CURRENT RESEARCH IN THE PLEISTOCENE

Volume 2 1985

A Peopling of the Americas Publication

THE CENTER FOR THE STUDY OF EARLY MAN

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Editor
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From the Editor

Some would hold that the late Pleistocene is easier to understand than other, much older, periods of the Earth's history, because remains from the Pleistocene are more numerous. Others would counter that the late Pleistocene is actually much harder to study than other periods of time because the abundant remains require interdisciplinary cooperation among various scientific fields. Specialists from only one discipline cannot reconstruct the late Pleistocene. However, the study of human prehistory does act as a catalyst working to pull other fields together toward a common denominator, that is, the reconstruction of Quaternary environments and human lifestyles.

A major step in the human emigration of the world was the progression of *Homo* into northeastern-most Asia, Beringia, and on into the Western Hemisphere. It is this period of human history that provided the initial focus of the Center for the Study of Early Man. However, other areas of study are equally as important to the theme of pre-10,000 yr B.P. humans in the Americas. Particularly, northeastern Asia (northeastern China and eastern Siberia) and modern analogs in taphonomy provide integral statements for understanding the broader topic including the environments of the late Pleistocene.

This is the second issue of *Current Research in the Pleistocene,* a journal published annually as part of the Center for the Study of Early Man's PEOPLING OF THE AMERICAS publication program. Note that the title is new, one that we hope conveys more information about the contents and interests. The journal focuses on the broad topic of the Pleistocene peopling and environments of the Western Hemisphere. Specialists from all over the world are invited to submit short current research statements for publication. Collectively, these concise, state-of-the-art reports provide an overview of trends and developments in New World early human studies and allied disciplines, all in a single source.

Current Research in the Pleistocene is different than other journals. Its purpose is to bridge the gap between abstracts, which might be published in academy and society meeting proceedings, and

those notes and short articles printed in regular peer reviewed journals. Authors are permitted to expound fairly freely about their ideas and research goals, as long as the articles pivot around the key phrases "current research" and/or "sound new ideas and thought." Views of the authors' are not necessarily those of the Center.

Manuscripts received are first read by the editorial staff to ensure that the minimum requirement is met (as outlined above). All manuscripts are edited for style and general grammar. The journal follows a style (see 'Information for Contributors') that permits continuity of format and allows for concise reporting. Each author is requested to submit in essence a "camera-ready" manuscript. Because one of the principal goals of the journal is to provide quick turnaround time for the printing of manuscripts, authors do not review galley or page proofs. The editorial staff compares the submitted "camera-ready" manuscript with the style-edited page proofs. If a submitted manuscript is found to require extensive editing or if editorial changes alter an inherent meaning, the author will be contacted prior to final printing. Because of this editorial policy, it is imperative that authors submit manuscripts that have been carefully proofed for content and grammar. It is suggested that all manuscripts be reviewed by a colleague of the author prior to submission. The editorial staff reserve the right to request an outside peer review of any manuscript prior to determining its acceptance for publication.

The success of this journal rests on the specialists who submit their reports of current research. If this is done, everyone interested in the study of the peopling of the New World and the paleoenvironmental reconstructions of the Western Hemisphere should be able to keep abreast of this fast-changing, interdisciplinary topic.

J.I.M.

Archaeology

Archaeological Research Activities of the University of Pittsburgh in 1984

J.M. Adovasio, A.T. Boldurian, and R.C. Carlisle

1984 was a particularly busy year for archaeology performed by the Cultural Resource Management Program of the Department of Anthropology at the University of Pittsburgh. Analysis of the more than 36,000 artifacts recovered from the Gateway Center Station site of the Pittsburgh Light Rail Transit system in downtown Pittsburgh continued throughout the year as did research into census, deed, tax, and other historical data on this section of the city. The excellent preservation and protected environment of the artifact-filled water wells have resulted in a large number of reconstructible ceramic and glass specimens including some rare yelloware specimens of the nineteenth century Pittsburgh potters, Bennett and Brothers. The final report on this project is at least one year from completion but publication plans are being formulated.

In March, an Archaic period site (36BK549) was excavated along the Schuylkill River and Maiden Creek in Berks County, near Reading, Pennsylvania for Texas Eastern Gas Pipeline Company. Seventeen Archaic projectile points and point fragments were recovered from apparently undisturbed contexts about 30 cm-40 cm below ground surface. Three discrete Archaic occupations are in evidence. Locus A, the westernmost of the three, produced only quartzite projectile points. Argillite, chert, and quartzite points came from Locus B while Locus C has examples of side-notched, corner-notched, straight-stemmed, and one ovate base point. Undisturbed Archaic sites in this part of the Schuylkill River drainage are not numerous, and the work conducted at 36BK549 offers the opportunity to extend our knowledge of Archaic cultural adaptations in this part of Pennsylvania.

The 1984 Summer Field Training Program in Archaeology once again concentrated on prehistoric open-air sites in the Cross Creek, Raccoon Creek, and Buffalo Creek drainages of southwestern Pennsylvania. The work was underwritten by both the University of Pittsburgh and a grant from the National Geographic Society. Studies were conducted at the Pershina site (36WH608) and the Krajacic site (36WH351), both of which have produced Paleoindian components, though in non-stratified contexts.

The Pershina site (36WH608) is a multicomponent upland locality on Raccoon Creek, a second order tributary of the Ohio River southwest of Pittsburgh. A large surface artifact collection of flaked stone tools, debitage, and numerous ground stone tools has been accumulated by the site's caretakers, Mr. and Mrs. William Ringelsbaugh. Excavations revealed two natural strata and six cultural

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features. The many ground stone artifacts suggest that plant processing may have been an important aboriginal activity at the site. An intensive late Archaic occupation characterizes the south end of the site. Two Miller-like lanceolate projectile points, a fluted biface fragment as well as several small, prismatic blades and blade fragments from the north end of the site reflect a much earlier initial occupation during the Paleoindian period.

The Krajacic site (36WH351) is a non-stratified, multicomponent site on a hilltop that forms part of the interstream divide between Cross Creek and Buffalo Creek. Alfalfa has been grown there for many years; thus, fieldwork has been limited so far to mapping surface contours, survey, and examination of surface collections. Krajacic farm is about 2 km south of a major outcrop of Monongahela chert, and the known lithic tool assemblage strongly suggests that the availability of this raw material was a major factor in the aboriginal occupation of the site.

Analysis of the site's 2,000 or so flaked stone artifacts began in early fall 1984 and is continuing. Over 80% of the assemblage consists of cores and unmodified debitage. Current research interest is focused on the several small, cylindrical, polyhedral cores from which small, prismatic blades were detached. A small number of Miller-like lanceolate biface preforms broken in the late stages of their manufacture are known from this site and suggest comparisons with the lithic inventory from Meadowcroft Rockshelter.

Current research at both the Pershina and Krajacic sites is aimed at determining the extent of Paleoindian occupation in the region, at clarifying the nature of the Miller (pre-Clovis) biface manufacturing complex, and at establishing technological relationships among pre-Clovis, classic Paleoindian and subsequent Archaic traditions in the Upper Ohio River Valley. Additional fieldwork at both sites will be conducted during the University of Pittsburgh's 1985 Summer Field Training Program in Archaeology from late June to mid-August.

A third major archaeological project undertaken by the Cultural Resource Management Program is Phase III cultural resource management work at the site of the Catawissa Bridge replacement in Columbia County, Pennsylvania. This work, being conducted for Parsons Brinckerhoff-Quade & Douglas, Inc. and the Pennsylvania Department of Transportation, began in early September. Earlier work by John Milner Associates, Inc. had identified the presence of site 36C09 and established its cultural significance. The site has early late Woodland Clemson's Island and possible Owasco cultural affiliations. Fieldwork is currently underway, but deeply stratified deposits, intact cultural features, abundant ceramic artifacts, net sinkers, lithics, burned rock, and charred seeds already have been identified or recovered. Excavations will extend until the fall of 1985.

Archaeological reconnaissance continued along the Texas Eastern Gas Pipeline Company's proposed gasline routes from Uniontown, PA to just outside Philadelphia. A major Monongahela village site (36FA40) was identified in the uplands overlooking the Youghiogheny River in Fayette County, Pennsylvania. Limited test excavations at the site by CRMP personnel revealed excellent preservation of subsistence remains as well as the presence of intact cultural features. Further excavations planned for the 1985 field season pro-

mise to yield important settlement/subsistence data and will undoubtedly contribute to our understanding of the Monongahela lifeways in this portion of western Pennsylvania.

A late Archaic resource procurement station (36BK559) was also discovered within the pipeline right-of-way in a relatively undisturbed context in Berks County, Pennsylvania. Projectile points typical of the late Archaic/Transitional cultural period were recovered during shovel probing activities. Phase II test excavations are currently being conducted at this site in an attempt to determine the nature of the site and the integrity of the subsurface deposits.

Members of the Cultural Resource Management Program continued to play an active role in the Committee on Pittsburgh Archaeology and History (CPAH), a cooperative interdisciplinary historic preservation advocacy group for the Pittsburgh area. In the less than two years since its founding, CPAH has been active in lobbying for urban archaeology and architectural preservation. At CPAH's urging, the Commonwealth of Pennsylvania initiated a nine-month long inventory of Allegheny County records. The survey concluded in December 1984, and CPAH is now pushing for the establishment of a Pittsburgh area archive/record management center, a city museum, and a city historic preservation ordinance. To that end, CPAH assisted the Historical Society of Western Pennsylvania in sponsoring a November 17, 1984 meeting entitled "Documenting Local History: Pittsburgh and Allegheny County Records."

Stone and Bone Artifacts with Pleistocene Fauna in Two Cave Sites in Interior Bahia, Northeast Brazil

ALAN L. BRYAN AND RUTH GRUHN

Near the town of Central, in the semi-arid *caatinga* zone of interior Bahia about 500 km northwest of the city of Salvador, is an extensive limestone block with many caves and rockshelters with evidence of human habitation. The Projeto Central, under the overall directorship of Profa. Maria Beltrão of the Museu Nacional in Rio de Janeiro, aims to recover and analyze paleoenvironmental and archaeological data from this region with a view to determining the nature of human occupation. In 1983 and 1984, with a research grant and leave fellowships from the Social Sciences and Humanities Research Council of Canada, we conducted excavations at four cave and rockshelter sites in the limestone block. Two of these sites, Toca dos Buzios and Toca de Manoel Latão, yielded simple stone and bone tools in stratigraphic association with bones of extinct fauna.

The Toca dos Buzios is a large and complex cavern system located on the northeast edge of the limestone block. Excavations in the northern chamber, which measure about 10 by 8 m, revealed a thick deposit of limestone rubble mixed with much ash and abundant fragments of gastropod shell. Less than half a dozen artifacts were recovered from this upper deposit of rubble, ash, and shell midden. At the rear of the chamber this zone was underlaid by a flowstone floor up to 15 cm thick. A yellow silt deposit was encountered underlying the flowstone floor, and filling a channel eroded into the bedrock floor of the cavern. Enclosed permineralized fragments of bone of extinct horse (two species), a large cervid, and a giant peccary indicated a Pleistocene age for this sealed basal deposit.

After the bone fragments from the yellow silt zone in the Toca dos Buzios were carefully cleaned in the laboratory, close examination of the surface of the bones revealed that 31 specimens of a total collection of several thousand small bone fragments bore sharp scratches, incisions, or patterned scrape marks indicating human utilization. These bone specimens are now being studied and photographed under a scanning electron microscope (SEM). As well, the yellow silt zone yielded nine small fragments of vein quartz, an exotic material in the cave sediments. Seven of these quartz fragments reveal evidence of flaking, and patterned use-wear is clearly visible on the flaked surfaces of two quartz chunks under the SEM.

The Toca de Manoel Latão, also a complex cavern system, is located on

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the south side of a limestone ridge, about 6 km west-southwest of the Toca dos Buzios. The eastern chamber, measuring 12 by 6 m, proved to be filled with a massive deposit of reddish-brown silt, increasingly cemented with depth. A level of roof fall, possibly significant as a climatic indicator, occurred in the silt zone at the 20-25 cm level; and bones of extinct mammals, including giant armadillo (*Pampatherium*), a large cervid, a camelid, and horse, were identifiable in the faunal assemblage between 20 and 60 cm below surface. Simple stone and bone artifacts were found to a depth of 60 cm below surface in the silt deposits. A horse podial with two sharp well-defined cut marks was recovered from the 40 to 50 cm level, definitely confirming the association of man with Pleistocene fauna at the Toca de Manoel Latão.

Most of the stone artifacts found in the levels with extinct fauna, below a depth of 20 cm, were vein quartz flakes or fragments with evidence of utilization on one or more edges or points. One well-used small quartz crystal flake was found at the 20-30 cm level. Most artifacts of quartzite (from a source 25 km southwest) were found above 20 cm depth, but a utilized quartzite flake was found at 30-40 cm depth. A utilized chunk of grey chert was recovered from a depth of 50 to 60 cm. Four fragments of possible bone projectile points were found below 20 cm depth, but the surface of the bone is too weathered to retain any marks of scraping or polish.

Excavations at two rockshelters, the Abrigo da Lesma and the Abrigo do Pilão, produced archaeological materials of Holocene age, associated with modern fauna. However, the basal zone in a thick deposit of ash and silt at the Abrigo do Pilão produced radiocarbon dates of 9,390 ± 90 yr B.P. (Beta-10017) and 9,450 ± 90 yr B.P. (Beta-10605); several limestone artifacts and flakes were recovered deep in a compact zone of red silt underlying this ash zone. No bone was recovered from the red silt zone.

It has proved impossible to obtain radiocarbon dates from the Toca dos Buzios and the Toca de Manoel Latão. No charcoal was found in the early levels; unfortunately the bone fragments from both sites were permineralized, with no collagen remaining. We can say only that the several extinct species of mammals present indicate that the human occupations are Pleistocene in age. It is probable that the age is comparable to radiocarbon dates ranging back to 31,500 yr B.P. from a series of hearths on well-stratified occupation floors at the rockshelter site of Toca do Boqueirão da Pedra Furada, in the southern part of the state of Piauí about 200 km north of Central (Guidon 1985). A classic pebble tool industry, with choppers and scrapers made on quartz pebbles, and simple flake tools as well, is associated with the early radiocarbon-dated occupation floors at the Toca do Boqueirão da Pedra Furada. Unfortunately no bone was preserved in the early occupation levels at this site.

We North American archaeologists working in interior Bahia have been struck by the extreme simplicity of the bone and stone technology manifested in archaeological sites dating from Pleistocene to late Holocene times. Very few stone or bone artifacts in the entire prehistoric sequence represent formal types, or even show evidence of intentional shaping: most have been modified in form only through use. If artifact assemblages of Pleistocene age in remote northeast Brazil may be taken as a possible indication of the earliest technologies to cross the Bering Straits, archaeologists must not ignore simply-modified bone

and stone specimens from Pleistocene contexts in North America as "geofacts," "equifacts," or "background noise."

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The Montgomery Folsom Site

WILLIAM E. DAVIS

Fieldwork was recently completed on one of the first Folsom sites on the Colorado Plateau documented with chronologically distinctive artifacts. Up to the present, isolated surface finds of the late Paleoindian projectile points have indicated the presence of late Pleistocene hunters and gatherers in the general area. However, until the discovery of the Montgomery Folsom site (42GR1956), there had been no intensive archaeological investigations of early man sites. For this reason, the site, found on a cultural resource management survey, was investigated by Abajo Archaeology of Bluff, Utah. The purpose was to document the highly distinctive Folsom assemblage which was apparent from the surface survey. Work was carried out by volunteers during December, 1984.

The Montgomery Folsom site is located on a bench to the east of the Green River, a few miles south of the town of Green River, Utah. Although additional sites of later age are present along the river near the Folsom site, the latter lacked evidence of any later occupation at or immediately adjacent to the site. Although subsurface testing showed the site to lack significant depth, evidence of recent human disturbances and vandalism also was lacking, thus the surface assemblage is believed to be undisturbed and unmixed. At least 98% of the 925 artifacts were obtained from a 100% surface collection.

The Montgomery Folson site lies within a major east-west fault zone. Exposed surface rocks in the vicinity include the Cretaceous Cedar Mountain Shale and the Brushy Basin and Salt Wash Members of the Jurassic Morrison Formation (Hintze and Stokes 1964). Erosion has created a classic badlands topography characterized by large, blocky sandstone talus boulders resting on steep slopes of eroding, multi-colored shale.

The site is situated on a broad bench formed by the resistant Salt Wash Sandstone Member capping the underlying Brushy Basin Member. A large erosional channel to the west and an erosional basin on the east separate the bench from the surrounding terrain. Directly south and below is a broad terrace, which borders the Green River, 120 m south of the site. Little soil deposition is present on the bench, with the majority of the cultural material exposed by deflation and minor water erosion. It is postulated that during the occupation of the site, the bench was covered in part with small, localized sand dunes 20 to 40 cm high, which may have supported an abundant understory of desert grasses.

A total of 188 tools and 737 items of debitage were recovered from the site. Two Folsom projectile point fragments were found. One of the fragments displays a transverse impact fracture while the other fragment appears to have

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broken during manufacture. In addition to the projectile point fragments, tools and debitage clearly exhibit a distinctive process in stone flaking technology easily recognized as paleolithic. Certain cultural indicators apparent in the artifact assemblage consisted of 12 spurred transverse end scrapers, 6 borers/gravers, and numerous flakes of bifacial retouch with heavily ground striking platforms, all of which are attributes distinctive of Folsom Paleoindian assemblages documented from the High Plains area (Frison 1978).

