collections from their respective stratigraphic units, i.e., the Gray Sand (GS) and Brown Sand Wedge (BSW). The bonebeds are significant for understanding Paleoindian activities both at the site and throughout the region. Since their excavation, the collections have gone unstudied and some misinformation has entered the literature (e.g., Hester 1972:38-39). The lack of incompletion of field documents and accession records and administrative complications have made further study difficult. Nevertheless, the objectives in investigating these two collections were to determine agencies of bone modification, examine the bone and lithic technologies, explore site formation processes, ascertain the radiometric potential, and secure radiocarbon assays if feasible.

OLD EXCAVATIONS

The bonebeds were recovered during Glen L. Evans’ work in 1949 and 1950 for Texas Memorial Museum (TMM) and during salvage work in 1956 by Arthur Jelinek along some pipeline trenches. The extensive “Evans bonebed” yielded a large assemblage of projectile points that formed the basis for the Portales Complex (Sellards 1952:72-74), but the bonebed (considered the largest bison kill at the site; Hester 1972:37) was never analyzed or described. The “Jelinek bonebed” contained mammoth bone and was, therefore, significant in light of the extensive Clovis occupation at the site.

The Clovis site contains a stratified sequence of late Quaternary deposits (C. V. Haynes 1975, 1995; Holliday 1995, 1997; Haynes et al. 1992; Haynes and Agogino 1966; Sellards 1952). In order to maintain historical continuity, this paper uses the stratigraphic terminology of Evans and Jelinek, both of whom followed the nomenclature of Sellards (1952:28), but the interpretations and especially the geochronology of C. V. Haynes (1995) are incorporated into the discussion.

The strata at Clovis essentially are continuous throughout the paleobasin, but considerable facies variation exists, especially on the microstratigraphic (i.e., archaeological) scale. The oldest fill is spring-laid sand divided into the Gray Sand (GS; Unit B of C. V. Haynes 1975, 1995; 13,000-11,500 yr BP) and the Brown Sand Wedge (BSW; Unit C of C. V. Haynes 1975, 1995; 11,500-11,000 yr BP). These two units are separated by an erosional unconformity. Near the basin margins, these sands have complex facies relationships with sand and rubble derived from the valley walls and with sand discharged directly from spring throats. The stratigraphic relationships of these sands along the basin margins, particularly the BSW, are problematic owing to destruction of stratigraphic sections by gravel mining. The GS and BSW are significant archaeologically because they yielded the Clovis artifacts and associated bone assemblages. Most of the Clovis features are from the BSW, but some Clovis materials are found on top of and in the upper GS. Most of the Paleoindian activity areas were found in the pond and marsh deposits of the Diatomite (D; Unit D of C. V. Haynes 1975, 1995; 10,800-10,000 yr BP) and the Carbonaceous Silt (CS; Unit E of C. V. Haynes 1975, 1995; 10,000-8000 yr BP). The D includes beds of pure diatomite, lenses of diatomite interbedded with mud or sand, and diatomaceous mud. The CS is an organic-rich sandy mud representing the accumulation of both silt and sand in an aggrading, marshy environment.

The relationship of the BSW to the GS and the D and its age and cultural association are problematic. The complex facies relationships and destruction of stratigraphic sections hampered these determinations. At C. V. Haynes’ (1975:61-62; Hester 1972:8-9) section 1, along the south wall of
the South gravel pit, a study of the BSW fauna by Slaughter (1975) suggested that the deposit was equivalent to the GS, but the microfauna suggested correlation to both the GS and D and indicated that the BSW is a time-transgressive deposit (Johnson 1986a, 1987a). The time-transgressive nature of the BSW was underscored by C. V. Haynes’ findings (1975:61-62; Haynes and Agogino 1966; Haynes et al. 1992; Stanford et al. 1990), which also confirmed Evans’ (TMM accession records) spring-discharge facies assessment. The only other extensive, systematic work in the BSW was that of Jelinek (Hester 1972). The bonebed, however, went unstudied and its age undetermined.

Jelinek’s 1956 excavations in the BSW took place in the connecting area between the North and South gravel pits (Fig. 2). All previous investigations were along the margins of the gravel pits (Hester 1972). Furthermore, trenches cut in this connecting area provided previously unavailable exposures of the stratigraphy (Hester 1972:51). Reported as an excavation of a partially articulated
mammoth (Hester 1972:51), the vast majority of the remains (ca. 89%) are those of ancient bison (Fig. 3; Table 1). The mammoth remains (7% of the collection) were not articulated (Jelinek 1956; Fig. 3). Six taxa of vertebrates are represented (Table 2). Specimens of antelope jackrabbit (Lepus alleni) and meadow vole (Microtus pennsylvanicus) reported by Hester (1972:53) could not be located in the current collection or in the field catalog or field notes (Jelinek 1956); however, Jelinek (1957 correspondence to Sellards) mentioned the presence of small mammal remains and a meadow vole from the BSW. The vole came from the top of the GS (Jelinek, personal communication, 1994).

The mammoth skull (TMM937-873-P56-27; Fig. 3) protruded above the BSW sediments after their deposition and was weathered until covered by younger deposits. When excavated, the eroded top of the skull lay at the contact between the D and the BSW (Jelinek 1956:8-9; 1985; Fig. 4). Jelinek (personal communication, 1985) observed this “period of erosion between the deposition of the BSW and the Diatomite” and wrote that the BSW “has marbleized [sic] effect as though was fluid or nearly so at time of deposition” (Jelinek 1956:11; Fig. 4). His observations on the sediments supported Evans' (TMM accession record; Hester 1972:32, table 10) interpretation of a spring seep deposit followed by a period of erosion represented by the disconformity between the two units. The remains of the mammoth skull and surrounding sediments were jacketed and stored at the TMM Vertebrate Paleontology Laboratory since 1957 without being disturbed.

Evans’ work was conducted around the North and South gravel pits where he mapped the exposed stratigraphy of the entire perimeter of both pits. Evans’ bonebed in the CS (also referred to as upper diatomaceous earth and silt, upper diatomite, upper bonebed, or upper lake bed in Evans’ TMM accession records) was located at Station E in the South pit (see Fig. 2). According to Evans’ observations (personal communication, 1985), the massive bonebed was about 18 to 24 inches (ca. 46 to 61 cm) thick and larger than the one at Plainview (Fig. 1; Sellards et al. 1947), but the bone was in much poorer condition (“very powdery”). The Evans bonebed was more like the one at Plainview in its distribution of disassociated elements than like the smaller ones at Lubbock Lake (Fig. 1; Johnson 1987b; Johnson and Holliday 1989) with their discrete piles of bone. Occasional articulated units of vertebrae, ribs, or lower legs (metapodialis to phalanges) were uncovered and astragali were common. The bonebed appeared to have been trampled by later animals under shallow water conditions as the bones were jumbled and the sediments convoluted (cf. Hester 1972:36, Fig. 42). Where bone could be recovered, generally a bone block (a segment of the bonebed covered with a plaster jacket and removed intact) was made. Evans (personal communication, 1985) thought that the bonebed was not the result of a single event, but an accumulation of kills and natural deaths, with disturbance caused by trampling and possibly carcass scavenging. An erosional surface was at the top of the CS in Station E and the unit cut out in some other places.

Selected bones were collected from the bonebed and five bone blocks were made, each with an in situ projectile point (cf. Hester 1972:37, Fig. 34) given the same accession number as the block. Due to the deteriorated condition of the bone in the field, the bone blocks now represent the majority of the faunal material left from the 1949 excavations. These blocks, then, contain not only the best preserved bone but also data on the bonebed itself and the relationships of the projectile points to the bone.

Data quality was affected by bone condition and sampling bias. Bone not in the bone blocks was dry, friable, and fragile (easily broken). Over the years, various preservatives were used to stabilize the bones, but they had not been cleaned prior to treatment. Investigation was impeded by masked surfaces and preservatives that cross-linked (i.e., became insoluble in their solvents due to gradual formation of a three-dimensional network), or thermosetting preservatives (i.e., those designed to be insoluble permanently), and could not be removed safely. Sediments and bones in each of the prepared blocks had been solidified with an unknown preservative (probably ALVAR, a common thermosetting preservative at the time). Bones could not be moved or handled for closer inspection, nor could more sediment be removed for greater exposure.
Three of the bone blocks (TMM937-34, 79, and 80) were prepared as display units (cf. Hester 1972:40, fig. 51) and two (TMM937-16, 937-17) remained as unprepared plaster jackets that were mapped in the field as bone block 1 (TMM937-16) and bone block 2 (TMM937-17) (cf. Hester 1972:37, fig. 34). The display units were identified as bone block 3 (TMM937-34), bone block 4 (TMM937-79), and bone block 5 (TMM937-80). These blocks had not been placed on the field map (cf. Hester 1972:37, fig. 34). The two plaster jackets were opened in 1950, the point in TMM937-16 removed and the point in TMM937-17 measured but left in place in the jacket, and the two jackets resealed (TMM accession records).

**METHODS AND SAMPLING**

The senior author inventoried the TMM Clovis site collections in the mid-1980s and investigated the materials collected by Jelinek (Hester 1972:51-53) and those from Evans’ 1949 work (Hester 1972:29-41; Sellards 1952). After the collection inventory, materials from the Evans and Jelinek bonebeds were correlated with all available data on file at TMM, Vertebrate Paleontology Laboratory (TMM-VP), and Texas Archeological Research Laboratory (TARL). Documents and materials had been split between these facilities, all part of the University of Texas at Austin. Further data were generated through personal interviews with Glen L. Evans and correspondence with Arthur Jelinek. During this study, the two bone blocks still in plaster jackets were opened by TMM-VP preparators, the exposed bone mapped, radiocarbon samples taken, and the blocks scheduled for resealing. The impressions in the sediment

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**Table 1. Inventory of elements from the Jelinek bonebed remaining in the Texas Memorial Museum collection. Elements are identified by their individual accession numbers (TMM937-873-P56-).**

<table>
<thead>
<tr>
<th>Element Type</th>
<th>Accession Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bison Elements</td>
<td>44 femur, 44 tibial diaphyseal segment, 45 astragalus, 48 diaphyseal segment, 49 rib, 50 diaphyseal section, 51 3rd phalange, 52 rib, 53 cervical vertebra, 54 proximal humerus, 55 metatarsal, 56 calcaneum, 57 astragalus, 58 pelvic section, 59 distal tibia, 60 left ascending ramus, 61 3rd phalange, 62 proximal metatarsal, 63 astragalus, 65 distal metatarsal, 66 proximal metatarsal, 68 distal femur, 68 femoral trochea, 68 femoral condyle, 69 distal metatarsal, 70 rib (1 section), 70 pelvic segment, 71 3rd phalange, 72 3rd phalange, 73 3rd phalange, 76 rib (end + 4 sections), 79 rib (head + 3 sections), 80 rib (3 sections), 81 rib (1 section), 82 rib (2 sections), 83 phalanx, 85 metacarpal, 86 thoracic vertebra, 86 thoracic vertebra, 87 cervical vertebra, 87 cervical vertebra, 87 rib end, 88 cervical vertebra, 89 rib (3 sections), 91 cervical vertebra, 91 vertebral segments (3), 92 rib (3 sections), 93 vertebra, 94 rib (2 sections), 96 femur, 96 femoral trochea, 97 lumbar vertebra, 97 lumbar vertebra, 97 vertebral process (3), 98 rib (end + 3 sections), 98 rib (end + 3 sections), M3 (2) and M2 (2), 98 rib (end + 3 sections), 98 rib (end + 3 sections), 3rd phalange, rib (12 sections), cervical vertebra, <em>horse premolar</em></td>
</tr>
</tbody>
</table>