Overall implications suggest that the site served as a base camp, possibly re-occupied several times. This conception is supported in part by several discrete and functionally different artifact concentrations occurring within the 150 by 185 m site area. The large amount of debitage, stone tools, and weaponry implies a relatively large concentration of several families, possibly a band, who engaged in tool production and maintenance, faunal procurement, and processing.

The site's location overlooking the river bank suggests that it was used as a hunter's lookout, but there is no evidence that a kill or butchering site actually exists in the area. According to Dr. Larry Agenbroad, who has excavated and studied late Pleistocene paleontological sites in the area, the principal game may have been bison (*Bison antiquus*). Greater precipitation during the postglacial period may have allowed more abundant grasses in the past to support large grazing animals.

The greatest expectation of the artifact analysis will be to describe the typological and technological attributes of the entire Folsom assemblage. Such a descriptive treatment will provide a basis for more accurate comparisons with other known Folsom assemblages and will reveal local and regional differences in Folsom lithic technology and tool use.

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Fluted Point Occurrences in Alberta

EUGENE M. GRYBA

Maurice Doll of the Provincial Museum at Edmonton and I have embarked on a project to compile a record of as many of the fluted point occurrences known from Alberta as possible. While many of the finds were made during the "Dirty Thirties", and specific provenience in a lot of cases has not been kept, it is felt that a current inventory would be of great value to prehistoric researchers, in general. Over 70 possible contenders have now been identified. A small sample of them is illustrated in Fig. 1. Many private collections remain to be examined. When the project is completed, it is estimated that close to 90 fluted points will have been documented for this part of North America.

This project is the first concerted inventory of Fluted Point Tradition artifacts found in Alberta since the general survey of local collections which was carried out in the mid 1950s (Wormington and Forbis 1965). However, unlike that survey which covered the range of prehistoric cultures, this one is concerned only with artifacts of the Fluted Point Tradition. Aside from insights on distribution, potential implications of this study range from those associated with the origin of this Paleoindian tradition to specific questions focussing on local settlement patterns, use of lithic material, cultural affiliations, variations in point manufacture, and so on.

Most of the fluted points (Fig. 1) appear formally and technologically similar to the Clovis type, or to the small multiple fluted forms recovered from the Sibbald Creek site in southwestern Alberta (Gryba 1983: Fig. 28-30) and from the Charlie Lake site in northeastern British Columbia (Fladmark and Gilbert 1984). There is a relatively high proportion of reworked examples (Fig. 1 G and H). A few of the points, because of their bold fluting or fine workmanship (Fig. 1 A and B), are reminiscent of the Folsom Complex. Unfluted examples which may belong to the Fluted Point Tradition also occur (see Wormington and Forbis 1965: Fig. 19 and 20; Carlson 1983: Fig. 6.8; Gryba 1983: Fig. 30).

The overwhelming majority of fluted points are made of locally available quartzites and siltstones. However, at least four specimens of brown chalcedony (Knife River flint), and two more made from a mottled brown chert, suggest some Paleoindians who occupied southwestern Alberta had affiliations to the southeast.

In Alberta, fluted points have a general distribution throughout the southern two-thirds of the province, roughly south of a line drawn from the town of Peace River east to Cold Lake, and coinciding largely with the major extent of agricultural land. To the west, distribution extends into the forested Rocky Mountain Foothills, for instance, at the Sibbald Creek site (Gryba 1983) and

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near Grande Cache, and even into the mountain Front Range in Banff National Park (Carlson 1983). Stratigraphically sealed components need to be uncovered and dated in order to provide answers relating to the temporal range, material cultural complexity, subsistence, and other aspects of the Fluted Point Tradition in this part of the continent.

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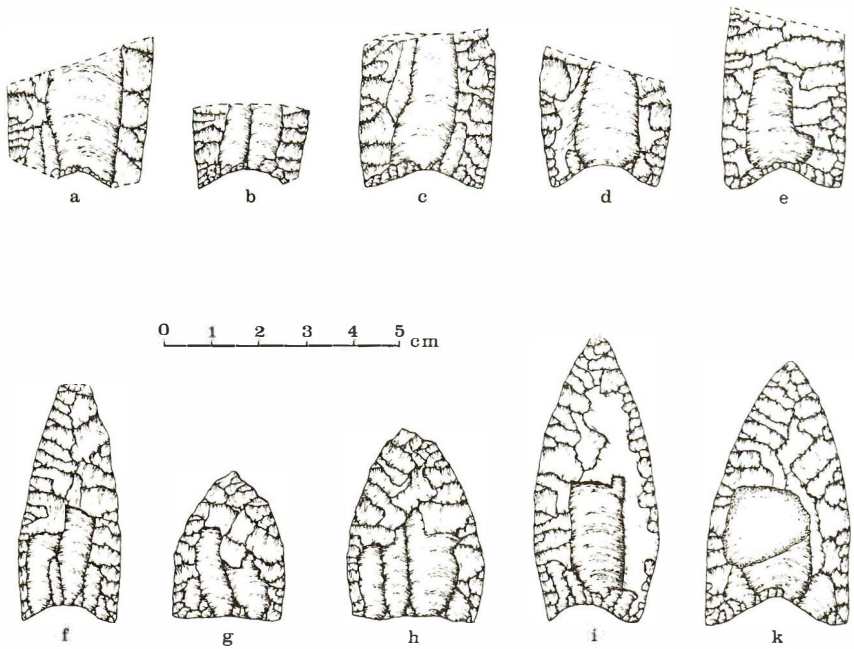

Fig. 1. Fluted points recovered from the Hanna (A), High River (B), Banff National Park (C and D), Penhold (E), Red Deer ? (F), Genesee (G), Buffalo Lake (H), and Drayton Valley (I and J) districts of Alberta.

Fluted Point Occurrences at the Sibbald Creek Site in Alberta

EUGENE M. GRYBA

Salvage excavations at the Sibbald Creek site (EgPr-2) in 1980 turned up two fluted points near the base of poorly stratified deposits. The site contained no less than 10 components, including two Historic Period ones, in unseparated but chronologically graded deposits to a depth of 45 cm below surface. The base of a Cody Complex point and a concave-based point with delicate lateral edge retouching (Midland?), four lanceolate examples, and several corner-notched points reminiscent of the Mount Albion type, plus gravers, eared end scrapers, crude bifaces, side scrapers, as well as other tools and debitage, were also recovered near the bottom of the deposits.

Bison (*Bison*), deer (*Odocoileus*), sheep (*Ovis*), and beaver (*Castor*) remains occurred just below the surface at EgPr-2. Only a few tiny scraps of calcined bone were found in the deepest levels. No intact hearths were encountered. Organic material, fine-screened from the 25-30 cm, 35-45 cm, and 35-40 cm below surface layers, yielded respective radiocarbon dates of 5,850 ± 190 yr B.P. (GX-8809), 7,645 ± 260 yr B.P. (GX-8810), and 9,570 ± 320 yr B.P. (GX-8808). A malfunction in an electronic counting device discovered a day after the third sample was run casts a question on the reliability of the last of these three dates. However, there is general agreement between the radiocarbon dates and the stratigraphic and archaeological evidence.

The Sibbald Creek site is located in the forested Rocky Mountain Foothills of southwestern Alberta 72 km west of Calgary, about 11 km from the edge of the open Plains and an almost equal distance from the Rocky Mountain Front Range. The site is situated on a remnant of an outwash plain nestled 50 m up the south side of a high hill where the valley floor widens at the confluence of Sibbald and Jumpingpound creeks. Today, the site offers a commanding view of an 800 ha open meadow which dominates the valley floor. Local paleoenvironmental conditions during the time when EgPr-2 was occupied by people of the Fluted Point Tradition remain to be determined.

Most of the core area of the Sibbald Creek site was originally slated for destruction through back-sloping during highway construction. A total of 217 m^2, or roughly a third of the core area of the site, was salvaged. Because of the proven archaeological significance the highway has since been rerouted and the remaining portion of EgPr-2 left intact.

The two fluted points from EgPr-2 are relatively small (Fig. 1). The first example is 25.8 mm long, 21.0 mm wide, and 4.1 mm thick, while the fragmen-

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tary example is 20.1 mm long, 29.7 mm wide, and 4.0 mm thick. Only the broken example shows basal and lateral edge grinding. Both points were manufactured from locally occurring fine-grained siltstones. Details of flaking and fluting are illustrated in Fig. 1. The regular spacing of the flake scars, their small size, the absence of pronounced crushing at the point of impact, and my personal knowledge of various flaking techniques lead me to conclude that the final shaping of the two preforms and the removal of channel flakes was most likely accomplished by direct hand-generated pressure.

The complete fluted point from the Sibbald Creek site is of similar manufacture to the specimen recovered by Fladmark from the Charlie Lake site in northeastern British Columbia. Three radiocarbon dates obtained from bison bones recovered from the layer which is believed to have yielded the multiple fluted point gave an average age of 10,487 yr B.P. (Fladmark and Gilbert 1984).

Fluted points, mainly of the Clovis style and of examples technologically similar to the multiple fluted point from EgPr-2, occur throughout the southern two-thirds of Alberta. They suggest an early post-glacial occupation of this part of North America. Such evidence from the Sibbald Creek site as the use of good quality, locally derived siltstone for the manufacture of the fluted points, the protected, southern aspect of the campsite, and its regional setting off the open Plains in the Foothills and in an area frequented by warm chinook winds and which has historically served as a bison wintering range, suggests that southwestern Alberta was occupied at this time by a "resident" rather than "transient" human population whose members were quite familiar with the seasonal climatic conditions and the range of alternative resources available in this part of North America.

Maurice Doll of the Alberta Provincial Museum and I have begun a province-wide survey of fluted point occurrences. To date, close to 70 specimens which might belong to the Fluted Point Tradition have been documented. The results of this survey will be published upon project completion.

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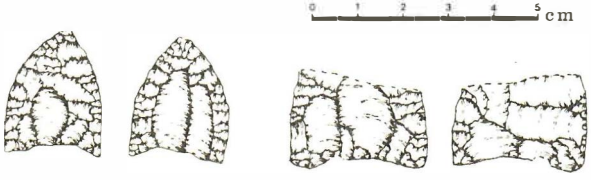

Fig. 1. Obverse and reverse aspects of the two fluted points recovered from the Sibbald Creek site.

A Clovis-Age Megafaunal Processing Station at the Lubbock Lake Landmark

EILEEN JOHNSON AND VANCE T. HOLLIDAY

Excavations at Lubbock Lake in Yellowhouse Draw on the Southern High Plains, Texas, yielded the remains of a variety of late Pleistocene megafauna in a single bone bed covering about 200 m^2. The bone bed (in Area 2, feature FA2-1) is significant because it provides evidence of human interaction with a number of extinct species while lacking human-modified lithics; it is also the youngest occurrance in the geologic record of two extinct species.

The feature is scattered across the surface of a gravelly point bar (substratum 1A), one of the oldest valley fills in the draw. The bone was buried by sandy, overbank sediments (substratum 1B) that fine upwards into a clay drape (substratum 1C). Substratum 1C is buried by diatomaceous and organic-rich lake and marsh sediments (stratum 2). The presence of FA2-1 within stream deposits raises the possibility that the bone is not *in situ,* as suggested by Stafford (1983). Some small bone fragments were found within 1B, suggesting that they were picked up by the overbank waters, but several lines of evidence demonstrate that the feature essentially is in place. Most of the bone rests horizontally on the gravel, whereas significant disturbance should produce bone wedged into the gravel or many more specimens supported by the sand. Preferred orientation is lacking and stream wear on the bones is absent. The fine-grained nature of the sediments that bury the bone and the presence of ripple cross bedding indicate that 1B was a low energy deposit incapable of moving most of the bone. Finally, the broken remains of an infant mammoth (*Mammuthus*) skull were found in anatomical position. Water flowing with sufficient energy to disturb FA2-1 would be expected to scatter these skull parts given their relatively flat and porous nature.

Several radiocarbon ages from strata 1 and 2 indicate that the feature dates to about 11,100 yr B.P. Wood found in 1B among the bones of FA2-1 assayed at 11,100 ± 100 yr B.P. (SMU-548; Holliday *et al.* 1983). Clam shell (*Sphaerium* and *Pisidium*), also found in the sand among the bones, yielded an age of 12,150 ± 100 yr B.P. (SMU-295; Holliday *et al.* 1983). However, wood found about 2 km downstream in the same stratigraphic position (top of stratum 1, immediately below stratum 2) yielded an age of 11,100 ± 80 yr B.P. (SMU-263; Holliday *et al.* 1983) and radiocarbon ages and Folsom points from the base of stratum 2 in Area 2 and elsewhere in the site indicate that the age of 11,100 yr B.P. is a reliable one for FA2-1 (Holliday *et al.* 1983).

The remains of a minimum nine individuals were recovered and include

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mammoth (*Mammuthus columbi*), camel (*Camelops hesternus*), horse (*Equus scotti* and *Equus* sp.), bison (*Bison antiquus*), short-faced bear (*Arctodus simus*), and giant armadillo (*Holmesina septentrionale*). The assemblage experienced a complex life history as some elements exhibit carnivore-induced modification, others human-induced modification, and some exhibit both. Human-induced modification includes cut lines in appropriate anatomical positions from meat retrieval and skinning operations, dynamic loading of intact fresh long bones from marrow processing, and the production of fracture-based utilitarian tools for use in these operations (Johnson 1985). The presence of *Arctodus* and *Holmesina* mark the first documented occurrance of these animals with man and man's utilization of them as a food source. The 11,000 yr B.P. age provides the youngest reliable date on these species (cf. Anderson 1984; Lundelius *et al.* 1983).

Bone butchering tools involved the dynamic loading of intact fresh long bones of ungulates and bear. Wear patterns, not breakage morphology, provides evidence of tool use (Johnson 1983: Fig. 31, 1985). This class of butchering tool is designated as expediency tools, which were made efficiently and quickly, regardless of performance. The tools were made in the activity area from bones of animals being processed, used in that processing, and then discarded with the rest of the faunal debris (Johnson 1983, 1985).

Bone quarrying of mammoth limb elements involved dynamic loading of intact fresh long bones that produced a number of large segments by radial fracture for use as blanks and cores (Johnson 1985). Two caliche boulders were found surrounded by bone fracturing debris and opened mammoth limb elements.

An extensive microvertebrate fauna represents the most complete record known for the Southern Plains late Pleistocene. Among the extant taxa, three areas of sympatry occur with faunal influences from the Northern Plains, south east from Louisiana, and the Trans-Pecos area. An ameliorated climate prevailed of narrowed annual temperature extremes, less seasonality, and a more effective moisture regime. Summers were cooler than present (ca. minimum 10°F) and warmer winters did not maintain freezing conditions.

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Paleoindian Investigations at Lubbock Lake: The 1984 Season

EILEEN JOHNSON AND VANCE T. HOLLIDAY

The Lubbock Lake Landmark (41LU1) is a ca. 120 ha archaeological preserve on the Southern High Plains of western Texas. The deeply stratified site, on the northern edge of the City of Lubbock, is in an entrenched meander of Yellowhouse Draw, an ephemeral tributary of the Brazos River. The 1984 field season focused on deposits encompassing the Paleoindian period: alluvial sediments of stratum 1 (12,000?-11,000 yr B.P.) and lacustrine and marsh sediments of stratum 2 (11,000-6,500 yr B.P.).

A bison (*Bison*) kill/butchering locale (FA5-12) in the shore facies (substratum 2s) of stratum 2 is being uncovered in Area 5. Substratum 2s is subdivided into local beds (LB) which consist of slopewash and lacustrine sediments. The bone bed is in clayey, organic-rich sediment from a lake transgression (substratum 2sLBc). All local beds in Area 5 often are highly convoluted either by bioturbation (bison trampling?) and/or surges in spring discharge which could deform saturated sediment. The locale appears typical of Lubbock Lake Paleoindian times, i.e., a single event of a small herd killed and butchered at the edge of a pond. Although projectile points were not recovered, lithic flake tools and resharpening flakes were, along with bone debitage from human-induced bone fracturing processes. Carnivore modification is lacking on the bison remains. Muskrat (*Ondatra*) remains were abundant. Two significant aspects single out this feature relative to the Southern Plains Paleoindian record: its age and the presence of exotic material. Lacustrine sediments (2sLBc) containing site FA5-12 yielded a radiocarbon age of 9,780 ± 100 yr B.P. (SMU-699, NaOH-soluble fraction). Southern Plains sites that date from 10,000-9,000 yr B.P. are rare. The exotic material is a mass of fine-grained iron oxide (TTU-A40842) ca. 5 cm in diameter. X-ray diffraction studies show that the material is pure hematite, probably from a hydrothermal source. The nearest known area of geothermal activity that could produce such material is the mountains of New Mexico. An earlier connection between the Southern High Plains and the Jemez Mountains of north-central New Mexico during Paleoindian times is documented by Johnson *et al.* (1985).

Geologic investigations focused on a late Pleistocene megafaunal bone bed (FA5-3) in a swale on a gravelly, buried terrace of stratum 1. Based on stratigraphic position, the terrace must be older than a megafaunal processing station (FA2-1) elsewhere in the Landmark that dates to 11,100 yr B.P. (Holliday *et al.* 1983), but the relationship of FA5-3 to the terrace has been unclear

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(Holliday and Johnson 1984). It now appears that marsh sediments that bury the feature filled the swale containing it very soon after the bone was left on the terrace. These marsh sediments were later buried by similar appearing, but younger (less than 9,000 yr B.P.) marsh deposits of stratum 2. The filling of the swale probably occurred prior to the downcutting and alluviation that preceded the FA2-1 event of 11,100 yr B.P. Additional specimens, primarily *Bison antiquus,* recovered from the bone bed exhibit human-induced modifications, primarily cut lines in appropriate anatomical positions. Carnivore-induced modifications appear lacking as do stream wear, differential sorting, or preferred orientation. Some weathering prior to burial had occurred but post-burial chemical weathering apparently did not.