*No accession number was written on the bone for this specimen.*

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**Table 2. Vertebrate taxa from the Jelinek bonebed represented in the Texas Memorial Museum collection (TMM937-873-P56).**

<table>
<thead>
<tr>
<th>Taxonomy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chrysemys scripta</td>
<td>red-eared slider</td>
</tr>
<tr>
<td>Antilocapra americana</td>
<td>pronghorn antelope</td>
</tr>
<tr>
<td>Bison antiquus</td>
<td>ancient bison</td>
</tr>
<tr>
<td>Equus sp.</td>
<td>ancient horse</td>
</tr>
<tr>
<td>Mammutus cf. columbi</td>
<td>Columbian mammoth</td>
</tr>
</tbody>
</table>
where projectile points had been located were not disturbed so that the points could be placed back into position if needed in the future. In mapping the Evans bone blocks, all measurements were taken from an arbitrary point established at an edge of each of the blocks. Only exposed bones were mapped, as no excavation of the blocks was permitted except to take the two radiocarbon samples. The display units had been set at an angle in order to expose bone at different elevations and allow visitors a look into the bonebed. Measurements were awkward to obtain but the jumbled nature and thickness of the bonebed, and the lack of an identifiable surface, were observable. The same radiocarbon sampling procedure was followed for the one plaster jacket from the Jelinek bonebed.

The Jelinek bonebed was in a spring-laid (i.e., fluvial) deposit, raising the possibility that the bonebed was modified by fluvial transport. The issue of the energy level of the water depositing the BSW and the effects of this movement on the bone has never been addressed. The extent of possible fluvial action on the creation and disturbance of the bonebed was investigated by considering the geologic data, examining the bone for evidence of fluvial abrasion, and studying the bone distribution for evidence of preferred orientation, sorting, and transport.

Fluvial influence was investigated with indices and Voorhies Groups. The FTI (fluvial transport index) measures how readily bones can be transported (i.e., predicts hydrodynamic transport) and the SWI (saturated weight index) measures the relationship between bone weight and potential for transport. The SWI is inversely related to the FTI (Todd and Frison 1986:68; Lyman 1994:174-176). These indices are plotted against %MAU (minimum animal units; Binford 1984) to determine the degree to which an assemblage is modified by fluvial action (Todd and Frison 1986:72). These indices were developed for mammoth and were not available for bison (Lyman 1994:176). SWI figures for zebra (Lyman 1994:175) were used as the closest rough estimate available based on size/weight of the animals. A multiple regression for analysis of variance produced an adjusted
Paleoindian Bonebeds at the Clovis Site

Table 3. Radiocarbon ages from the Evans bonebed, Bone Block 1 (TMM937-16) and 2 (TMM937-17) and the Jelinek bonebed, Jelinek Block (TMM937-873-P56-27) at the Clovis site. Radiocarbon samples were taken with a clean trowel and placed into new, self-sealing polyethylene bags. The provenience tags were placed between the sample bag and an outer bag.

<table>
<thead>
<tr>
<th>Yr BP</th>
<th>Lab No.</th>
<th>$\Delta ^{13}$C</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8690 ± 70</td>
<td>SMU-1671</td>
<td>-21.3</td>
<td>Bone Block 2</td>
</tr>
<tr>
<td>8970 ± 60</td>
<td>SMU-1672</td>
<td>-21.9</td>
<td>Bone Block 1</td>
</tr>
<tr>
<td>10,780 ± 110</td>
<td>SMU-1880</td>
<td>-20.0</td>
<td>Jelinek Block</td>
</tr>
</tbody>
</table>

Radiocarbon ages on the bone blocks from the Evans bonebed provide some additional information on the chronology of post-Folsom activity and artifact styles for the region. The sediment in block 2 (TMM937-17) yielded a radiocarbon age of ca. 8700 yr BP and block 1 (TMM937-16) is dated to ca. 9000 yr BP (Table 3). The age from block 2 essentially is identical to the dating of a Firstview feature at Lubbock Lake (Johnson and Holliday 1981, 1989). The difference between the ages from the two blocks, with no statistical overlap at two-sigma, suggests that at least two bone accumulating events are represented in the Station E Evans bonebed.

THE JELINEK BONEBED

The current collection contains 105 bones with apparently eight field catalog entries missing and five bones, originally thought to have been bone tools but now recognized as sternal ribs (intercostal cartilage; Jelinek, personal communication, 1994), that were given to the University of Michigan Museum of Anthropology (Jelinek 1956). Based on a combination of size, epiphyseal closure, and side-of-bone, four bison (Table 4) comprise the minimum number of individuals (MNI) represented in the collection—three adults (one of which is a male) and a subadult (Figs. 5-8). Left (TMM937-873-P56-41) and right (TMM937-873-P56-22) mandibles have the P4-M3 erupted and the M3 in slight to beginning wear. This eruption and wear pattern apparently places this animal around 3 to <3.6 years old (Reher 1974). These mandibles are considered to represent subadult bison and indicate a fall to early winter death.

The area of Jelinek's (1956) work was not a
Figure 5. Bone distribution of adult bison No. 1, Jelinek bonebed.

Figure 6. Bone distribution of adult bison No. 2, Jelinek bonebed.

Figure 7. Bone distribution of adult bison No. 3, Jelinek bonebed.

Figure 8. Bone distribution of subadult bison, Jelinek bonebed.
high energy one during formation of the bonebed. This conclusion is based on the well-sorted, fine-grained texture of the BSW (a fine sand) in the area of Jelinek's work and in many other areas of the basin, in contrast to the poorly sorted, coarser texture of the BSW in some basin-margin settings (cf. Fryxell 1972:81; Haynes et al. 1992:341; Warnica 1966:349). This facies relationship shows that coarser sediments were moved in settings where the energy from spring discharge and slopewash was highest, but the energy rapidly dissipated away from these settings. Throughout most of the basin, therefore, the waters that deposited the BSW could only move sand and did not have the energy to move most of the bone in the bonebed.

None of the bones is fluviually modified. Of the minimum 118 bones uncovered, orientation could be reconstructed for only 53 elements. This number is not enough for a reliable assessment by direct means (Shipman 1981) as to whether or not bones were oriented by water action.

Bivariate plots for both FTI and SWI (Fig. 9a-b) indicate that the mammoth material from the Jelinek bonebed was not transported and no significant correlation was found. Elements most and least susceptible to transport are the most common among the seven bones plotted. The low adjusted \( r^2 \) underscores that %MAU and FTI and %MAU and SWI are not related. The non-transported/low variability pattern is the same for bison (Fig. 9c) and for the combined mammoth/bison bones (Fig. 9d).

All the Voorhies groups (Table 5) are represented in the assemblage as a whole as well as for bison, with only the main groups represented by the mammoth bones. This overall representation indicates a deposit undisturbed by fluvial action. If sorted, the assemblage was affected by non-fluvial actions (Behrensmeyer 1975:489; Lyman 1994:172-173). The notable differences (deviation from the expected) for the bison material are the less-than-expected number in Group I&II bones and the more-than-expected number in Group III bones (Fig. 10). The bones most likely to move first are present as expected. With so few mammoth bones, the results are skewed but nevertheless indicate that Group I bones are represented in expected frequency, as are Group II bones. The overrepresentation of Group III is the result of the small sample size but underscores the lack of transport of the mammoth material. The
Figure 9. Bivariate plots of fluvial transport index (FTI) and saturated weight index (SWI) by per cent of minimal animal units (%MAU) to investigate bone transport potential in the Jelinek bonebed. (a) FTI by %MAU and (b) SWI by %MAU for mammoth remains; (c) SWI by %MAU for bison remains; (d) SWI by %MAU for composite assemblage. The data indicate that fluvial transport was not a factor in the formation of the bonebed.

Figure 10. Frequency profiles of Voorhies Groups for expected, bison, mammoth, and composite assemblages, Jelinek bonebed.
Table 5. Distribution of bison and mammoth bones from the Jelinek bonebed by Voorkes Groups. Elements are identified by their individual accession numbers (TMM937-873-P56-).

<table>
<thead>
<tr>
<th></th>
<th>Bison</th>
<th>Mammoth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voorkes Group I</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 axis</td>
<td>93 vertebra</td>
<td>82 rib</td>
</tr>
<tr>
<td>33 cervical vertebra</td>
<td>40 rib</td>
<td>87 rib</td>
</tr>
<tr>
<td>53 cervical vertebra</td>
<td>49 rib</td>
<td>89 rib</td>
</tr>
<tr>
<td>88 cervical vertebra</td>
<td>52 rib</td>
<td>70 rib</td>
</tr>
<tr>
<td>87 cervical vertebra</td>
<td>70 rib</td>
<td>92 rib</td>
</tr>
<tr>
<td>91 cervical vertebra</td>
<td>78 rib</td>
<td>94 rib</td>
</tr>
<tr>
<td>* cervical vertebra</td>
<td>79 rib</td>
<td>98 rib</td>
</tr>
<tr>
<td>86 thoracic vertebra</td>
<td>80 rib</td>
<td>* rib</td>
</tr>
<tr>
<td>97 lumbar vertebra</td>
<td>81 rib</td>
<td></td>
</tr>
<tr>
<td><strong>Voorkes Groups I and II</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38 1st phalange</td>
<td>61 3rd phalange</td>
<td>73 3rd phalange</td>
</tr>
<tr>
<td>22 3rd phalange</td>
<td>71 3rd phalange</td>
<td>* 3rd phalange</td>
</tr>
<tr>
<td>51 3rd phalange</td>
<td>72 3rd phalange</td>
<td>83 phalange</td>
</tr>
<tr>
<td><strong>Voorkes Group II</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54 humerus</td>
<td>44 femur</td>
<td>55 metatarsal</td>
</tr>
<tr>
<td>26 radius</td>
<td>68 femur</td>
<td>62 metatarsal</td>
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<tr>
<td>28 radius</td>
<td>96 femur</td>
<td>65 metatarsal</td>
</tr>
<tr>
<td>30 radius</td>
<td>34 tibia</td>
<td>66 metatarsal</td>
</tr>
<tr>
<td>85 metacarpal</td>
<td>59 tibia</td>
<td>69 metatarsal</td>
</tr>
<tr>
<td>35 pelvis</td>
<td>29 metatarsal</td>
<td></td>
</tr>
<tr>
<td><strong>Voorkes Groups II and III</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 ramus</td>
<td></td>
<td>25 humerus</td>
</tr>
<tr>
<td><strong>Voorkes Group III</strong></td>
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<tr>
<td>22 mandible</td>
<td></td>
<td>27 skull</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90 mandible</td>
</tr>
</tbody>
</table>

* No accession number was written on the bone for this specimen.

The combined assemblage is similar to that of the bison assemblage. The frequency profiles of the bison, mammoth, and combined assemblages do not fit the expected ones for redeposition of transported bone (Behrensmeyer 1975:491; Lyman 1994:173). These data indicate that agencies other than fluvial action have influenced the composition of the Jelinek bonebed.

Among the bison remains (Fig. 3; Table 6), evidence of human modification occurs in the form of blow marks (on ribs and pelvic sections) and helical fractures with intersecting fracture fronts (on long bones) (Johnson 1985). Cut marks are noted on only one element, a right mandible (TMM937-873-P56-22; Table 6); the marks extend on the exterior ramus from P₄ to M₁.