A number of radiocarbon ages now are available for the Paleoindian features in Area 5. In addition to the age for FA5-12, a locale immediately below FA5-12 (FA5-17, substratum 2sLBb; Holliday and Johnson 1984) has a finalized radiocarbon age, from lacustrine sediment, of 9,950 ± 120 yr B.P. (SMU-1261, NaOH-soluble fraction). This age supercedes that reported by Holliday and Johnson (1984). This locale produced projectile points of a hitherto unrecognized and undocumented design and exotic material (obsidian) from the Jemez Mountains. A bison kill/butchering locale (FA5-7) immediately above FA5-12, at the base of marsh sediments (substratum 2B) that bury substratum 2s, yielded radiocarbon ages on the lake sediments, of 9,075 ± 100 yr B.P. (SI-4179, NaOH-insoluble fraction) and 9,170 ± 80 yr B.P. (SMU-829, NaOH-soluble fraction). It also produced a projectile point of a hitherto unrecognized and undocumented design different from that in FA5-17.

Lubbock Lake now has a minimum of eight Holocene Paleoindian occupations that span a 2,000 year period (10,500-8,500 yr B.P.). Prior to the investigations into the three locales in Area 5, a region-wide gap of occupations and knowledge had existed between occupations at 10,000 yr B.P. and those at 8,500 yr B.P. Only two dated sites were known from within that time span, both ages on bone (Rex Rodgers, 9,180 ± 80 yr B.P., SMU-274, Speer 1978; Lake Theo, 9,360 ± 170 yr B.P., Tx-2879, Harrison and Killen 1978). The Area 5 sequence begins to fill that regional gap towards a more expanded and detailed chronology and occupational view.

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The Quince Site: A Stratified Paleoindian to Woodland Occupation in the Ouachita Mountains of Southeast Oklahoma

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The Quince site (34AT134) is located on an alluvial terrace of McGee Creek, a major tributary to Muddy Boggy Creek, in the southeast Oklahoma section of the central uplift of the Ouachita Mountains Physiographic Province. First recorded in 1976, the site was intensively tested in 1982 and 1983 by the Institute of Applied Sciences, North Texas State University as part of the McGee Creek Project, funded by the Department of the Interior, Bureau of Reclamation (Perttula *et al.* 1983).

Deep alluvial deposits at Quince contain a record of occupations spanning the early Holocene, ca. 10,000 yr B.P., to the Woodland period. Within the 3 m of alluvium, eight occupations have been defined, and two others may be present in the as yet poorly sampled levels below 1.7 m. Woodland (Occupation Horizon I), late Archaic (OH II-III), and middle Archaic (OH IV) components are present within the upper cultural deposits. Only the Woodland occupation, however, has been dated at this time. An uncorrected ^{14}C date of 1,710 ± 50 yr B.P. (Beta-6678) and a thermoluminescence date of ca. 1,670 yr B.P. (Alpha-981) indicate an occupation affiliated with the early Fourche Maline Culture. The late Archaic and middle Archaic occupations have been estimated to date between 2,000-3,000 yr B.P. and 5,000-6,000 yr B.P., respectively (Wyckoff 1984). A geological disconformity is present at about 1 m below the surface; cultural material below that depth dates to the late Paleoindian period and is exposed in an alternating series of sandy loam, sandy clay loam, and clay loam deposits. Occupation horizons V-VIII occur within the top 40-50 cm of the Paleoindian deposits, with postulated horizons also at 60 and 95 cm below the contact. Tools and debris have been recovered to 3 m below surface in limited excavations, but no time diagnostic artifacts were identified, and it is unclear whether this material is *in situ*.

The best estimate for the dating of Paleoindian horizons at Quince would appear to be ca. 10,500-9,500 yr B.P. Both Dalton and Plainview projectile points are present in OH VI and VII, with examples of one or the other forms from OH V and VIII as well. The estimated date is based on Plainview data from the High Plains of Texas (Holliday *et al.* 1983) and evidence obtained from well defined Dalton components (Goodyear 1982). The association and contemporaneity of these point forms in eastern Oklahoma Paleoindian assemblages has long been discussed, but little substantive information about

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this relationship had been recovered prior to the Quince site excavations.

The top three Paleoindian occupations are amenable for the analysis of intrasite spatial patterning. Each contains burned rock hearths and/or scatters, with tools and debris clusters adjacent to the hearths. Both tool and debris densities are low by comparison to more recent occupations. A total of 176 tools and 6,800 pieces of lithic debris were recovered from early assemblages.

Tool data for these Paleoindian horizons indicate a relatively diverse assemblage of retouched flakes, gravers, thin and thick bifaces, and pyramidal and discoidal cores. Thirty-six projectile points and fragments, plus numerous end and side scrapers, were also found. Groundstone implements are infrequent. A small adze form is also noted from several of the horizons; this may be analogous to the Dalton adze (Goodyear 1982).

The tool kit, whose character is dominated by the increased frequency of hunting and scraping implements over more recent occupations, appears to represent evidence for a major focus on hunting and processing of game animals. Stone tool production and refurbishing activities are also represented. While most tools are made on local cherts, many of the bifacial tools are made on high quality non-indigenous stone, including Boone chert from the Arkansas Valley and Ozark Highland, and Edwards Plateau chert from central Texas.

Rarely have Paleoindian occupations with good stratigraphic context been found in the Ouachita Mountains. Only the Bell and Billy Ross sites in eastern Oklahoma have been reported (Galm and Hofman 1983; Wyckoff 1968). The ongoing analysis of the tools and features from the *in situ* occupations at Quince provide a wealth of data on the nature of activities carried on at the site during the early Holocene. Consequently, the potential to understand the utilization of mountain environments by these Paleoindian groups is greater now than at any previous time.

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Pleistocene Archaeological Research in San Diego

B.O.K. Reeves

Research has focussed primarily on San Diego, California, in the last four years. The months of January-April, 1982 were spent doing field archaeological studies, supported by a research grant from the Social Sciences and Humanities Research Council. Our program, which included both site survey and test excavations, was by a six-person volunteer crew. Site survey focussed on the location of both primary surface sites, characterized by unifacial large chopper-chopper tool assemblages on late Pleistocene - marine and riverine terraces, and primary and secondary sites on deposits of Pleistocene age.

Controlled surface collections were carried out at 90 + surface sites and a representative assemblage of unifacial cobble/core tools, manufactured on quartzite, basalt, and other volcanics. In these sites with quartzite tools were also found naturally spalled "bipolars", which were often used as blanks for chopper manufacture. No bifaces were found nor artifact/lithic types characteristic of the known Holocene cultural record.

Use-wear replicative analysis by Margaret Newman (University of Toronto) suggest the "choppers and chopping tools" range from "cores" with no discernable wear patterns to one exhibiting both soft and hard wear, the latter the product of wood chopping or butchering.

Excavations were carried out in three primary and one secondary site. One primary site located in coastal La Jolla, on a high marine platform, had a unifacial flake and chopper tools, and anvils and hammerstones in association with buried soils on top of eroded sandstone 1 m below surface. No shell was preserved. A radiocarbon date from a later occupation 20 cm below the surface yielded a date of ca. 9,000 yr B.P. Thermoluminescence dating by Dr. David Huntley (Department of Physics, Simon Fraser University) of the site sediments suggests an age of ca. 23,000 yr B.P. for the early occupation.

A "fire hearth" was found in riverine terrace sediments on the Otay River, which geologically dates to Stage 2 times. A thermoluminescence date was obtained ca. 14,000 yr B.P. The hearth was an intensive 10 cm thick, 1 m in diameter/burned clay feature in association with a buried soil. Two percussed basalt flakes were found in the bank 1 m distant in the soil.

A secondary site was investigated 16 km inland in the El Cajon Valley of an old Pleistocene lake basin, part of the San Diego River drainage. Here stream alluvium, in which a series of buried soils are developed, had infilled part of the basin. Unifacial quartzite core and flake artifacts were recovered from stream gravels, below buried soil. Thermoluminescence dating of the latter suggests an age of ca. 20,000 yr B.P.

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A nearby primary site, in association with an old late Pleistocene erosional terrace in the El Cajon Valley was also tested. Percussed cores and flakes were found at the base of a 2 m soil profile, developed on eroded granitic bedrock. Independent geo-stratigraphic studies by Ray Schlemon confirm a mid-Wisconsin age for this surface deposit. Collected data, including some thousands of artifacts and naturally-spalled objects are currently being analysed.

The program has been successful in resolving the problem of the natural versus the man-made nature of the early San Diego artifact assemblages. Carter's "bipolar blade/core" characteristic of Texas Street can be most economically explained as the result of natural spalling from weathering and thermal stress. Quartzites were observed and collected undergoing this process from present chaparral fires. These objects are a minor component of the sites and often used as tool blanks. The assemblage is typical of the Circum-Pacific chopper-chopping tool tradition. The bifacially edged discoidal shaped chopping tools may be a "diagnostic" element of these early assemblages in North America.

Sites of this complex were extremely common throughout southern San Diego county. Many have continued to be lost through development as local archaeologists either refuse to accept them as of human origin or do not collect the sites.

Stratigraphic test excavations to demonstrate geologic/temporal associations were less successful as permission to excavate would not be gained from the preferred sites, which occur in association with fan and river terraces of known late Pleistocene age. Some sites had "clearances" from local archaeologists. The site tested and dated however, does indicate at least a stage 2-3 age for this chopper/chopping tool complex.

Only one well stratified buried terrace campsite - the Brown site - remains in San Diego. Briefly investigated by Minshall and Morriarity in 1967, the chopper/chopping tool complex was found in excellent stratigraphic context in stage 3-4 deposits. The site is critical to resolving dating problems. We had hoped to reopen the site to collect material for dating. However, access was denied. This site is the single most important site in the San Diego area.

The Sycamore Site and Its Role in Pennsylvania Prehistory

HARRY J. TUCCI

The Sycamore site is located in Union Township, Berks County, in southwestern Pennsylvania. The major occupation of the site is a Paleoindian base camp, although the site has not been radiocarbon dated yet. The Paleoindian period in Pennsylvania generally ranges from 12,000 yr B.P. to 10,000 yr B.P.

The Sycamore site lies in an upland area of the Schuylkill River Valley, with the nearest water being a third order tributary of the Schuylkill River. The site is located in the Welsh Mountains rather than on the broad floodplains or associated terraces of the river. The location of the site is unique in that most known sites from the earlier time periods in this area of Pennsylvania are located on the rich alluvial floodplains, where they are stratified and deeply buried. The Sycamore site has no discernable stratigraphy and extends to a maximum depth of only 65 cm below surface; the Paleoindian component begins at a depth of 45 cm.

The site was discovered during a transect survey of the surrounding area, during which the author was invited to examine a farmer's artifact collection from local fields. Among the collection was a fluted point of brown Pennsylvania jasper, which led to the subsequent investigation of what has since become known as the Sycamore site.

Subsequent investigations revealed a relatively intact, buried Paleoindian component. Two other fluted points of Pennsylvania jasper were recovered, along with a possible third fluted point made from chert. The predominant tools recovered from the site were small end scrapers made from Pennsylvania jasper. Also recovered, in limited quantities, were spokeshaves, gravers, drills, sidescrapers, unifacial and bifacial knives, sidescrapers, denticulates, and debitage.

Preliminary testing also revealed several features, which may be associated with the Paleoindian component. These features contained preserved floral and faunal remains which are currently under analysis. When this analysis is complete, paleoenvironmental reconstructions will be possible.

Only 20 m^2 of an estimated 300 m^2 have been excavated. Plans for continuing work are being made. Future work may tell us why the Paleoindians chose this upland setting for the site of their base camp, and what resources they were exploiting in the vicinity of the Sycamore site.

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Early Holocene Occupation Along Whitewater Draw, Southeastern Arizona: The Sulphur Spring Stage

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The Sulphur Spring stage of the Cochise Culture of southeastern Arizona has been a source of controversy for five decades. In Whitewater Draw, Sayles and Antevs (1941) reported that Sulphur Spring ground stone artifacts were associated with extinct megafaunal remains and concluded that the Sulphur Spring stage dated between 12,500 and 11,000 yr B.P. (Sayles 1983). Based on the apparent age of the Sulphur Spring stage and acceptance of its association with extinct megafauna, some researchers (Waters 1983, n.d.) have suggested that the Sulphur Spring stage sites may represent specialized plant processing stations of the Clovis Culture. However, other archaeologists (Waters 1983, n.d.) have questioned the validity of the association between extinct fauna and artifacts of the Sulphur Spring stage and see no relationship to the Clovis Culture. My geoarchaeological investigations of Whitewater Draw were undertaken in 1982-1983 to resolve this controversy.

Sulphur Spring artifacts are found at four sites in Whitewater Draw. Artifacts occur in secondary contexts within correlative fluvial sand and gravel deposits at three sites (AZ FF:6:9, AZ FF:6:8, and AZ FF:10:1 Double Adobe site) and within less disturbed sediments at AZ FF:10:14. Early Cochise Culture artifacts have also been recovered from the Lehner site in the adjacent San Pedro Valley (Haynes 1982).

Ground stone artifacts, milling stones and handstones, are the most common element of the Sulphur Spring assemblage and outnumber flaked-stone tools at most sites (Sayles and Antevs 1941; Sayles 1983). Flaked-stone artifacts are predominately unifacially worked flake scrapers, plano-convex scraper-cores, and core-choppers. Bifacial flaking is rare and only four biface fragments have been recovered from Sulphur Spring stage contexts.

Twelve radiocarbon dates on charcoal from deposits containing artifacts at four sites and 10 additional dates from the alluvium allow temporal placement of the Sulphur Spring stage. Four radiocarbon dates from the alluvium containing Sulphur Spring artifacts at AZ FF:6:9 range from 8,390 ± 190 yr B.P. (A-3233) to 8,650 ± 180 yr B.P. (A-3232). The Sulphur Spring artifact-bearing sand at AZ FF:6:8 dates between 8,140 ± 220 yr B.P. (A-3277) and 9,340 ± 180 yr B.P. (A-3238) and the underlying artifact-bearing gravel is undated. At AZ FF:10:1 dates of 8,840 ± 310 yr B.P. (A-3377) and 8,760 ± 210 yr B.P. (A-3379) are associated with artifacts in the upper sand. Ten additional dates from cor-

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relative deposits at Double Adobe range from 8,270 ± 250 yr B.P. (A-188c) and 9,120 ± 270 yr B.P. (A-2235) (Waters 1983, n.d.). Artifacts have also been recovered from the underlying undated gravel. A date of 10,420 ± 100 yr B.P. (A-1152) was reported from a similar gravel 240 m downstream from the site AZ FF:10:1 and is associated with mammoth (*Mammuthus*) remains, but no artifacts (Damon and Long 1972; Sayles 1983). This date may be applicable to the artifact-bearing gravel at AZ FF:10:1 (Double Adobe) and AZ FF:6:8. Two radiocarbon dates, 9,860 ± 80 yr B.P. (SMU-197) and 9,900 ± 80 yr B.P. (SMU-204), are associated with Cochise Culture artifacts at the Lehner site, Arizona (Haynes 1982) which directly overlie the Clovis horizon. Therefore, radiocarbon dates from strata containing Sulphur Spring artifacts place this stage between approximately 8,000 and 10,000 yr B.P. and possibly as early as 10,400 yr B.P. based on the single date from the gravel near Double Adobe. Additional dates are needed to ascertain the true maximum age of the Sulphur Spring stage.

No extinct faunal remains were found in Sulphur Spring artifact-bearing deposits at AZ FF:6:8, AZ FF:6:9, or AZ FF:10:14. The only associations between extinct fauna and Sulphur Spring artifacts occurs at AZ FF:10:1, where mammoth camel (*Camelops*), horse (*Equus*), dire wolf (*Canis dirus*), and bison (*Bison*) remains have been recovered from the alluvium with artifacts of the Sulphur Spring stage (Sayles and Antevs 1941; Sayles 1983).

Fossils from the alluvium from the Double Adobe area are mostly isolated disarticulated finds, but two discoveries of articulated remains have been reported: (1) Haury (1960) recovered articulated camel leg bones in the sand from which Sulphur Spring artifacts had previously been recovered, and (2) Windmiller (see Sayles 1983) uncovered the remains of a single mammoth (two lumbar vertebrae articulated) in gravel 240 m downstream from AZ FF:10:1. A radiocarbon date on charcoal collected from the gravel near the mammoth is 10,420 ± 100 yr B.P. (A-1152) (Damon and Long 1972). Because the bones are articulated, they are considered to lie in primary association within the alluvium dated to approximately 10,400 yr B.P. However, the bones recovered from the alluvium in radiocarbon dated contexts between 8,000 and 9,400 yr B.P. are probably reworked from older deposits. They are not articulated and there are abundant older sediments from which they could have been dislodged.

Therefore, megafaunal remains are not in primary association with Sulphur Spring stage artifacts in the alluvium dated between 8,200 and 9,400 yr B.P. However, it is possible that Sulphur Spring people did temporally overlap with relict populations of Pleistocene megafauna during the terminal Pleistocene. This question however, remains unresolved, because no direct association of articulated megafaunal remains and Sulphur Spring artifacts have been found.

In summary, radiocarbon dates place the Sulphur Spring stage of the Cochise Culture between 8,000 and 10,000 yr B.P. and probably to 10,400 yr B.P. Evidence suggest that the Sulphur Spring people did not temporally overlap with Pleistocene megafauna except possibly during the terminal Pleistocene. Failure to find diagnostic artifacts of the Clovis Culture and Sulphur Spring stage mixed on a site, their superposition at the Lehner site, and the chronological placement of the Sulphur Spring stage show that they are not temporally equivalent.

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Physical Anthropology

Scavenger Modification of Human Remains

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C.K. Brain (1981) has commented on the difficulty of obtaining detailed information on scavenger modification of human remains either from natural situations or experimentally. He was referring specifically to hyena (*Crocuta, Hyaena*) modification, but the scarcity of information applies across species, despite its critical importance to the interpretation of the fossil record.

Forensic anthropology can be viewed as a form of taphonomy with much to offer to the understanding of taphonomic events and how they may affect human remains. Forensic cases can provide modern analogs for interpreting scavenger alteration of human skeletons, including dispersion, disarticulation, and damage to bone. This paper briefly presents two illustrative forensic cases. Terminology used here was developed in Mead and Sorg (n.d.) and based on Bonnichsen (1979), Binford (1981), and Haynes (1980, 1983). Both cases were exposed in remote wooded areas of northern Maine for more than one year after death, and both exhibit rodent and carnivore modification.

Case No. 83-1012 is a robust adult male killed with a gunshot to the head in July, 1982, and discovered 16 months later. The remains were almost completely skeletonized, with some ligamentous tissue at the joints and along the spine. During a second search the following June more bones were recovered, all within a 30 m diameter. Missing were both patellae, right fibula, both feet, most of both hands, two cervical vertebrae, and one rib. Probable carnivore modification includes removal of both distal femora, proximal and distal ends of both tibiae, and proximal and distal ends of the left fibula. Diaphyseal ends are scalloped with marrow cavities scooped out. The diaphyses are generally unmarked, not channelled, and do not exhibit punctures, rotational scars, pitting, or splintering. The distal diaphysis of one tibia has a minor number of shallow, short (about 1.5 cm) striae. The distal diaphysis of the fibula has a small area (about 0.25 cm diameter) with a minor number of tiny pits. The flat bones lack any evidence of modification. Preliminary interpretation is that a non-canid carnivore removed the epiphyses and a small scavenger produced the striae and pits.

Case No. 80-361 is an adult female who died of unknown cause in August, 1978. Bones were discovered 20 months later when a dog brought home both femora, both innominates, and a right tibia with a small amount of soft tissue attached. The remaining bones were found at the probable site of death 75 months later in an area about 10 m in diameter and about 2 km from the dog's home. Bones from the first collection showed evidence of "carnivore activity," but were not described in detail; bones from the second collection show exten-

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sive modification of flat bones, particularly the skull (Fig. 1), scapulae, and innominates, all with similar patterns. In addition, the proximal left humerus and the acromion have been scooped out, but with no pits, punctures, or striae. Preliminary interpretation is that a canid modified bones from the first collection and the second collection was modified by rodents.

Work is proceeding to develop a more robust nomenclature for rodent modification, to link macroscopic and microscopic patterns, and to compare modification of these and other cases with other modern analogs.

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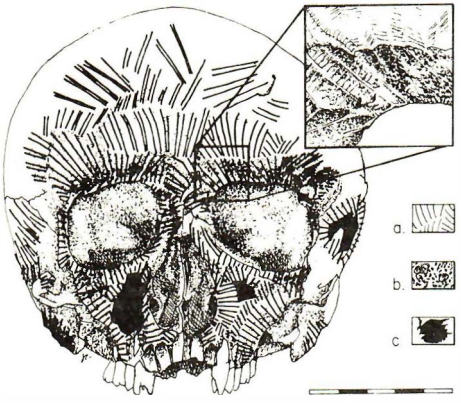

Fig. 1. Skull from Case No. 80-361 in frontal view showing extensive rodent modification. Prominent features such as the brow ridges, orbit margins, and occipital condyls (not shown) have been completely gnawed off exposing cancellous bone or even creating "windows" to the cranial cavity. Gnawing has occurred intensively all over the face and forehead, and less intensively over the entire cranium. The detail shows the wide, overlapping, parallel grooves, including "chatter" marks within the grooves; these are probably due to scraping by incisors. A = rodent gnawing. B = spongy bone. C = window through bone.

The Paleoindian Skeletal Material from Horn Rock Shelter in Central Texas

DIANE YOUNG

Horn Rock Shelter No. 2 (41BQ46) is a stratified, well-dated rockshelter on the Brazos River in eastern Bosque County in central Texas. It contains a record of human occupation from the Paleoindian period through historic times (Watt 1978). In 1970, a double burial, comprised of an adult and child, was discovered 442 cm below the modern surface of the rockshelter floor. There are radiocarbon dates on both charcoal (9,500 ± 200 yr B.P., Tx-1830; 9,980 ± 370 yr B.P., Tx-1722) and shell (10,030 ± 130 yr B.P., Tx-1998; 10,310 ± 150 yr B.P., Tx-1997) taken from above the burial but in the same stratum (Watt 1978). The antiquity of this burial, the paucity of other securely dated Paleoindian skeletal remains, and the completeness of these two individuals make this skeletal material unique in the New World.

The two individuals were buried in flexed positions, lying on their left sides, with the child facing the back of the adult. Multiple grave goods accompanied the burial. The skull of the adult rested on top of three inverted turtle carapaces stacked within one another. A fourth carapace had been placed in front of the adult's face and a fifth was found under the adult's pelvis. The insides of the turtle carapaces had been scraped clean of vertebral fragments indicating intentional preparation (Redder 1984). Other grave goods included two antler billets, two sandstone slabs, a fragment of red ochre, and four perforated canines (non-human). Scattered throughout the burial fill were 80 shell beads. The burial was covered with 19 limestone slabs.

Both skeletons are primarily intact but have suffered some warping and breakage from ground pressure. Portions of the bones are covered with deposits of calcium carbonate. This post-mortem damage will preclude some measurements and makes others approximate.

Preliminary analysis of the skeletal remains has provided the following information. Based on dental calcification and eruption as well as a lack of any epiphyseal fusion on the post-cranial material, the child is estimated to be approximately 12 years old. There is evidence of a minor infection in the right maxillary sinus. No traumatic injuries are evident.

The second individual is an adult based on the eruption and severe attrition of all teeth, the fusion of all epiphyses, and very minor degenerative changes on the proximal ends of the ulnae. Despite the severe dental attrition, there is no evidence to place this individual into an "old adult" category. The state of dental attrition more likely reflects harsh use rather than advanced age. The occlusal surfaces of the anterior mandibular teeth are rounded towards the front,

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suggesting their possible use as tools.

The sex of the adult was probably male. This estimation is based on both metric and non-metric observations on the skeletal material as well as the "male nature" of the associated grave goods. The adult had an infection in the left maxillary sinus, possibly associated with an apical abcess. There is a healed fracture on the left fifth metatarsal and abnormal bone deposition and resorption on the left third cuneiform and navicular. This may or may not be related to the fractured metatarsal. An odontome, an anomaly also noted on the Midland skeleton (Wendorf *et al.* 1955), is located on the floor of the left nasal cavity.

Stature estimations for the adult range from 161 to 169 cm. The bones show sharply defined areas for muscle attachments suggesting a muscular build. The browridges on the adult are very pronounced but not out of the range of more recent populations.

In addition to providing the osteological description of the Horn Rock Shelter material, the continuing study at Texas A & M University will compare these remains to other skeletal material to provide some assessment of population affinities. The Horn Rock Shelter skeletons will be compared with regional populations from prehistoric sites in Texas and a temporal sample drawn from other alleged Paleoindian skeletal finds presently known in North America. Though it has yet to be determined if the Paleoindian population can be defined by any specific suite of morphological characteristics, the importance of this material makes these comparative studies necessary if not conclusive.

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Lithic Studies

New Approximation for the Hydration-Age of Obsidians of the Ilaló Region of Ecuador

EMILIO BONIFAZ

The ages reported in Bonifaz (1977, 1978) have had to be corrected because of new results on the studies of the composition of the obsidians and because the oldest specimens (those of the last glaciation) had been submitted to lower temperatures than the most recent specimens. Previously I used a rate of 6 μm^2 per 1,000 years. In 1979, I (Bonifaz 1979) proposed to use a composite formula for the determination of the hydration rate on obsidian thought to be more than 10,000 years in age. The formula I developed for the dates presented beyond is:

$$t + t' = \frac{M^2 \times 1000}{K} + \frac{1000(M'^2 - M^2)}{K'}$$

where: t = time that the artifact was submitted to hydration rate K; t' = time that the artifact was submitted to hydration rate K'; K = rate of hydration during time t; K' = rate of hydration during time t' ;M = microns of hydration that correspond to rate K and time t; M' = total hydration of artifact.

Dr. Friedman (personal communication 26 July, 1979) provides for me two different hydration rates: (1) at 10°C, 2 μm^2 per 1,000 years, and (2) at 21°C (the present temperature of the Ilaló region), 7 μm^2 per 1,000 years. Friedman states that these rates are correct to $\pm$ 20% of their value.

The calculation of the temperature of the Ilaló region during the Pleistocene has been presented (Sauer 1965). The present snow level is at 4,800 m elevation. With the Ilaló region at 2,600 m elevation, the difference would be 2,200 m for the 21°C, or about 1°C for each 100 m elevation. The snow level during the last glaciation was apparently at least 1,200 m below its present level, or about 3,600 m elevation. The difference with the altitude of the Ilaló region would be 1,000 m, and at 1°C for each 100 m, this would correspond to a temperature of about 10°C during the last glacial period.

The 10°C would correspond to a hydration rate of 2μm^2 per 1,000 years, using the composite formula, which in turn, would apply to the obsidians of more than 8.367 μm of hydration, indicating an age of 10,000 yr B.P. A total of 58 hydration-date Pleistocene age determinations were completed. Hydration rates ranged from a low of 8.37 to a high of 16.94, which correspond to artifact ages of 10,030 yr B.P. to 118,482 yr B.P. respectively.

An additional five hydration-dates were obtained from artifacts containing original cortex. This outer surface region produced hydration rates ranging from 18.20 to 25-28, which corresponds to ages of 140,620 yr B.P. to 287,500-376,000 yr B.P. respectively.

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Editor's Note: A list of the laboratory specimen number and its corresponding hydration rate, age in yr B.P., the description of the artifact, and other details may be obtained by writing to the author.

Use-wear Analyses of Paleoindian Unifaces from the Initial Late-Glacial Occupation at the Indian Creek Site

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Excavations at the stratified Indian Creek (24BW626) floodplain occupation site in the west-central Montana Rockies have sampled two pre-10,000 yr B.P. living surfaces overlying a Glacier Peak, Layer G, ashfall dated to 11,130 ± 130 yr B.P. (Davis 1984; Mehringer *et al.* 1984). The initial use of this site, dated to 10,980 ± 110 yr B.P., is characterized by sparse, fragmentary, utilized and intrusive faunal elements and a flaked-stone tool and debitage assemblage attributed to a Clovis, transitional Clovis-Folsom, or Folsom occupational event. Except for a bifacial chert core, basal corner fragments of two fluted points, a reused but complete Clovis point formed on a flake rather than a biface (Haynes 1982), and two wide channel flakes, the flaked stone tools in the sample were made on marginally retouched flakes.

An excavated 64 m^2 area yielded dispersed bones and dentitions of utilized and intrusive mammals. Michael Wilson (University of Calgary) has preliminarily identified marmot (*Marmota*), bison (*Bison*), probable jackrabbit, microtine and ground squirrel-sized rodents, and unidentified large and small mammals. Based on a fragmentary juvenile dentition, possibly of bison, Wilson has tentatively suggested that this occupation took place in the spring.

The second author conducted lithological, technological, and use-wear studies on the assemblage. Madison Limestone Formation cherts, such as occur in the immediate site vicinity, dominated the lithic assemblage, followed by a locally available fossiliferous silicified siltstone. Small amounts of agate, quartzite, silicified wood, quartz crystal, basalt, and obsidian were present. A large bifacial core of Hartville Uplift chert from southeastern Wyoming and a single flake of Alibates agatized dolomite from Texas were also recovered.

Analyses of Paleoindian lithic assemblages usually emphasize reconstruction of the reduction techniques associated with biface or other core reduction sequences that preceded the production of projectile points. Since the technology of this Indian Creek occupation emphasized the production of marginally retouched flake tools, a shift in research strategy became necessary. The effective absence of cores inhibited determination of specific flake production techniques; however, variations among flakes in platform characteristics, flake scar patterns, and flake scar counts indicated that several techniques were employed to produce desired flakes.

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The use-wear study conducted by the second author followed "low-power school" techniques (Odell 1979). Use-wear patterns, in conjunction with edge angle and edge shape, were relied on to interpret specific activities at Indian Creek. The third author independently examined the assemblage for polishes diagnostic of particular uses, following techniques of the "high-power school" (Keeley 1980).

The second author identified two patterns of edge modification on end scrapers: rounding and polish extending from the distal edge slightly onto the dorsal face and crushing and step-flaking at the same location. The first is typical of hide scraping. The second is thought to represent intentional sharpening, as is indicated by steeper edge angles. Interestingly, the scrapers in the second category are beaked, and each beak displays tip crushing and abrasion suggestive of engraving. Several gravers were identified in the assemblage. A limited number of side scrapers displayed working edges marked by limited rounding and polish. The third author interpreted this type of polish as that resulting from cutting soft materials such as meat and hide. Whittling tools were also recognized by both analysts. With a few exceptions, these two approaches to use-wear analysis proved complimentary. The high-power examination of polishes enhanced use-wear interpretations for those tools that displayed particular polishes.

Tasks inferred by analysis of stone tools from the initial occupation at the Indian Creek site included lithic procurement and curation; lithic tool production and maintenance; food procurement, processing, and preparation; hide working; and/or bone, antler, or wood working. The inferred Paleoindian domestic behaviors evidenced by hunter-gatherers in the course of camping during spring months beside a stream in a deciduous forest, surrounded at higher elevations by coniferous forest, offer an interesting increment to the study of Paleoindian activities at an occupation site.

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Chert Sources and Paleoindian Lithic Processing in Allendale County, South Carolina

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With the exception of a few excavated sites in central Florida, the Paleoindian occupation of the Southeastern United States Coastal Plain (Alabama, Florida, Georgia, and South Carolina) is basically unstudied and unknown. The most prominent manifestation is the remarkable number of Suwannee points found by sport divers in the fossil-rich, clear rivers of northern Florida.

Tertiary cherts provided the basic cryptocrystalline lithic material for the Coastal Plain. Chert outcrops are distributed fairly continuously from Tampa Bay, Florida, westward to southeast Alabama, and northward diagonally in a line across the upper Coastal Plain of Georgia terminating in the area of Allendale County, South Carolina. Like other areas of the east, the density of Paleoindian lanceolates in the Coastal Plain is linked to the proximity of cryptocrystalline quarries. The petrologic characteristics of these cherts and the geographic distributions for purposes of source analysis have been determined for Florida (Upchurch *et al.* 1981) and recently for South Carolina (Upchurch 1984; Goodyear and Charles 1984).

As part of a survey to discover and evaluate chert resources related to the Oligocene Flint River Formation in the South Carolina Coastal Plain, fieldwork was conducted during 1983 and 1984 in Allendale County (Goodyear and Charles 1984). A total of 11 new quarries was recorded. Where possible, each was stratigraphically tested and sampled for petrologic analysis by Sam Upchurch. Based on the results of thin-section descriptions of samples from these quarries and from six outcrops located near the Savannah River in Georgia, it is concluded that what has been called "Allendale chert" by archaeologists is all one material (silicified grainstone) native to the Flint River Formation.

Because Allendale chert was a preferred lithic material for Paleoindian and Archaic groups in South Carolina, quarries and quarry-related sites were tested for early deposits with stratigraphic integrity. Two quarry-related sites were found to have great potential for isolating Paleoindian and early Archaic remains (12,000-9,000 yr B.P.). The site of 38AL23, located on a terrace of the Savannah River, has quarry debris and tools buried as deep as 150 cm. Because of the presence of chert and continuous alluvial deposition of sand during the Holocene, this site has great potential for continuous cultural sequence begin-

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ning with Clovis. No diagnostic Paleoindian bifaces were recovered during initial testing, but more work is planned for 1985.

The site with the most diagnostic data recovered is 38AL135. It was discovered washing out of a cutbank of Smiths Lake Creek, which cuts through a floodplain of the Savannah River. The Paleoindian horizon is represented by a discrete layer of bifaces, cores, and debitage about 10 cm in thickness at 110-120 cm in depth. The chert from this zone is highly weathered, typical of Paleoindian diagnostics made from Allendale chert. A fluted lanceolate preform (Fig. 1A) was found on the beach which matches the discolored, highly weathered material found *in situ* at 110-120 cm below surface. From 50-90 cm a preceramic middle Archaic zone occurs; it consists of brightly colored, heat-treated lithics. Excavations on the floodplain near the bank profile uncovered the weathered lithic horizon at the same depth. The density of early material excavated, however, was light. The only diagnostic recovered was that of a thick graver tool (Fig. 1H). It is clear from these differences in density that much of the site has collapsed into the creek.

Two days were spent dredging the creek with a four-inch airlift operated by underwater archaeologists. Lithic debris and tools were lifted up and washed over quarter-inch screen. The number of artifacts was enormous including the six lanceolate preforms shown in Fig. 1 (B-G). The Paleoindian point style(s) represented is not clear based on the preforms. Based on the absence of diagnostics spanning the time from 10,000-5,000 yr B.P., there is strong evidence that the site has a closed Paleoindian occupation. The attraction to the site was Allendale chert available in the Savannah River when it flowed further east than today. Using the criterion of river smoothed cortex, chert exploitation only occurred before 10,000 yr B.P. and again about 5,000 yr B.P. Currently, this is the only "pure" Paleoindian quarry discovered for the Southeastern Coastal Plain. Further dredging and excavation of the remaining floodplain deposit should provide hundreds of diagnostics permitting a detailed technological study.