A bone pile in the northwest corner is composed of 25 elements (Table 7), primarily ribs (11), intercostal cartilage (3), and vertebrae (6), all from one bison (Fig. 5). The ribs are whole and exhibit impact areas and crushing along either the lower borders (distal ends) or upper borders (proximal ends) near the neck of the head, or on both areas. A lumbar vertebra (TMM937-873-P56-97) has a blow to the anterior right edge of the centrum and attendant comminution. This damage is consistent with butchering (Johnson 1987b).

A rib (TMM937-873-P56-52) and intercostal cartilage (TMM937-873-P56-57) lie adjacent to the bone pile and may have been disturbed from it (Fig. 5). The rib exhibits the same damage as the ribs in the pile. This disturbance could be from gravitational settling of the pile (Hill and Behrensmeyer 1985) or carnivore activity, as one of the lumbars (TMM937-873-P56-87) has chew marks.

Three of the bones exhibit a mixture of helical (fresh) and horizontal (dry) bone breakage (Table
Table 6. Modified bones in the Jelinek bonebed. Identified by specimen accession number (TMM973-873-P56).

<table>
<thead>
<tr>
<th>Acc. No.</th>
<th>Element</th>
<th>Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>distal radius</td>
<td>helical fracture; impact and rebound blows</td>
</tr>
<tr>
<td>28/30</td>
<td>radius</td>
<td>mixed helical and horizontal fractures; 3 impact blows; chattering on fractured surface</td>
</tr>
<tr>
<td>29</td>
<td>proximal metatarsal</td>
<td>helical fracture; impact blow; wedge flake scar; hackle marks on fracture surface</td>
</tr>
<tr>
<td>42</td>
<td>tibial diaphyseal segment</td>
<td>helical fracture; impact blow</td>
</tr>
<tr>
<td>50</td>
<td>diaphyseal segment</td>
<td>helical fracture; impact blow</td>
</tr>
<tr>
<td>52</td>
<td>rib</td>
<td>helical fracture; impact blow</td>
</tr>
<tr>
<td>54</td>
<td>proximal humerus</td>
<td>helical fracture</td>
</tr>
<tr>
<td>59</td>
<td>distal tibia</td>
<td>mixed helical and horizontal fractures</td>
</tr>
<tr>
<td>62</td>
<td>proximal metatarsal</td>
<td>helical fracture; impact blow; chattering on fractured surface</td>
</tr>
<tr>
<td>64</td>
<td>vertebra</td>
<td>helical fracture</td>
</tr>
<tr>
<td>65</td>
<td>metatarsal</td>
<td>helical fracture</td>
</tr>
<tr>
<td>66</td>
<td>proximal metatarsal</td>
<td>helical fracture</td>
</tr>
<tr>
<td>68</td>
<td>distal femur</td>
<td>helical fracture; impact blow</td>
</tr>
<tr>
<td>69</td>
<td>distal metatarsal</td>
<td>mixed helical and horizontal fractures</td>
</tr>
<tr>
<td>81</td>
<td>rib</td>
<td>helical fracture; impact blow</td>
</tr>
<tr>
<td>92</td>
<td>rib</td>
<td>crushing</td>
</tr>
<tr>
<td>98</td>
<td>rib</td>
<td>impact blow; crushing</td>
</tr>
<tr>
<td>97</td>
<td>lumbar</td>
<td>impact blow; cracking</td>
</tr>
</tbody>
</table>

Table 6. Modified bones in the Jelinek bonebed. Identified by specimen accession numbers (TMM973-873-P56).

<table>
<thead>
<tr>
<th>Modifications by Carnivores</th>
</tr>
</thead>
<tbody>
<tr>
<td>femur</td>
</tr>
<tr>
<td>87 lumbar vertebra</td>
</tr>
</tbody>
</table>

Table 7. Inventory of elements from bone pile in the Jelinek bonebed. Identified by specimen accession numbers (TMM973-873-P56).

<table>
<thead>
<tr>
<th>Bison antiquus</th>
<th>88, 91</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>87, 97</td>
</tr>
<tr>
<td></td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>49, 78, 79, 80, 81, 82, 89, 92, 94, 95, 98</td>
</tr>
<tr>
<td></td>
<td>74, 75, 76</td>
</tr>
<tr>
<td></td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>84</td>
</tr>
<tr>
<td>Mammuthus cf. columbi</td>
<td>90 ramus</td>
</tr>
</tbody>
</table>

6). The split-line interference with the helical fracture surface indicates drying took place before fracture (Johnson 1985). None of these bones shows trampling or carnivore markings (Table 6). Only two bones exhibit evidence of carnivore modification (Table 6). Bone cylinders and tooth punctures are typical of canid activity (e.g., G. Haynes 1983; Binford 1981), probably done either by dire wolf (Canis dirus) or grey wolf (Canis lupus). Both canids are known for the regional Clovis-age faunas (Johnson 1986a; Lundelius 1972).

Although few in number, the bones exhibiting fresh breakage and those having a mixture of fresh and dry breakage provide the basis for examining site formation processes. The bison bones broken when fresh indicate either a kill or scavenging shortly after death. The bison bones with the fresh-dry breakage pattern indicate scavenging from a few days to possibly a year after death, depending on environment and climate (beginning of Weathering Stage 1 according to Behrensmeyer 1978, and Phase 2 according to Johnson 1985:187-188). One possibility is an initial kill or scavenging for meat and marrow linked with a second bone scavenge activity for marrow within a few days time; i.e., the entire event took place over a short period of time by the same group of people. An alternative possibility involves the kill or scavenge activity as one event and the bone scavenge as a later separate and unrelated event.

This latter scenario seems unlikely because
the bones appear to have been covered by the sands within a relatively short time after death. This estimation is based on the limited carnivore activity and lack of extensive subaerial weathering. Such weathering is noted on only one bone (Table 6). The bones lay out long enough for desiccation cracks to form, suggesting a surface microenvironment of dry conditions; however, the bones exhibit chemical weathering that took place after burial in the sandy sediments.