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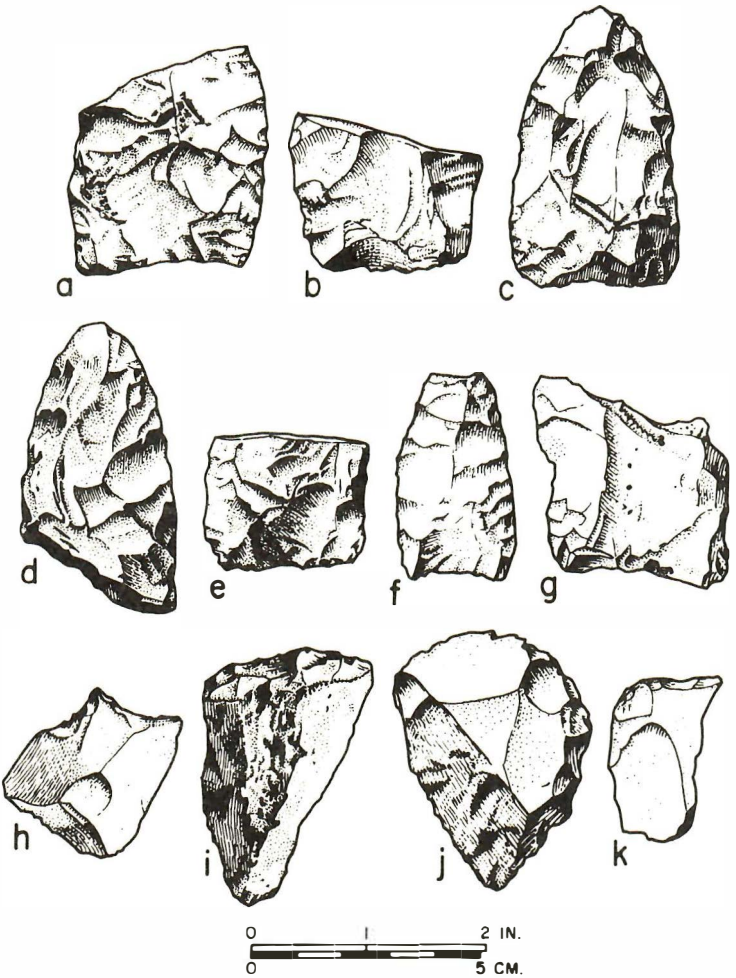

Fig. 1. Paleoindian bifacial (A-G) and unifacial (H-K) artifacts from 38AL135.

Trace Element Analysis of Paleoindian Obsidian Artifacts from the Southern High Plains

EILEEN JOHNSON, VANCE T. HOLLIDAY, FRANK ASARO, FRED STROSS, AND HELEN MICHEL

An attempt to determine the source of obsidian for three Paleoindian artifacts from Lubbock Lake and Blackwater Draw Locality #1 (BWD#1) recently was made as part of a regional study of Southern Plains late Quaternary localities. The two sites, ca. 160 km apart, are in the same drainage system: Lubbock Lake in Yellowhouse Draw and BWD#1 in a basin tributary of Blackwater Draw. The two draws join a few kilometers downstream from Lubbock Lake to form Yellowhouse Canyon, an ephemeral tributary of the Brazos River. Recent excavations (1983) at Lubbock Lake uncovered five projectile points of a heretofore unrecognized and undocumented design and associated flake tools in the context of a bison kill/butchering locale (FA5-17). The feature was found within the shore facies (substratum 2s) of the lacustrine/marsh deposits of stratum 2 (Holliday and Johnson 1984). Organic sediments yielded a radiocarbon age of 9,950 ± 120 yr B.P. (SMU-1261; NaOH-soluble fraction). One of the projectile points (TTU-A39314) was made from obsidian.

Several obsidian artifacts were recovered from the Paleoindian levels at BWD#1 during excavations by Texas Memorial Museum (TMM) (Hester 1972). Although the stratigraphy is unclear, an obsidian Clovis point (TMM 937-862) appears to be from the "Brown Sand Wedge" (Hester 1972:49) (Unit C of Haynes 1975). This unit generally is sandy and was deposited by low energy spring discharge between about 11,500 and 11,000 yr B.P. (Haynes 1975). The point was recovered in association with mammoth (*Mammuthus*) remains. A broken obsidian biface (TMM 937-23) was recovered from a bison (*Bison*) kill in the upper part of the "Carbonaceous Silt" or Unit E (a lacustrine deposit) near TMM Station E and dates to between 10,000 to 8,500 yr B.P. (Haynes 1975; Hester 1972).

Paleoindian obsidian artifacts are uncommon on the Southern High Plains and obsidian projectile points are very rare. The source of these artifacts was determined not only to establish the origin but also the possible range of outcrops being used and to provide evidence for possible interaction among peoples inhabiting the two sites. Given the rarity of the exotic material and the importance of the points, non-destructive X-ray fluorescence (XRF) analysis was selected. The closest obsidian sources for the Southern High Plains are the volcanic areas of Mexico, New Mexico, and Wyoming. Most of the obsidian

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of known sources from Texas sites come from New Mexico or Mexico (cf. Mitchell *et al.* 1980). Because of its proximity, the Jemez Mountains area of New Mexico was hypothesized as the general source area for the three obsidian artifacts.

Results of the analysis are as follows: TTU-A39314 Ba <8, Ce 83 ± 7, Nb 91, Zr 225, Sr/Zr <.023, Rb/Zr 1.013 ± .014; TMM937-862 Ba <6, Ce 81 ± 6, Nb 79, Zr 200, Sr/Zr <.017, Rb/Zr 1.044 ± .013; TMM937-23 Ba 13 ± 3, Ce 107 ± 7, Nb 45, Zr 192, Sr/Zr .018 ± .006, Rb/Zr .865 ± .012; Valles Caldera source reference group Ba <4, Ce 77.7 ± .9, Nb 85, Zr 192, Sr/Zr <.026, Rb/Zr 1.07 ± .05. While the ratios are precise, the absolute values of Niobium (Nb) and Zirconium (Zr) are not accurate because of uncertainties inherent in the non-destructive analysis due to the varying shapes and sizes of the samples. These errors would tend to make the Nb and Zr values larger than the reference group. The Lubbock Lake sample and the BWD#1 Clovis point match and have a source provenience on the southeast side of the Valles Caldera (Jemez Mountains area) in northcentral New Mexico. This general provenience is ca. 350 km northwest of BWD#1 and 500 km from Lubbock Lake. The BWD#1 broken biface has a different and unknown provenience which may or may not be in New Mexico. The Valles Caldera source referred to in the present work is the same as that reported for other obsidian artifacts from the Texas Panhandle, High Plains, and Central Texas that date between A.D. 900-1400 (Mitchell *et al.* 1980). The artifact of unknown provenience is from a different source.

Although sources in New Mexico are expectable, the confirmed provenience of two of the materials provides independent evidence for a number of considerations. First, a large number of obsidian sources are available in the Valles Caldera and surrounding volcanic area yet only a few appear to have been utilized for artifacts found on the Southern High Plains. Second, source use appears to have varied through time. What constraints, such as territoriality and outcrop exposure, governed this variation are unknown. Third, the use of the same obsidian source for artifacts at Lubbock Lake and BWD#1 provides an independent link between these two strongly similar sites. And fourth, the early presence of the exotic obsidians in these two sites indicates long distance trade, travel, or both and may be the beginnings of later well-established trade routes and relationships between the Southern Plains and the Puebloan Southwest.

The authors would like to thank Drs. Thomas R. Hester (University of Texas, San Antonio) for his efforts on our behalf for arrangements for this obsidian source study and William Reeder, Director of Texas Memorial Museum, for allowing access to the BWD#1 material for analysis. This investigation is part of the continuing research of the Lubbock Lake Project funded by the National Science Foundation (SOC75-14857; BNS7612006; BNS7612006-A01; BNS78-11155), National Geographic Society, Texas Historical Commission (National Register Program), Center for Field Research (EARTHWATCH), City and County of Lubbock, The Museum, Texas Tech University, West Texas Museum Association, and the Lubbock Lake Landmark Community Volunteers.

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Lithic Techniques of the Tulare Lake Locality, California

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The antiquity of finds in the Tulare Lake locality has been indicated by fluted points resembling both Clovis and Folsom types as well as by Pleistocene faunal remains (Riddell and Olsen 1969). Uranium series dates obtained on mineralized bone have included: 1) mammoth (*Mammuthus* sp.) tusk at 10,778 ± 488 yr B.P.; 2) a human cranial fragment at 11,379 ± 71 yr B.P.; 3) horse (*Equus* sp.), at 15,696 ± 370 yr B.P.; and 4) a human cranial fragment at about 15,802 yr B.P. (James West, personal communication). It is beyond the scope of this paper to discuss the dating technique.

The collections reported on herein were made by local collectors along what was once the southern shore of Tulare Lake. Twenty to thirty archaeological sites may be involved. Materials diagnostic of later prehistoric periods are found in these collections. Thus, associations of the artifacts to the Pleistocene fauna, temporally diagnostic artifacts to the chipping techniques discussed below, and the representative nature of these collections must all remain unconfirmed.

Four chipping techniques were identified: 1) direct free-hand percussion manufacture of flakes; 2) biface thinning; 3) bipolar production of small flakes; and 4) percussion blade/micro-blade production. The first of these is ubiquitous and tends to be found throughout time in California. The second technique is evidenced in the locality by projectile points representative of a surprisingly complete sequence for the region's prehistory. It is also indicated by a range of biface manufacturing failures and thinning flakes, some retaining the biface edge on their striking platforms.

Chipped stone crescents have long been recognized in this locality (Gifford and Schenck 1926; Harrington 1954; Tadlock 1966). The biface reduction sequence for some crescents was found to include the following: 1) production of a flake blank; 2) biface thinning by soft hammer percussion; and 3) finishing by pressure flaking. Manufacturing failures common to biface thinning were noted: 1) failure at edge control (thick or irregular edges); 2) thinning failures (piece narrowed faster than it became thin or humps created by hinge or step terminations); and 3) breakage due to excessive force or material flaw. Crescents are often placed in the late Paleoindian period for California.

Bipolar chipping was identified by the presence of linear shatter grading into "orange wedges" as well as by flakes and cores. All three types exhibited crushing and flake scars originating from both proximal and distal ends. Some bipolar cores were reworked flakes. No reworked biface fragments were identified as are found further north in the state. Temporal placement is uncer-

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tain, but evidence from elsewhere in the state suggests the technique to be generally late, perhaps beginning around 4,000 yr B.P. (Rondeau n.d.).

Evidence for blade/micro-blade production includes the flake types and their cores. They appear to have been manufactured by direct percussion with a soft hammer. The blades and microblades may form a continuum, but the nature of the collection makes this unclear. Since convincing documentation of blade or micro-blade production in California is essentially non-existant, a temporal placement cannot be offered. These findings should not be confused with the known bladelet-drill industry of the ethnographic Chumash. It is tempting to suggest that the blade/micro-blade manufacture is associated with the presence of fluted points (Green 1963), but this cannot be substantiated. Documentation of this chipping technique will be a focus of future research.

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Methods

Paleoindian Studies and the Disappearance of Collected Material

RICHARD A. ROGERS AND LARRY D. MARTIN

Probably no scientific field has been more influenced by the mysterious loss of collected data than Paleoindian studies. This problem has been of great importance from the inception of the field.

The first excavation of a Paleoindian site by scientifically trained personnel occurred in 1895 at the 12 Mile Creek site in Kansas (Williston 1902; Rogers and Martin 1984). A fluted projectile point was found under the scapula of an extinct bison (*Bison*). This discovery was of great scientific importance because it demonstrated the presence of humans in North America during the ice age. A night meeting was held by S.W. Williston and H.T. Martin at the Chancellor's house at the University of Kansas to lecture about the discovery. A large crowd attended including many prominent local people. The projectile point was put into a box and passed around the crowd during the lecture. It was eventually noted that the artifact was missing from the box, but no one in the crowd would admit to taking it, and it was never recovered. A photograph of the artifact remains, but the site did not persuade North American archaeologists to accept a Pleistocene human presence in North America. A factor in this lack of acceptance was that the artifact itself could not be produced.

The Lone Wolf Creek site was excavated in Texas in 1924, and produced extinct bison remains associated with three projectile points (Figgins 1927). One of the projectile points "disappeared" (presumably stolen). The loss of this artifact was not as serious as the 12 Mile Creek site incident, because several artifacts remained.

An important question in Paleoindian studies is whether some of the Pleistocene human immigrant populations had "Neanderthaloid" features. A highly mineralized human calotte with extremely large brow ridges and thick skull walls, was recovered from the Lagoa Santa region of Brazil. The specimen was photographed, but later become lost at the museum where it was stored (Bryan 1978:318). The Yuha skeleton has also disappeared. This specimen, whose antiquity is controversial, has been claimed by some to be Paleoindian.

It is apparent that loss of material due to theft is a serious problem in Paleoindian studies and has already contributed to the slowing down of the acceptance of new ideas and data.

The loss of such important data in the Western Hemisphere points up the need for special precautions to be taken with Paleoindian material. The material

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is either easily misplaced or attracts thieves. Critical data should be protected in much the same way as commercially valuable objects. Storage in a vault, and avoidance of public display unless stringent safeguards are available would be desirable.

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Taphonomy-Bone Modification

On the Importance of Hair for Pleistocene Studies

ROBSON BONNICHSEN AND CHARLES W. BOLEN

Hair is something that we all have. It hardly seems worth a second thought until we lose it. Someone has calculated that the average person loses up to 200 hairs or hair fragments per day. Fur-bearing animals probably lose many times this number. Under most preservation conditions, shed hair does not last long. Hair does preserve in Arctic permafrost, dry arid caves, and damp, cold deposits such as might occur in high altitude, limestone caves. Hair studies are at an embryonic stage of development and appear to be of importance for paleoecological and archaeological reconstructions. The purpose of this note is to suggest that hair may be more abundant and thus more important than commonly thought.

The guard hair from each taxa is unique (Brunner and Coman 1974; Moore *et al.* 1974). Through the comparative study of hair plucked from contemporary taxa and hair picked from mummies of extinct taxa, Charles Bolen (with Larry Agenbroad) is developing at Northern Arizona University a reference collection of Holocene and late Pleistocene animal hairs. By studying the morphology of the cuticle, medula, and scale patterns of control samples, Bolen is developing methods to key hair from ancient contexts. Properly identified hair can compliment skeletal studies conducted by vertebrate paleontologists and faunal analysts in determining what taxa are present at paleontological and archaeological sites.

Hair studies may have great importance for specialists searching for Pleistocene evidence of humans. Theoretically speaking, hair is universally the most common remain deposited by humans. Just imagine how many hairs a single individual would produce over a lifetime. If an individual lost 200 hairs a day, our hypothetical person could lose 73,000 hairs or hair fragments per year and 4,745,000 if they lived to the age of 65.

The beauty of hair is it is abundant and taxa can be discriminated from one another. Additionally, human hair can be raced—caucasoid hair can be discriminated from mongoloid hair. An inherent danger in inferring the presence of past human populations on the basis of hair recovered from archaeological sites is excavator contamination. Fortunately, we were aware of this factor in conducting our pioneer study at False Cougar Cave, in the Pryor Mountains of south-central Montana (Bonnichsen *et al.* 1985). We did not have any mongoloid crew members during the five-year excavation period (1978-1982) at the cave.

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While screen washing damp sediments from False Cougar Cave (2,600 m above sea level), we noted that small amounts of hair periodically occurred in the screen wash matrix. Bolen became interested and collected bulk samples from the site during the summer of 1982 for flotation. Before collecting his sample from the north wall of the cave near the drip-line, he scraped the 3.4 m deep profile by trowel to remove potential hair contamination. The hair record extended from the surface to 2.0 m in depth. In total 850 hairs from 22 taxa were identified from the column. These are preliminarily reported elsewhere (Bonnichsen and Bolen n.d.).

What at first seemed surprising about the False Cougar discovery was the recovery of two human hair segments from arbitrary level 3 and four segments of mongoloid hair from arbitrary level 16. The hair found in level 16 occurs under charcoal radiocarbon dated at 10,530 ± 140 yr B.P. (SI-5289). Approximately 1 m east of the hair column outside of the cave drip-line, charcoal collected from a small lens produced a date of 14,590 ± 300 yr B.P. (Beta-5752). A large boulder occurs between where the hair was collected and the 14,590 date. Consequently, it cannot be categorically demonstrated that the human hair and the date are stratigraphic equivalents.

We wanted to make certain that Bolen's human hair identification was correct. One of the hair samples from level 16 was sent to Walter Birkby, a well-known forensic expert from the University of Arizona, for an independent blind test of our identification. Birkby initially suggested that human hair can be confused with bear (*Ursus* sp.) hair. In a comparative study backed by photomicrographs, he concluded that the hair from level 16, "while human and possibly of (basically) mongoloid origins" (Birkby personal communication to Jim I. Mead, 1985). Birkby has suggested the possibility of crew contamination; we believe this suggestion is improbable and that the human hair is of Pleistocene age. The full details of these studies will be presented elsewhere.

In summary, we suspect that we inadvertently discarded hundreds of thousands of hairs while processing screen wash matrix for bones. Furthermore, it is probable that we discarded human hairs from Pleistocene levels—the most important evidence for demonstrating the presence of humans.

Pryor Mountain Paper No. 24.

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Taphonomic Observations on Guanaco Skeletons

Luis Alberto Borrero

A few sites in Tierra del Fuego present evidence of guanaco (*Lama glama guanicoe*) consumption by man ca. 10,420 yr B.P. (Massone 1983) and ca. 9,590 yr B.P. (Laming-Emperaire *et al.* 1972). More recent sites (Borrero *et al.* n.d.) also consist mainly of guanaco bones, and display very low visibility. These circumstances were considered sufficient to justify a study of the processes by which guanaco bones incorporate into the sediment, as well as of the transformations exhibited by the exposed bones. The goal is to achieve a body of information capable of assisting us in the identification of natural versus cultural assemblages. These studies will also be of value in assessing the importance of the guanaco as background fauna in Fuegian archaeological sites.

Monitoring of several guanaco skeletons was conducted in a two-year period (1983-1984) at Cape San Pablo, Tierra del Fuego, Argentina. In that area every year a number of guanacos die, unable to cope with the rigors of the winter. Different habitats are represented in the Cape San Pablo area: woods, alluvial plains, moderately high hills, and the sea coast. Skeletons of recently dead guanacos in those different habitats were selected to be monitored, emphasizing differences in slope and substratum. The only habitat not represented in the sample is the sea coast. The area has an estimated mean annual precipitation of 400 mm, and a mean annual temperature of 5°C, freezing and thawing of soils is an important characteristic of the area. These conditions are interesting, because there are few examples of taphonomic studies concerned with high latitude situations. The methodology simply consists of regular inspection of the guanaco bodies and mapping the distribution of the bones, hide, and hair through different intervals appropriate for the different subjects under study. The action of foxes and prey birds was observed, both being the most important predators and scavengers in Tierra del Fuego. No evidence of big cats or other Pleistocene predators has been uncovered in Tierra del Fuego.

Some preliminary conclusions are derived from this study. (1) Less than one year is sufficient time for the complete disarticulation of the guanaco skeleton in the open. The bone scatter after a year fluctuates between 5 and 14 m in diameter, principally as a function of slope, in combination with scavenging, freezing, and thawing. When that dispersion was attained bones were almost completely clean, and scavengers lost their interest in them. Few spatial modifications follow, and the principal processes there on are: disintegration by weathering (with line cracks showing ca. 21 months after the animal died) and burial.

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(2) Guanacos lying on high bush are apt to be 50% articulated up to one year. Individual bones carried by scavengers may travel several meters, but after a year the disarticulation indexes (developed by A. Nasti, from Instituto Nacional de Antropología) are lower than those for the guanacos in the open.

(3) Incorporation of guanaco bones into the sediment proceed in several different situations: a) due to guanacos trampling, because they usually use the same paths. This behavior was specially monitored in winter, with guanaco footprints over recently fallen snow as a check on the antiquity of the behavior, b) due to normal sedimentation processes in the alluvial plain of a small stream (six months for a semi-articulated skeleton), and c) due to sedimentary processes helped by the normal decay of the Fuegian woods (12 months for individual disarticulated bones, plus the backbone and attached ribs, normally those on the side in which the animal collapsed).

(4) After disarticulation and complete exposure of the bones to weathering, it takes nine months to reveal small crack lines.

(5) Action of foxes was directed, in a complete skeleton, to the following points: skull, proximal humeri, neck, scapula (distal rather than proximal), and pelvis (sometimes associated with proximal femur). It was observed that the principal goal when attacking a complete recently died animal is to eviscerate it, destroying distal ends of some ribs as a corollary.

Finally, it must be stressed that in the area of Cape San Pablo several cases of guanacos dying over archaeological sites were observed. Some of their bones subsequently migrated into the archaeological assemblage. The excavation of those sites will be pursued in order to observe the effect of the recently incorporated bones, hoping to obtain information useful for the adequate separation in other non-controlled situations.

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Artificial Phallus or Fallacious Artifact: A Cautionary Note

R. George Corner and Michael R. Voorhies

There is much current interest in culturally-modified Pleistocene megafaunal remains, especially as evidence for the early penetration of *Homo sapiens* into the New World. Our purpose here is to emphasize the necessity for workers engaged in such studies to become well acquainted with *unmodified* skeletal elements, particularly of species belonging to totally extinct lineages. It is a little-appreciated fact that many Pleistocene species have bones with shapes not closely comparable with homologous elements of recent large mammal skeletons commonly available in osteological collections. Some of these "aberrant" elements are reminiscent of artifactual shapes and might be confused with deliberately manufactured objects.

A case in point is the "phallic carving" from Jalisco, Mexico recently figured by Dolzani (1984). The specimen, a large mammal vertebra described as "heavily mineralized" and "possibly upper Pleistocene in age", does indeed have a remarkably suggestive protuberance arising from the upper left (as figured) corner of the vertebral centrum. In the accompanying caption the protuberance is identified as "a portion of the neural arch carved into the shape of a phallus." If the knoblike process were in fact part of the neural arch then strong evidence would exist for extensive modification of the bone, including complete removal of the dorsal portion of the arch. It is our contention, however, that the orientation of the specimen has been misinterpreted and that the "carved" portion of the vertebra is the costellar process of a camelid cervical vertebra of normal morphology.

Our conclusion is based on the close resemblance of the Mexican specimen to unmodified sixth cervical vertebrae of camel (*Camelops*), the common genus of large camelid in Pleistocene deposits of western North America (Kurtén and Anderson 1980). Numerous examples of this element are available in the collections of the University of Nebraska State Museum and all display costellar processes with a more-or-less phallic morphology (Fig. 1). The resemblance is especially marked in specimens affected by postmortal abrasion or scavenging as there appears to be a zone of weakness circumscribing the process some 2 or 3 cm from its tip.

The osteology of *Camelops* has been thoroughly described by Webb (1965:16) who notes that the anteroventral costellar processes (sometimes termed the ventral branch of the transverse process) of the cervicals "become progressively heavier and longer from the third cervical vertebra back, reaching a maximum

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on the sixth vertebra." Unfortunately Webb does not provide illustrations of the sixth cervical and such are not readily available in the literature. Hence it is readily understandable that workers lacking access to one of the three or four museums having large *Camelops* samples have probably not seen this bone before. We urge workers with problematical specimens to check them against the large systematic collections of Pleistocene mammal remains that exist in several North American institutions.

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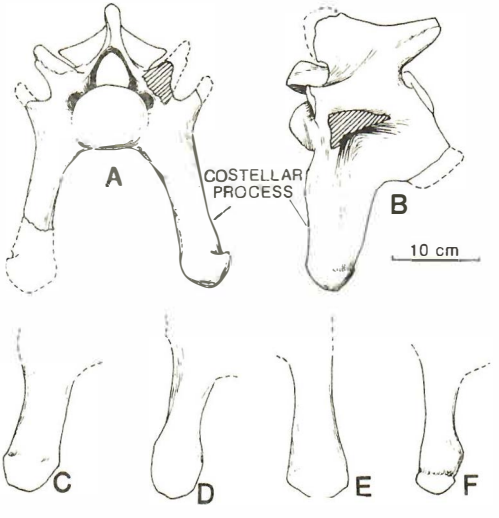

Fig. 1. Sixth cervical vertebrae of Pleistocene *Camelops* illustrating "phallic" appearance of costellar process. A: Anterior view of UNSM 93087, Gordon Quarry (late Irvingtonian), Sheridan Co., NE; B: Lateral view of same specimen. C-F: posteroventral aspect of costellar processes only, showing variation in morphology. C: UNSM 49133; D: UNSM 49103; E: UNSM 46667; F: UNSM 93088. C, D, and E are from the Red Willow Local Fauna, Rancholabrean (see Corner 1977) and F is from Hay Springs Quarry (late Irvingtonian).

Modifed Bones of Possible Pre-Clovis Age from Southwestern Nebraska

THOMAS P. MYERS AND R. GEORGE CORNER

Wet gravel pits in southwestern Nebraska, near McCook, have produced a large late Pleistocene faunal assemblage including musk ox and caribou as well as artifacts of Paleoindian age. Many of the bones exhibit concoidal and spiral fractures suggestive of human activity according to the criteria of Bonnichsen (1979) and Morlan (1980). While we are not prepared to accept these specimens as definite evidence of a pre-Clovis occupation south of the glacial ice, we do believe that they bear upon this question and that they should be brought to the attention of other specialists.

The most suggestive piece (UNSM 48784) is a right basal portion of a naturally shed caribou antler (*Rangifer tarandus*) from 25 Rw-108. This species probably left the area 500 to 1000 years before Clovis times. The specimen is broken off just above the base of the bez tine and with only the bases of the brow and the bez tines present (Fig. 1a). The breaks on the beam and the tines were probably made during transport through mining apparatus. The medial basal portion of this specimen exhibits a faceted, polished area of roughly triangular shape whose maximum dimensions are 33.0 mm across the base by 23.5 mm at right angles to the base. The polish continues for a distance of 32.0 mm above the apex of the faceted area. The juncture between the faceted area and the base of the antler is slightly rounded. The polished faceted area bears a number of faint striations, some of which are almost parallel to the base while others are at an angle of approximately 50°. That is, the striations cross-cut one another.

The partial right antler (UNSM 46302) from 25 Rw-102 consists of the basal portion with the brow tine broken out, the base of the bez tine and the first posterior tine (Corner 1977: fig. 2D). The beam is broken below the second posterior tine at a point where the cross-section of the beam is beginning to flatten. The brow tine was apparently broken out prior to burial by force from below while the bone was still green. The medial basal portion of this specimen has a semi-circular faceted and polished zone which measures 22.5 mm across the base and 13.0 mm high. Above this is a roughened area which extends 29.0 mm above the base of the antler. Both zones are adjacent to the scar left by the removal of the brow tine. The faceted, polished area is marred by striations at a 15° angle to the base of the tine. These are somewhat deeper and broader than those of the first specimen, and are probably attributable to a different cause.

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UNSM 49978 is the distal one-third of the left femur camel (*Camelops hesternus*) (Fig. 1b) from 25 Rw-102. This species survived as recently as 10,000 years ago and has been reported from Clovis, Folsom, and Hell Gap sites on the plains (Frison *et al.* 1978). The bone appears to have been broken by at least two blows, one each to opposite sides of the shaft at approximately 45° angles to the anterior-posterior axis while the bone was still fresh. The resulting spiral fractures descend the bone and terminate almost opposite one another. The concavity of the anterior-most spiral fracture is virtually unmodified except by normal wear. The posterior-most concavity is polished across the green bone break and exhibits at least three facies. This polished area exhibits fewer striations than the rest of the area close to the break. The striations which do exist are approximately perpendicular to the long axis of the bone. This polished area extends up to and across one of the lateral points formed by the intersection of the spiral fractures. Striations on this polished area are also perpendicular to the longitudinal axis of the bone and this pattern of striations extends down the shaft well past the polished area.

We found little similarity in the "wear" patterns between the possible caribou antler artifacts and other modern or paleontological caribou antlers in the collections of the University of Nebraska State Museum. The *Camelops* femur is unusual in the degree of wear which it exhibits; but it might be reasonably interpreted as the extreme of a continuum between unmodified bone and heavily used opportunistic bone tools. While we would have little difficulty in accepting these specimens as artifacts if they had been found in proper archaeological context, the geomorphological circumstances in which they were found make us gravely suspicious of them. We are still unable to accept such evidence as an unequivocal demonstration of human presence on the Central Plains in pre-Clovis times.

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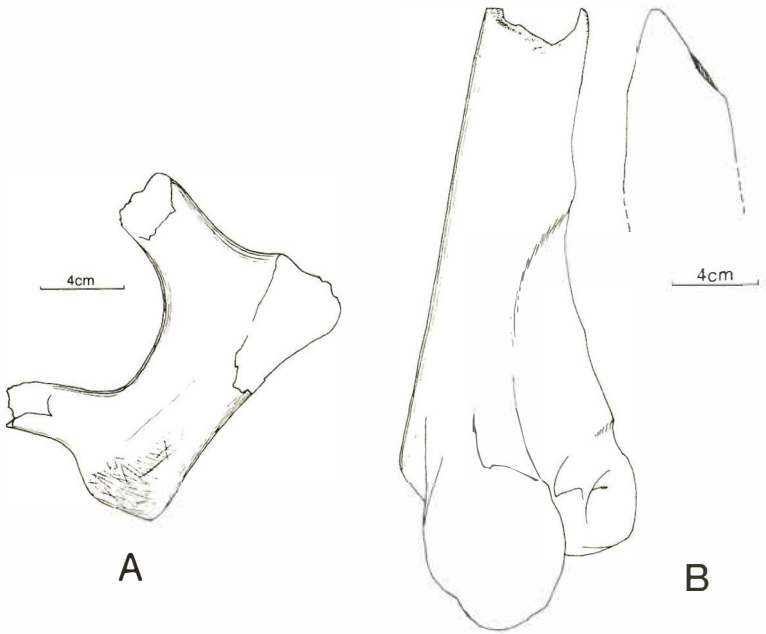

Fig. 1. Modified bones of possible Pre-Clovis Age from Nebraska. A. basal fragment of caribou (*Rangifer tarandus*) antler with polish (stippled) and cross-cutting striations on the medioproximal surface. B. distal half of camel (*Camelops hesternus*) femur with intersecting conchoidal fractures and faceted polished (stippled) surfaces faintly marked by transverse striations.

The Hunter Ranch Mammoth: Analysis of a Single-Carcass Death Site

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Preliminary excavations by the University of Wyoming and the Wyoming State Archaeologist's Office at the Hunter Ranch Mammoth locality (48LA481) north of Cheyenne, Wyoming in June, 1984 resulted in the recovery of the scattered remains of a single adult mammoth (cf. *Mammuthus columbi*) positioned below at least four superimposed paleosols (Walker *et al.* 1984). Although no clear evidence of cultural involvement in the death of this animal has been demonstrated, taphonomic and geologic analyses can be used in the evaluation of possible human involvement. Patterns of skeletal element distribution and representation, bone weathering and breakage, and studies of the taphonomy of modern elephant carcasses provided a starting point for interpretations. Additional excavations are planned to clarify problems developed during this preliminary examination.

Although there is some weathering of most of the mammoth bone from the deeply covered portion of the site, the weathering is restricted to superficial longitudinal cracks (weathering stage 1; Behrensmeyer 1978) with little or no deep cracking or flaking of the bone surfaces. The weathering of the bones from the site is similar to that which occurs on the bones of smaller animals (bison and domestic cows) within the first few years after death (Todd 1983). It is not possible at this time to say how weathering rates of large proboscidian bones relate to those for smaller animals. Observations on the locations of weathering cracks on several of the long bones serve as the basis for some preliminary interpretations about the depositional history of the site. Details on these observations can be found in Walker *et al.* (1984).

Based on at least two lines of evidence, the bones from the Hunter Ranch Mammoth locality suggest movement after they were defleshed and had begun to dry and weather. Portions of many of the elements that were recovered as the "downside" exhibit weathering features that would suggest they had, at one time in the depositional history of the site, been exposed to the elements as the "skyward" surface of the bones. This indicates movement of the bones for some time after the death of the animal. Crader (1983) suggests the longer an animal has been dead before being covered, the more widely dispersed the carcass becomes. This may be the case here at the Hunter Ranch Mammoth locality.

Similarly, the presence of greater carbonate deposition on the skyward surface of the bones also suggests post-mortem and even post-depositional move-

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ment of the bones. A possible scenario for the taphonomy of these bones can be proposed as follows. First, the animal died, the bones were defleshed and laid on the surface of the ground for some time, possibly up to three or four years. The bones were then buried to some depth for an unknown period of time before being re-exposed. The bones were then mixed and overturned, resulting in the carbonate layers being placed on the now skyward surface and the previously weathered surface now being down. The site was then re-covered, with part of it directly below a depression or swale. At a still later period, an unknown portion of this depositional unit was removed, the surface was stabilized, and then additional material was deposited over the entire site area, followed by a minimum of three soil stabilization periods, and then modern soil development.

It has been noted numerous times (Coe 1978) that modern elephant (*Loxodonta*) groups will return to where a family member died and spend several hours around the pile of bones, often picking them up and carrying them around. This happens enough that a depression is often formed around the bones, possibly similar to that seen at the Hunter Ranch locality (Walker *et al.* 1984), which may have persisted long after the majority of the bone was covered during the second depositional period.

The distributions of bones at the Hunter Ranch Mammoth locality is probably the result of a set of long-term processes and is not an accurate reflection of the locations of elements at the time of the animal's death. It had not been possible to determine the distance or directions of movement. The number of smaller bone fragments present may indicate the bones have weathered in the same general areas in which they were recovered, and have not been transported long distances since they began to deteriorate.

The cooperation and assistance during this excavation and analysis of the Hunter Ranch Mammoth locality by Dames and Moore Consulting Company and the United States Bureau of Reclamation is gratefully acknowledged. We are especially grateful to Mr. Jim Hunter, Hunter Ranch Company, Horse Creek and Cheyenne, Wyoming for permission to excavate. Additional financial support was provided for this project by the Wyoming Recreation Commission (Wyoming State Archaeologist's Office), The University of Wyoming (Department of Anthropology), and the Wyoming Archaeological Foundation.

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Paleoenvironments: Plants

Pollen Analysis of Rapid Late-Glacial Environmental Fluctuations in the Lemhi Mountains of Idaho

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Early man occupied the broad intermontane valleys north of the Snake River Plain, Idaho, by approximately 11,500 yr B.P. (Dort 1975). Climatic conditions in the area during the late-glacial period were severe and unstable. Analysis of pollen extracted from laminated to massive silts that accumulated in a small pond retained behind a mid-Pinedale end moraine reveals a sequence of rapidly changing late-glacial environments. This pollen analysis, described below, illustrates that a cold, moist spruce (*Picea*) parkland alternated twice with spruce/fir (*Abies*) forest indicative of slightly milder conditions. These environmental fluctuations occurred between approximately 11,250 yr B.P. and 10,000 yr B.P.