None of the bison bones exhibited trampling marks or fluvial modification, but four (TMM937-873-P56-34, -44, -68, and -69) were found in steeply inclined positions that indicate disturbance (Shipman 1981; Voorhies 1969). Unstable positions are typical of bones pushed into or moved within sediments by trampling (Fiorillo 1989; G. Haynes 1991), or rapid alluvial deposition (Voorhies 1969), or for decomposing carcasses or articulated units (Hill and Behrensmeyer 1985). Since the bones do not exhibit trampling marks, the first of these possible causes can be ruled out. Given the composition of the bison bone assembly, the last cause also can be eliminated. The bones in unstable positions probably were moved under high-energy conditions, but not from fluvial action. The disturbed bones were in the vicinity of the mammoth skull in the northwest corner (Fig. 3) and were positioned above the base of the skull. One of these bones exhibited human modifications while another had carnivore damage (Table 6). The disturbance of these bones, then, probably was the result of activities by people and carnivores.

Eight mammoth bones were recovered from the excavations (Fig. 3), six of which could be located during the analysis reported here. One element exhibited human modification; none showed carnivore, trampling, or fluvial modifications, and all were chemically weathered. One of the vertebrae (TMM937-873-P56-64) had a helical fracture on the left side of the neural spine. The two elements that may preserve evidence of human modification (a humerus, TMM937-873-P56-25, and a diaphyseal segment, TMM937-873-P56-21) were missing, but based on the field map (Fig. 3) they appear to have had helical fracture surfaces.

Jelinek (1956:8,12) noted that the mammoth bones were weathered, that "most of top of skull eroded off," and the mammoth ramus (TMM937-873-P56-90; Fig. 3) lay "above most Bison bone in BSW [brown sand wedge]." The mammoth ramus lay from 0-7 inches above the bones in the bone pile (Fig. 3). The ramus was edentulous and highly friable due to subaerial weathering. The mammoth remains consistently were higher than most bison bones; however, in comparing the elevations of the mammoth humerus (TMM937-873-P56-25) and skull (TMM937-873-P56-27) with those of bison bones immediately adjacent to them, the humerus and skull were on the same level or lower than the bison material. These data may indicate the mammoth remains were there before the bison bones were laid down, rather than deposited later. If that were the case, then the mammoth ramus may have been positioned on top of the bone pile intentionally by the people during butchering. If the mammoth materials postdate the bison, then the association of the mammoth ramus and bison bone pile was fortuitous. In any event, the extensive subaerial weathering and the elevational differences indicate that the mammoth and most of the bison material were not associated and therefore do not represent a single event.

THE EVANS BONEBED

Of the 26 accession entries for bones separate from the bone blocks, 19 entries representing 22 elements were located in the TMM collections, in addition to 16 upper molars without accession numbers (Table 8). Except for the teeth, all the elements were lower leg bones (four tarsals, five metapodials, and 11 phalanges). No evidence of human or trampling modifications was present. Cortical surfaces varied from unweathered to highly weathered. Subaerial weathering with split-line desiccation cracks was common (13 of the 22 elements). Of these, five metapodials (Table 8) exhibited cortical spalling and large, deep split-line cracks. Four elements were unweathered but had incipient drying cracks. The distal condyles of a metatarsal (TMM937-277) were either chewed by carnivores or damaged from erosion. Based on the size, side, and epiphyseal closure of metatarsals, a minimum number of three bison were represented (one adult male, one adult female, and a subadult). Seasonality could not be established as no intact mandibles were recovered. The upper
molars varied from beginning wear to heavy wear. Thirty-six bones were mapped in bone block 3, most of them bone scaps. Identification to element was difficult due to the fragmentary and shattered nature of the material and the limited exposure of many bones. Identifiable bones primarily were ribs and vertebrae (Table 9). Buried bones, mostly ribs and vertebrae, were noted in cross section all along the side walls. A scapula was exposed in cross section along a side wall with only a small portion exposed at the surface. Projectile point TOM937-34 was lying on its side at an acute angle with the tip going into the ground below the level of the bone adjacent to it.

Twenty-four bones were mapped in bone block 4. Ribs were the single most dominant element and no identifiable vertebrae were present (Table 9). Most of the exposed bones were higher in the sediments than the humeri exposed at the bottom of the display unit. Projectile point TOM937-79 rested on edge among a cluster of bones, with its tip underneath a carpal, its left edge abutting a rib, and its base adjacent to another rib. Only two bones (a vertebral and a piece of bone scrap) were exposed in bone block 5 and the projectile point (TOM937-80) was across the cren ellipse. In mapping bone block 2, the projectile point (TOM937-17) was found lying on edge at an acute angle.

Neither butchering nor trampling marks are noted on any of the bones in the blocks or on those collected individually. Preservation of such marks is happenstance and their observation unlikely due to the weathered cortical surfaces of most bones and occasional masked surfaces. Nevertheless, the unstable position of at least three points from the bone blocks indicates the probability of some disturbance to the deposit, such as trampling. The head of the humerus in bone block 4 may exhibit carnivore chewing and scraping, or the damage may be from weathering erosion. The differential subaerial weathering patterns indicate at least three different microenvironments across the bonebed, or three different events in the formation of the bonebed. This is underscored by the great thickness of the bonebed (up to 61 cm) and depth range of all plotted artifacts (between 2 and 23 cm from the top of CS) (Table 10; Evans 1949; Johnson 1986b). The condition and positions of the bones, positions of the projectile points, thickness of the bone deposit, and depth variation of artifacts verify Evans' original interpretation of multiple, mixed bonebeds. The disturbance to Evans' bonebed is not an isolated case, as jumbled bone and convoluted sediments occur elsewhere at the site for this period (Hester 1972:36, Fig. 42).

Twenty-five projectile points, including six tips and one midsection, were found in place within the bonebed. The 18 complete points form a heterogeneous group varying in shape and size due to extensive refashioning to provide new tips or bases (Wheat 1972). These points also exhibit sharpened and crushed edges concordant with their use as butchering tools (e.g., TOM937-79). Several show impact scars at the tip from their use as weapons, including three of the points from the bone blocks (TOM937-16, -17, and -79).