The study site is a small subalpine meadow (2,440 m elevation) on the eastern slopes of the Lemhi Mountains, Idaho. The site is approximately 45 km northwest of the Jaguar Cave archaeological site (Dort 1975). Fine sediments accumulated in the meadow to a depth of 8-9 m behind an arcuate moraine (moraine p, using the terminology of Butler *et al.* 1985). A radiocarbon date of 10,130 ± 500 yr B.P. (Beta-3659) for an organic horizon at a depth of 160 cm provides a convenient boundary for delimiting late-glacial from post-glacial sediments.

Pollen was extracted from four sedimentary units of unusual interest, and of sufficient thickness to provide bulk samples of 3-4 kg necessary for separation of pollen utilizing a zinc chloride heavy-liquid flotation technique (Johnson 1981). Extracted pollen was mounted in a silicone medium and examined under a compound microscope. For routine identification, 400x was used; 1,000x was used with an oil immersion lens for difficult identifications or when attempting to distinguish between Haploxylon and Diploxylon pine (*Pinus*) grains. Pollen counts ranged from 246 to 304 grains for the four sedimentary units.

All four sedimentary units from which pollen grains were extracted overlie, and are therefore younger than, volcanic sediments recovered at a depth of 7 m. The volcanic layer has been tentatively identified as Glacier Peak B tephra, dating from approximately 11,250 yr B.P. (Butler *et al.* 1985). The uppermost of the four sedimentary units provided the organic matter dated at 10,130 ± 500 yr B.P.

The oldest sedimentary unit (unit 9; Butler 1982) is a massive, uniform layer (dry Munsell color, 2.5Y6/4). Clay and organic matter content from this unit

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were very low. The pollen assemblage derived from pollen in the sediment is interpreted as a cold and moist spruce parkland very near the paleo-treeline, indicative of a treeline depression of 360-480 m compared to modern conditions. These figures are similar to those reported by Waddington and Wright (1974), who suggested that upper treeline in the Yellowstone Park area (Wyoming), prior to 11,600 yr B.P., was 500 m lower than today. Pollen counts expressed as a percent of the total, that suggest a cold moist spruce parkland, include: pine, 33%; spruce, 5%; fir, under 2%; and willow (*Salix*), 10%. Other pollen percentages from the assemblage may be found elsewhere (Butler 1982).

The next oldest sedimentary unit examined (unit 8; Butler 1982) directly overlies unit 9. It is high in organic matter and clay content, with a subangular blocky structure. Its color is 2.5Y8/4 (dry Munsell). Pollen extracted from the unit showed high percentages of pine, spruce, and fir (60%, 15%, and 6%, respectively). No other pollen types exceeded 5% of the total. Even if some differential pollen destruction of smaller, more fragile grains is assumed, the high levels of the coniferous pollen point toward a vegetative assemblage lower in elevation relative to treeline than the underlying unit. A mature subalpine spruce-fir forest is suggested, indicative of somewhat milder climatic conditions.

The third unit examined (unit 7; Butler 1982) represented a group of varve-like rhythmites. Several couplets of the rhythmites were aggregated and sampled for pollen. The presence of the rhythmites suggests that glacial meltwater was present in abundance, perhaps associated with the termination of the last Pinedale-equivalent glaciation. The pollen data, however, illustrate a return to a cooler climate and upper spruce forest (pine, 25%; spruce, 12%; fir, 8%; willow, 11%; Roseaceae, 13%). The presence of numerous spores in the unit may imply that local moist conditions associated with the glacial runoff obscured the regional pollen picture.

The uppermost unit sampled, radiocarbon dated at 10,130 ± 500 yr B.P., was similar in structure and characteristics to unit 8. The pollen totals from this unit illustrate the onset of milder and somewhat drier post-glacial conditions. The totals include pine, 58%; spruce, 5%; fir, 17%; Douglas fir (*Pseudotsuga*), 3%; and sagebrush (*Artemisia*), 6%. Douglas fir pollen has poor transport capacities (Alley 1976), indicating its nearby presence at the time. The vegetation complex suggested by the pollen data represents a forest located slightly toward the lower treeline margin.

The variety and rapidity of environmental fluctuations in the approximately 1,000-year time span examined in this study suggest that early man would have probably frequently migrated altitudinally and latitudinally. The rapidly changing climate would have been best endured in a stable cave environment, such as found at Jaguar Cave in the adjacent Beaverhead Mountains.

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Riparian Plants Were a Major Component of the Diet of Mammoths of Southern Utah

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The contents of 25 fragments of mammoth (*Mammuthus*) dung from Bechan Cave, southern Utah, have been identified and quantified. The fragments are from complete or near-complete boluses that were collected during excavations of the dung unit during February and June, 1983 and June, 1984. Evidence for the identification of the boluses as mammoth dung includes their size and the coarseness of their vegetable contents, which is similar to that of modern elephants (*Loxodonta* and *Elephas*), and the presence of mammoth hair in the dung unit (Agenbroad *et al.* 1984; Davis *et al.* 1984; Mead *et al.* 1984; Mead *et al.* n.d.).

Plant macrofossils from the dung unit (a mixture of dung from the mammoth and at least eight other species) include a mixture of wet-ground and upland plants (Davis *et al.* 1984). Nearly one-third of the counted macrofossils are sedge (*Carex*) achenes. These are followed in abundance by cactus spines (17.6%), and grass florets (12.6%). Wood fragments include birch (*Betula*) (12.3%), rose (*Rosa*) (11.4%), saltbush (*Atriplex*) (5%), sagebrush (*Artemisia*) (3.1%), and smaller amounts of blue spruce (*Picea pungens*), wolfberry (*Symphoricarpos*), and red-osier dogwood (*Cornus stolonifera*). Similar associations are found today along streams from 2,366 to 2,180 m elevation in the region, 1,000 m above the site elevation.

The macrofossils from the dung unit do not provide direct evidence of mammoth diet because they were not recovered from just mammoth boluses. Several animals could have introduced plant fragments to the unit. This includes the woodrat (*Neotoma*) which could have carried many of the wood pieces into the cave.

To obtain direct evidence on the diet of extinct mammoths, 25 fragments of mammoth boluses were carefully dissected under 7x magnification. The identifiable plant remains were removed from the matrix and weighed. Preservation of these remains is excellent because of the dry cave environment.

Fig. 1 shows the percent by weight of the more abundant plant macrofossils recovered from the dung. Over 95% of the boluses are graminoid matrix comprised of crushed culms and leaves of grasses, sedges, rushes (*Juncus*), and small amounts of sand. The non-matrix portion is dominated (88% of the non-matrix

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fraction; Fig. 1) by saltbush wood and fruits, followed by sedge achenes (5%), cactus parts (4%), and sagebrush wood (1%).

The abundance of saltbush, cactus, and sagebrush in the dung indicates xeric upland vegetation while the dung layer was being deposited from 11,670 ± 300 yr B.P. (A-3212) to 16,700 ± 250 yr B.P. (A-3514). Pollen analysis of the sandy matrix surrounding the dung suggests that regional vegetation was sagebrush steppe at that time (Davis *et al.* 1984).

However, the abundance of aquatic plants in the dung demonstrates the importance of the riparian community to the diet of mammoths. Over two-thirds of the 25 dung fragments contained sedge achenes and five contained rush seeds. Other remains of aquatic plants include a naias (*Najas*) seed and a microphyll of horse-tail (*Equisetum*). Riparian vegetation near Bechan Cave may have attracted mammoths to the site. At the time Paleoindians reached southern Utah, mammoths and other megafauna may have been concentrated along streams and other mesic sites in an otherwise arid landscape.

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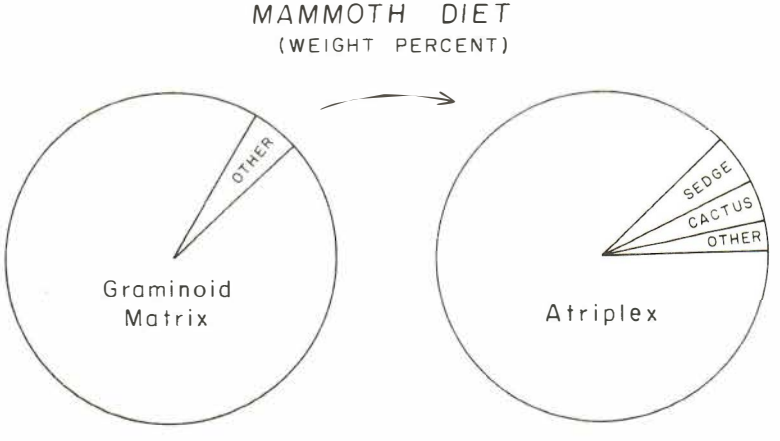

Fig. 1. Percent by weight of plant macrofossils in 25 mammoth dung balls from Bechan Cave.

Ice-age Desert in the Southern Great Basin

W. GEOFFREY SPAULDING

Paleoenvironmental studies employing fossil pollen and plant macrofossils from ancient packrat (*Neotoma* spp.) middens have been used independently to reconstruct late Quaternary climates and phytogeography of the southern Great Basin. Palynological investigations of lowland sedimentary sequences in the northern Mojave Desert (Mehringer 1965, 1967) were followed by studies of upland paleovegetation using packrat middens (Spaulding 1985; Wells and Berger 1967). The latest research, on lowland packrat midden sites in the Amargosa Desert, southern Nevada, has confirmed an important aspect of pollen-based reconstructions, the hypothesis of late Pleistocene desertification. Pollen-stratigraphic data from Tule Springs, in the Las Vegas Valley of southern Nevada, indicated a progressive trend toward increased aridity that began by ca. 12,000 yr B.P. (Mehringer 1967). In other words, the drying trend that resulted in the development of the present North American deserts began at least 2,000 years before the end of the Pleistocene (set at 10,000 yr B.P. by INQUA convention [Olausson 1982]).

This scenario of latest Pleistocene desertification contrasts strongly with evidence for widespread persistence of woodland in current desert areas until the end of the early Holocene (ca. 7,800 yr B.P.; Van Devender 1977). Middens from the lower elevations (<1,000 m) of the southern Great Basin were not available in the 1970s, but those from western Arizona and the trough of the Colorado River demonstrated that juniper (*Juniperus* spp.) woodland was widespread in current desert habitats at least as low as 365 m elevation (King and Van Devender 1977). Thus, in the absence of macrofossil evidence for glacial-age shrublands, and with abundant packrat midden evidence for xerophytic woodland occurring as late as 7,800 yr B.P. in some areas, it appeared that woodland was widespread in the desert West during the latest Pleistocene and early Holocene (Van Devender and Spaulding 1979). In this scenario, the pollen data from Tule Springs reflects merely an increase in abundance of xerophytic shrubs in woodland vegetation dominated primarily by junipers.

New data suggest that desertification was **not** delayed until the Holocene in all areas. Recently collected middens from the Amargosa Desert valley in the northern Mojave Desert establish that desert scrub existed as high as 910 m elevation toward the end of the last glacial maximum. Samples from the point of Rocks-3 (PR-3) packrat midden (36°34′N lat., 116°05′ W long.) provide the oldest desert scrub macrofossil assemblages known in North America. The oldest four, dated at 17,530 ± 200 yr B.P. (Beta-10423), 17,230 ± 250 yr

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B.P. (Beta-10424), 17,000 ± 270 yr B.P. (Beta-10422), and 14,810 ± 400 yr B.P. (A-2927), are dominated by the shrubs rabbitbrush (*Chrysothamnus nauseosus;* 5% to 27% of the number of identified specimens [NISP]), shadscale (*Atriplex confertifolia*; 12% to 24% of NISP), mormon-tea (*Ephedra nevadensis*-type; 6% to 24% of NISP), and snowberry (*Symphoricarpos* sp.; 13% to 49% of NISP). Of the 6,356 identified macrofossils in these samples, 4 minute twigs of juniper and 2 pinyon (*Pinus monophylla*) seed fragments are the only tree remains. Younger macrofossil assemblages from the PR-3 midden, and adjacent sites from 790 to 940 m elevation, record changes in vegetation that began by ca. 11,700 yr B.P.; grasses (Poaceae) and succulents (Utah agave, *Agave utahensis;* cacti, *Opuntia* spp.; Joshua-tree, *Yucca brevifolia*) typify middens dating between this age and ca. 9,400 yr B.P. Thermophilous desert shrubs appear after this time. The immigration of two of these shrubs, white bursage (*Ambrosia dumosa*) and desert spruce (*Peucephyllum schottii*), is reliably recorded in a time series from the Skeleton Hills-2 (Sk-2) midden (940 m elevation; 36°38′N lat., 116°17′W long.). The oldest sample to contain these species is dated to 9,220 ± 150 yr B.P. (Beta-9163; Sk-2(5); *P. schottii,* 1.2% of NISP; *A. dumosa,* 0.4%). Their abundance in the next youngest sample, Sk-2(1) dated at 8,810 ± 150 (*P. schottii,* 25.8% of NISP; *A. dumosa,* 5.3%), suggests expansion in the local community. The arrival time of the important desert perennial, creosote bush (*Larrea divaricata*), postdates the youngest sample, dated at 8,220 ± 90 yr B.P. (Beta-9171). To the north in the Eureka Valley of California (37°20′Nlat., 117°47′W long.), creosote bush immigrated between ca. 5,400 yr B.P. and 3,900 yr B.P.

The macrofossil record from 10 new midden sites in the northern Mojave Desert, from 36°24′N to 37°20′N lat., establishes that desert vegetation was probably common in xeric habitats in the southern Great Basin during the last six to eight millenia of the late Pleistocene. Time series of midden samples also demonstrate progressive change toward more xerophytic plant communities beginning by ca. 12,000 yr B.P. They confirm Mehringer's (1967) hypothesis that desertification was underway before the close of the Pleistocene, and they contrast with the packrat midden record from the trough of the Colorado River. The persistence of woodland until the end of the early Holocene at low elevations (<1,000 m) may have been a phenomenon largely restricted to the monsoonal Southwest. Maritime tropical air could have been important in allowing mesophytic vegetation to persist in these southern, monsoonal deserts after the onset of global warming (Spaulding *et al.* 1984). In the interior of the Great Basin, out of reach of the primary influence of maritime tropical air, desert vegetation developed as much as 9,000 years before it did at equivalent elevations in western Arizona.

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Late-Glacial and Holocene Vegetation History in Southeastern Massachusetts: A 14,000 Year Pollen Record

SUZANNE SUTER

A 14,000 year pollen record reveals the history of postglacial vegetation change in southeastern Massachusetts. Twelve radiocarbon dates, with 13,360 yr B.P. (at 953 cm) as the oldest, are available from a 10 m core from Winneconnet Pond (41°58'N, 71°07'W, 20 m elevation), a 60 ha shallow (3 m maximum water depth) lake near Taunton, Massachusetts. The site is 5 km northwest of Williams St. Bog, where Davis (1960) obtained a late-glacial pollen record. The core is composed of 60 cm of olive clay overlain by 9.4 m of gyttja. The rate of total pollen accumulation in the basal sediments was low, averaging less than 10,000 grains/cm²/yr, but after 12,000 yr B.P. (870 cm), total pollen accumulation rates increased to over 20,000 grains/cm²/yr.

Six pollen assemblage zones are evident in the diagram of pollen percentages (Fig. 1). These are: 1) the birch/sedge/myrtle (*Betula*/*Carex*/Myrtaceae) zone from ca. 14,000 to 13,600 yr B.P. (1,000 cm to 970 cm), 2) the spruce (*Picea*) zone from 13,600 to 12,400 yr B.P. (970 cm to 890 cm), 3) the pine (*Pinus*)/spruce zone from 12,400 to 11,300 yr B.P. (890 cm to 820 cm), 4) the spruce/pine/alder (*Alnus*) zone from 11,300 to 10,500 yr B.P. (820 cm to 750 cm), 5) the pine/birch zone from 10,500 to 9,100 yr B.P. (750 cm to 600 cm), and 6) the oak (*Quercus*)/alder zone from 9,100 yr B.P. to present (600 cm to 0 cm).

The pollen percentages of birch, myrtle, and sedge peak in zone 1, and pollen from willow (*Salix*), hornbeam (*Carpinus*), grass, and other herbs is abundant. Arboreal pollen types present at this time include oak and pine, but low pollen accumulation rates for these types suggest that oak and pine trees probably did not grow in the vegetation near Winneconnet Pond and that the presence of their pollen probably resulted from long distance transport. The high percentages of herb pollen and low rates of total pollen accumulation in zone 1 suggest that an open, treeless vegetation grew near Winneconnet Pond from 14,000 to 13,600 yr B.P.

In zone 2, spruce pollen percentages peak at 55% by about 13,000 yr B.P., and herb values are lower than they were in zone 1. The accumulation rates for spruce pollen in zone 2 are low, ranging from 1,000 to 4,000 grains/cm²/yr. The pollen accumulation rates for birch, myrtle, sedge, grass, willow, and other herbs are similar to their rates in zone 1, suggesting that the decrease in pollen percentages of these taxa is an artifact of the increased amounts of spruce pollen.

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The pollen data suggest that an open spruce woodland grew near Winneconnet Pond from 13,600 to 12,400 yr B.P.

The first major peak in pine pollen percentages occurred at approximately 12,000 yr B.P. when nearly 100% of the pine grains were red (*Pinus resinosa*) and/or jack pine (*P. banksiana*). After 12,000 yr B.P., the ratio of red/jack pine pollen to white pine (*P. strobus*) pollen decreased to 70:30. This ratio remained constant when total pine pollen percentages decreased after 12,000 yr B.P.

Spruce pollen percentages reached a maximum of 57% at 11,000 yr B.P. This percentage is comparable to the peak spruce pollen percentage in zone 2, but the spruce pollen accumulation rate of 15,000 grains/cm^2/yr is much higher than it was in zone 2. The higher pollen accumulation rate suggests that more spruce trees grew in southeastern Massachusetts at 11,000 yr B.P. than at 12,000 yr B.P. A sharp peak of alder pollen percentages is associated with the abrupt decline of spruce pollen percentages after 11,000 yr B.P.