**DISCUSSION**

Three major agencies were involved in bone modification, identified as human, carnivore, and environmental. Of the three, carnivore activity seemed to be the least intrusive. Direct evidence for it on the bone was minimal. For the Evans bonebed, the reality of the situation, however, was assumed to be masked due to sampling bias. In order to assess that assumption and the role of carnivores in the bone assemblages, carnivore activity at other Plains Paleoindian sites with appropriate data was investigated (Table 11). These albeit very limited data may indicate that the Evans and Jelinek bonebeds reflect the field reality in terms of carnivore activity despite their small size and both the sampling bias and masked surfaces in the Evans bonebed material.

Another assumption was that subaerial weathering and carnivore activity are related, in that length of exposure allowed access to the bones by carnivores as well as the formation of weathering features (e.g., split-line cracks, spalling). The carnivore activity in the Jelinek bonebed was limited to bison bones that are not subaerial weathered (scavenged while fresh). The few bison bones that exhibited a mixed fracture pattern did so because of split-line interference (a drying feature) indicating that the bones had dried for a period of time prior to fracturing. No carnivore markings appeared on these bones and the size of the percussion marks indicate they were dynamically opened by people (Casparo and Blumenschine 1994). For the Evans bonebed, the agency of modification was not as clear cut and the damage to the bones could be either from carnivore activity or weathering. Nevertheless, the damaged bones were subaerially weathered.

The carnivore activity in the Jelinek bonebed
focused on fresh bone while that in the Evans bonebed focused on subaerially weathered bone. Based on limited data (Table 11), an assumption of a positive relationship between amount of carnivore activity and subaerial weathering of bone cannot be made. The data sets are conflicting, but the Lubbock Lake and Colby data sets indicate that the more likely relationship is between amount of carnivore activity and access to fresh bone; i.e., carnivores are more likely to scavenge fresh to nearly fresh bone (exposed for a short period of time as opposed to weeks or months). Carnivore scavenging would take place within a very short time after people left the area. Saunders and Daeschler (1994:22-23) offer an alternative scenario of Clovis peoples having tamed wild canids (most likely wolves). If they did, these canids would have access to the bone during butchering or afterward by scavenging.

For the bison assemblage from the Jelinek bonebed, people scavenged the bone at some point, presumably for marrow. Marrow remains edible for a period of time, depending on local and microenvironmental conditions (Johnson 1985) that would allow for desiccation cracks to form. This mixed fracture pattern also occurs at Lubbock Lake in the late Holocene bison bonebeds (Johnson 1987b). Such a pattern may well be the hallmark of bone scavenging by humans seeking the fullest use of the nutritional resources available to them.

Direct evidence on the bones for butchering and other activities is limited for the Jelinek bonebed and nonexistent for the Evans bonebed. In the Jelinek bonebed, only one element exhibits cut marks while the rest of the evidence consists of blow marks, dynamically fractured bone, and bone piling. Most elements are whole. For the Southern High Plains Paleoindian Period, this situation is typical (Johnson 1987b, 1989; Speer 1978). Cut marks are rare and blow marks far more common, a pattern apparently tied to the goal of butchering (i.e., meat acquisition; Johnson 1987b, 1991a). The lack of marrow retrieval and rarity of cut marks are associated in that cut marks on shafts of long bones are more related to peristomial removal, which is necessary to fracture the bones, than to butchering (Johnson 1985, 1987b).

This pattern is in juxtaposition with the mixed fracture pattern seen in the bison remains in the Jelinek bonebed. Marrow retrieval appears to be an activity occurring some time after butchering and therefore is a secondary use of the carcasses, i.e., a scavenging act. Whether this secondary use was by the same people who butchered the bison or by another group could not be determined.

The role of scavenging in Paleoindian subsistence is not clear but increasing data (e.g., Saunders 1980; Saunders and Daeschler 1994) indicate that scavenging did occur. Such behavior put people in competition with large carnivores both as primary predators and as scavengers. Hunting can be viewed as a high risk (may or may not kill animals that day; may or may not be hurt in the attempt) but high yield (depending on number and size of game animals) venture (Bettiger 1980, 1991; Binford 1980; Lieberman 1993; Winterhalder and Smith 1981). Scavenging, on the other hand, can be viewed as a low risk (carcass already available; little or no threat of being hurt) but variable yield (depending on condition of carcass and size of animal) activity. Scavenging may often be viewed as "safe;" but this assumption needs to be evaluated. Competition with the large carnivores may affect human scavenging activities. Partitioning would avoid direct competition, thereby minimizing this danger.

None of the dynamically fractured bison bone was used as a bone butchering tool or shaped into a bone tool. Dynamic fracturing was consistent in the two collections, with the use of the high-velocity impact technique using a hammerstone in a cantilevered one-anvil mode and one-hand-over-the-shoulder posture (Johnson 1983:193, 209-210). At Lubbock Lake (Johnson 1985, 1987b), this technique/mode/posture was the common one used for dynamic fracturing of bison bone.

If the mammal humerus and diaphyseal segment were dynamically fractured, the action fits a pattern seen at other mammal-related sites (e.g., Hanusa 1989; Johnson 1985; Miller 1989; Steele and Carlson 1989). This activity is a quarrying operation to secure diaphyseal segments for use as blanks in the production of bone foreshafts and other tools and to produce large, heavy-duty bone flakes (Johnson 1985:202-203). A number of bone foreshafts, apparently made from mammal compact bone, have come from various stratigraphic excavations at Clovis (Hester 1972) as well as other Clovis-age sites (e.g., Lahner and Bonnichsen 1974).

Various lines of evidence form the foundation for delineating site formation and disturbance processes at these localities. For Jelinek's (1956) excavation, the area was a dry, sandy setting along the margins of the basin (cf. Hester 1972:174, Fig. 130). Various events occurred in creating and then disturbing the bonebed prior to burial, but fluvial action was not involved. The mammal and bison remains appear to represent two separate events, although which was first could not be determined. People were involved with both events but whether or not as primary predators (formation) or scavengers (disturbance) could not be determined. Actual butchering activities could not be detected. If the mammal material was laid down first, then the main disturbance was by people placing the mammal remains over the pile of bison bones. Differential settling based on size and bone density is a possibility if the bonebed represented a single event or a single surface; however, this possibility does not account for the placement of the mammal remains over the bone rib pile.

Based on bone damage patterns and bone position, both people and carnivores disturbed the bone carcasses. Meat retrieval during butchering and piling of the primarily thoracic-cavity unit was followed by scavenging activities of carnivores (seeking fresh bone, based on Lubbock Lake and Colby data sets; see Table 11) and people (seeking edible marrow in dry bone). The limited weathering of the bones indicated a fairly rapid burial. Whether or not the bison represented a kill (i.e., people were responsible for the site formation) or were found carcasses (i.e., human activity was a "disturbance") could not be determined.

The Evans bonebed also is at the margin of the basin (Hester 1972:174, fig. 130) but in a marshy environment with water-saturated sediments. Several events contributed to its formation and disturbance. The radiocarbon ages indicate at least two episodes of bone deposition. The bone weathering patterns suggest the possibility of at least three episodes or differential weathering environments across the bonebed. No direct evidence of butchering or other human activities were noted on the bones; however, the projectile points were reworked heavily for use as butchering tools and expedient flake tools also were recovered (TMW accession records; Hester 1972). Carnivore activity contributed to at least one occurrence of disturbance. While direct evidence of trampling on the bones was not found, field records and photo-documented numerous bones in high-energy positions within convoluted sediments. Trampling, then, also contributed to at least one
of mammoth in Clovis economy again is being reevaluated. Clovis subsistence now is viewed as broad based, with mammoth one of many game animals (e.g., Johnson 1991b; Ferring 1995). The mammoth carcass was also a significant technological resource, as indicated by the remains of Jelinek’s (1956) excavation, the El Llano Dig #1 excavation (Saunders et al. 1990, 1991), and elsewhere (Johnson 1985; Hannon 1989; Miller 1989; Steele and Carlson 1989).

The Clovis bonebed was not produced by a single event, and therefore does not represent “one of the largest [ison]s ever found at the site” (Hester 1972:37). As the herd size of the individual kills will never be known, whether the episodes represent large-scale or small-scale kills or both cannot be determined. Based on general similarities to the bonebed at Plainview (formed by at least two kills; Johnson 1989), rather than to those at Lubbock Lake (Johnson 1987b), large-scale kills are more likely scenario.

The Clovis site is one of the most significant sites in North America. Excavations over the last 60 years have yielded few published, in-depth studies. With the destruction of the site, these unstudied collections represent a prime data base for the Paleolithic record. As Saunders and others (1990, 1991; Saunders and Daeschler 1994) have demonstrated, new discoveries still are to be made.

Acknowledgments

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REFERENCES CITED

Agin, George A., and Irwin Rosner

Blecha, Peter, and Anders M. K

Blott, J. H.

Bonk, R.W.

Bollas, H. E.

Bonnichsen, Robert, and Marcelle S. Grinnell

Brett, J. E.

Brown, W. R.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

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Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.

Bryant, J. P.
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Hughes, Elaine

1984


Hunt, C. B.

1974


Jelinek, Arthur

1956

Field notes for the excavations in the Brown Bed Wedge at the Clovis site. On file at the vertebrate Paleontology Lab, Texas Memorial Museum, Austin.

Johnson, Eileen

1983


Lundelius, Ernest L., Jr.

1972


Lyman, R. Lee

1985


Martín, Charles W., and William C. Johnson

1995


Matthews, J. A.

1985


Miller, Suzanne J.

1989


Pagano, Robert R.

1981


Rader, Charles A.

1974


E. Johnson & V. T. Holliday

1995


Johnson, Eileen, and Vance T. Holliday

1981


1989


Lubec, Lawrence, and Robson Bonnichsen

1974


Lubbe, Daniel E.

1993


Pagan, Thomas J.

1978


Pepper, Robert D.

1980


Pepper, J., and Edward B. Daeschler

1994


Pepper, J. W., C. Vance Haynes, Jr., Dennis Stanford, and George A. Agogino

1990


1991


Scharpenseel, H. W.

1971


1979


Sellschop, E., H., and Glen L. Evans

1960


Sellschop, E., H., Glen L. Evans, and Grayson M. Meade

1947


Shipman, Pat

1981


Slaughter, Bob H.

1975


Speer, Roberto D.

1978


Saunders, Jeffrey J.

1986


Saunders, J. D., and Edward B. Daeschler

1994


Saunders, J. D., C. Vance Haynes, Jr., Dennis Stanford, and George A. Agogino

1990


Saunders, J. D., George A. Agogino, Anthony T. Boldurian, and C. Vance Haynes, Jr.

1991


Scharpenseel, H. W.

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Sellschop, E., H., and Glen L. Evans

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Sellschop, E., H., Glen L. Evans, and Grayson M. Meade

1947


Shipman, Pat

1981


Slaughter, Bob H.

1975


Speer, Roberto D.

1978


Stanford, Dennis, C. Vance Haynes, Jr., Jeffrey J. Saunders, George A. Agogino, and Anthony T. Boldurian

Steele, D. Gentry, and David L. Carlson

Stevens, Dominique F.

Todd, Lawrence C.

Todd, Lawrence C., and George C. Frison

Voorhies, Michael R.

Warnica, James M.

Wendorf, Fred

Wendorf, Fred, and James J. Hester

Wheat, Joe Ben

Winterhalder, Bruce, and Eric Alden Smith

Wormington, H. M.