After 10,500 yr B.P., total pine pollen percentages increased and the ratio of red/jack pine pollen to white pine pollen decreased to 1:3. This ratio of red/jack pine pollen to white pine pollen remained approximately 1:3 throughout the Holocene pollen record. White pines were therefore the trees that replaced spruce trees on the landscape. A peak in birch pollen percentages and the initial appearance and expansion of hemlock (*Tsuga*) pollen percentages also occurs in zone 5.

The pollen assemblage in zone 6 is characterized by increased pollen percentages of oak and alder. Beech (*Fagus*) pollen occurred in significant quantities by 6,700 yr B.P., and hickory (*Carya*) is first evident by 6,400 yr B.P. Hemlock pollen percentages declined abruptly at 4,700 yr B.P. and hemlock was absent from the pollen record for about 1,000 years. Increased percentages of birch, hickory, and beech pollen followed the decline in hemlock pollen percentages. By 3,700 yr B.P., hemlock pollen percentages increased but not to their former values. Chestnut (*Castanea*) pollen appears in low amounts intermittently throughout the record.

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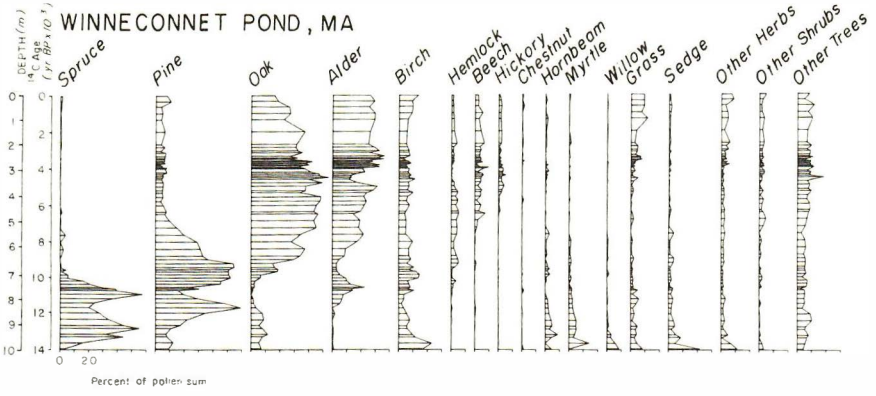

Fig. 1. Pollen percentages for selected taxa. Percentages were calculated from total pollen, excluding aquatics and spores.

Paleoenvironments: Vertebrates

New Discoveries in Northeast China

CHEN CHUN

In 1935, V.V. Ponosov showed P. Teilhard de Chardin, in Hardin, a wedge-shaped core (Fig. 1.1), collected in presumably final Pleistocene sediment of Kuhsiangtun. The wedge-shaped core, in grey chert, was at a depth of about 8 m, and in close associations with woolly rhinoceros (*Coelodonta*) and mammoth (*Mammuthus*) remains. From this specimen, together with three other wedge-shaped cores separately collected from Chikuchinze, near Turfan, Xinjiang and from the Campus site, near Fairbanks, central Alaska, Teilhard de Chardin put forward the presumable existence of a world-wide sub-Arctic sheet of human culture at the dawn of the Neolithic (Teilhard de Chardin 1939).

From 1933, many Japanese scholars had also carried out excavations in the area of Kuhsiangtun, and unearthed about 10 stone artifacts. In the past, owing to the unclearness of the boundaries of the strata, as well as the redeposit and the mixture of the cultural remains and the fossils caused by geological effect, some scholars regarded the cultural remains from Kuhsiangtun as belonging to the Mesolithic or even the Neolithic ages.

Recently, investigations were made for two months and the primary layer yielding artifacts and fossils was found. The excavation was made on the terrace of the Warm Spring River near Kuhsiangtun. Three radiocarbon dates obtained from the wood fossils 10-13 m below the surface are all in excess of 40,000 yr B.P. For this reason, it was believed that the cultural remains formerly discovered in the Kuhsiangtun formation might belong to the Paleolithic age (Zhang 1981).

In 1974, one upper Paleolithic site was discovered at Shibazhan (the Eighteenth Stop), Huma county, Heilontjiang (52°24′05″N, 125°19′56″E) (Zhang 1981). It is the northernmost Paleolithic site so far discovered in northeast China. Many stone artifacts were found in the deposit of the second terrace of the Huma River, about 0.3-3.0 m below the surface. The deposit is yellowish and yellow-brownish sandy clay, belonging to the top part of the late Pleistocene sediment. The cultural remains include: cores, flakes, various scrapers, and burins. The most attractive finds among them were several wedge-shaped cores. They were made of grey chert, similar to that from Kuhsiangtun in feature. The date of the Shibazhan site was estimated as belonging to the end of the Upper Paleolithic age (Fig. 1.2).

Another important microlithic site in the Heilongjiang is Angangqi. In 1928, a lot of microlithic remains were discovered by A.S. Lukashkin and reported separately by Teilhard de Chardin (1932) and Liang (1959). The cultural remains were buried in a sandy-clay sediment belonging to the Holocene lake

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and swamp deposits. The recent tests of ^{14}C showed the ages of the cultural remains had lasted from 7,570 ± 85 to 4,820 ± 80 yr B.P. In 1982, a Paleolithic locality was excavated *in situ*. Many flaked stone tools and mammalian fossils were unearthed from the deposit about 2-3 m in depth. One cylindrical microcore (Fig. 1.3) and many paleoliths were uncovered. The radiocarbon date of this deposit is 11,800 ± 50 yr B.P. (Huang *et al.* 1984).

Heilongjiang is the northernmost province in China. A lot of prehistorical evidence in archaeology showed that early man had long lived there and left abundant cultural remains in the area. The microlithic belonging to the Neolithic age scattered vastly. However, those of the Paleolithic age are not so common. The new findings from the three sites mentioned above are of great significance to the work of tracing early man's peopling in the area and their emigration to northeast Asia and North America.

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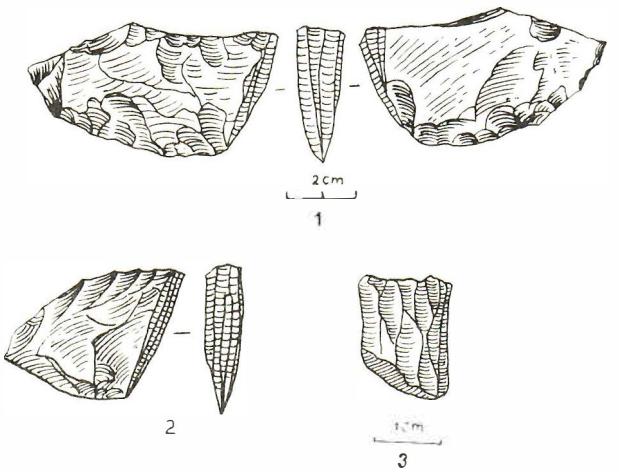

Fig. 1. Microcores from: Kuhsiangtun (1); Shibazhan (2); and Angangqi (3).

A Partial Muskox Skeleton from Eolian Deposits, Southwest Colorado

VICKIE L. CLAY AND SARAH W. NEUSIUS

A partial cranium, cervical and thoracic vertebrae, and rib fragments were discovered in trenching operations of the Dolores Archaeological Project (a cultural resource mitigation program administered by the University of Colorado at Boulder) in southwest Colorado. This find was excavated, partially conserved, and identified as extinct muskox (*Symbos* sp.) in 1983. One kg of thoracic vertebra yielded a collagen date of 15,970 ± 155 yr B.P. (SI-6137). The muskox was stratigraphically located between two loess deposits that occur in the Four Corners region (Arrhenius and Bonatti 1965).

Initial discovery of the muskox cranium was made in excavation trench 32 as illustrated in Fig. 1. Sixty cm of cultural (i.e., Anasazi) occupation surfaces and refuse covered the natural Bt and Ck horizons which contained the skeletal remains. The break between the Ck2 and Ck3 horizons is interpreted as a stratigraphic unconformity between two episodes of regional loess deposition.

Wisconsin-aged muskox discovery in the Four Corners region is important for a number of reasons. Paleontologically, it is the only reported occurrence of articulated cranial and post-cranial remains from this species (McDonald *et al.* n.d.). Paleobiogeographically, it is one of few reported occurrences of the extinct muskox on the Colorado Plateau and one of fewer than 100 finds in North America (Clay *et al.* 1985). Pedologically, the ^{14}C dated remains date the upper regional loess deposit and soil genesis processes to no earlier than approximately 16,000 yr B.P. (Price *et al.* 1984). And from a geological standpoint, this find substantiates deglaciation and concurrent loess deposition in the Dolores River drainage and surrounding areas to approximately 16,000 yr B.P. (Carrara *et al.* 1984).

Although cultural associations were searched for none were found. The age and extent of these deposits will aid in the search for early man and additional Pleistocene fauna in this region of the Southwest.

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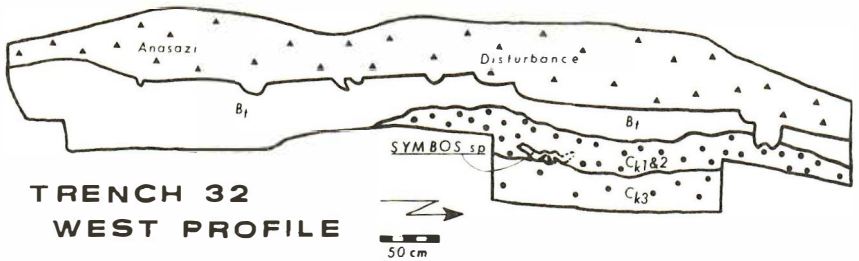

Fig. 1. Profile illustrating location of initial muskox cranium discovery.

The Late Pleistocene Lindsay Mammoth (24DW501), Eastern Montana: Possible Man-Mammoth Association

LESLIE B. DAVIS AND MICHAEL CLAYTON WILSON

The skeleton, mandible, and tusks of a single mammoth (*Mammuthus* cf. *imperator;* J.J. Saunders, personal communication 1971) were found in late Pleistocene loess on the rolling High Plains near Lindsay, Dawson County, Montana, 12.4 km northwest of Glendive (SE ¼ SE ¼ Sec. 6 and NE ¼ Sec. 7, T17N, R52E; 105°8′ 45″ W. Long., 47°15′12″N. Lat.). The site may predate presently known human occupation of the area, and thus could link hypothesized pre-Clovis to Clovis mammoth hunters.

George Arthur, then of Montana State University, visited the location in 1966 and obtained funding to study the situation. The first author tested the possibility of human association by excavating in 1967, recovering the skeleton for the Museum of the Rockies. The skeleton lay in primary context in a 1.2 m thick loess mantle on the lee side of a ridge developed on a weathered Fort Union Formation (Paleocene) unit. The loess was derived from nearby proglacial lake beds, the site being only a few kilometers from the Wisconsin maximum ice margin. Loess began to accumulate around 13,000 to 12,000 yr B.P. The bone bed was radiocarbon dated to 11,925 ± 350 yr B.P., S-918; 10,980 ± 225 yr B.P., I-9220; 10,700 ± 290 yr B.P., WSU-652; and 9,490 ± 135 yr B.P., I-7028, unpublished chemistry (all dates uncorrected) (Davis 1982). Much of the bone collagen had been leached out of the bones and tusk, but the bones had not mineralized. The ivory is light cream in color and chalky because of decalcification.

The dentition is in the ultimate stage, with the M3s in advanced but not severe wear and with the M2s eliminated. Lamellar frequency of lower molars (4-7), their width (120 mm), and low number of dental plates (15?16) were used by Saunders to establish the paleospecies. He estimated, from eruption and wear of the left lower molar (the best preserved), that the Lindsay mammoth was about 45 years old at time of death (relative to Law's [1966] aging criteria for African elephants). A tusk length of 2.7 m with a proximal diameter of 20 cm and wide lower molars characterize a mature bull. Height in life to top of cranium is reconstructed as 4.3 m, after Osborn (1942).

A 147 m² (Fig. 1) area was excavated to a depth of 3.5 m, to Paleocene sediments. While all freshly exposed bone is still intact, pressure fractures and mechanical and chemical decomposition caused some elements to fragment

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when moved. Some possible cut marks were noted, and one humerus and one tibia appear to have been gnawed.

Intrusive to the loess, directly associated with deposition of the mammoth skeletal elements, were eight blocks of sandstone probably derived from the Tongue River member, Fort Union Formation. Flat-lying strata of similar lithology are exposed 0.3 km north of the site at 100 m lower elevation. The sandstone blocks, which collectively weigh 4.5 kg, occurred beneath the mandible, beneath the vertebrae and articulated ribs, and beside and beneath one modified humerus, a co-occurrence suggestive of contemporaneity with the skeleton. The blocks may have been used as percussion implements in butchering but lack indications of wear. Presence in the deathbed of these transported sandstone blocks is indirect evidence of post-mortem scavenging by humans.

The skeleton was disarticulated and elements dispersed and weathered prior to burial. The arrangement and unnatural relative positions of some elements suggest artificial intervention rather than natural downslope dispersal (slope = 10-13%), specifically, stacking of femora across one another and atop the ribs and separation from the cranium of the mandible and its reorientation at nearly 180° from its articular position. The mammoth's mouth may have been battered; two dental plates from upper dislodged molars were beneath vertebrae, 4 m distant and the anterior edges of both mandibular molars had received impact.

Absence of flaked stone artifacts and bone tools does not, by itself, disallow the possibility that the mammoth carcass was scavenged by humans. Nonperishable projectiles would not have been needed, and butchering, dismembering, and bashing tools may have been carried away.

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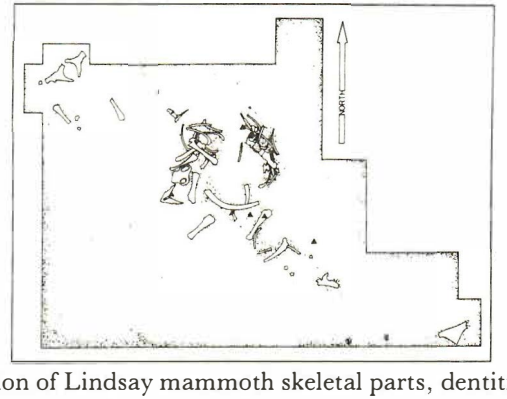

Fig. 1. Distribution of Lindsay mammoth skeletal parts, dentitions and tusks: sandstone blocks show as black triangles.

Quaternary Mammalian Faunas and Climatic Variations in Eastern China

HUANG WANPO

The mammalian faunas and climatic changes during late Pleistocene and Holocene times in eastern China have been reviewed. Variations in climate were accompanied by rapid sea-level fluctuations during the late glacial and post glacial. Studies of the Penghu, Hsiaonanhai, and Shinnongjia faunas reveal that there was a widespread drop in air temperature during the late Pleistocene (15,000 to 10,000 yr B.P.). During the cold stages, mammals such as the woolly rhinoceros (*Coelodonta antiquitatis*), mammoth (*Mammuthus* sp.), horse (*Equus ferus przewalskii*), roe deer (*Capreolus* sp.), *Scaptochirus* sp., and mole-rat (*Myospalax*) migrated from northern China to southern China. In contrast, studies of the Yingsui, Xiawenggan, and Dingjiabu faunas indicate that there was a widespread rise in air temperature during the Holocene (7,000 to 3,000 yr B.P.). During the warm stages, mammals such as Sumatran rhinoceros (*Dicerorhinus sumatrensis*), tapir (*Tapirus indicus*), and Asian elephant (*Elephas maximus*) migrated from southern China. Professor Zhu has pointed out that about 5,000 to 3,000 years ago the climate of northern China was basically the same as that of southern China today. The relationship between the mammalian faunas and the corresponding climates is illustrated in Fig. 1.

Editor's Note: This article is followed by the Chinese translation.

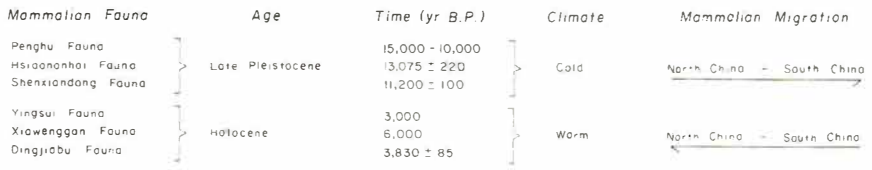

Fig. 1. Mammalian faunas of eastern China with their corresponding ages, associated climate, and direction of migration.

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中国东部第四纪哺乳动物与气候变迁

黄 万 波

第四纪以来，全球性的气候变迁，在世界各地都有反映，中国位于欧亚大陆东南隅，具有一定程度的同时性。从哺乳动物化石的角度来说，我国的情况，尤以更新世晚期之末的大理冰期和全新世的大西洋期最为明显。根据台湾省澎湖动物群、河南省小南海动物群以及江苏省神仙洞动物群的组合性质，表明在晚更新世之末，即距今15，000—10，000年，由于气温下降，湖泊、沼泽和海面消退，东南海域出现陆桥，致使古北区系的哺乳动物，例如披毛犀、猛犸象、蒙古野马、鹿等向南迁徙。距今7，000—3，000年，又因气温回暖，海面上升，陆桥中断，导致东洋区系的哺乳动物，例如苏门犀、亚洲象、印度豹等沿我国东部低海拔地区向北伸展。

现就文中涉及的一冷一暖气候变迁与动物群之关系，概括如下表所示：

动物群	时代	年代(B.P.)	气候	动物迁徙(中国东部)
澎湖动物群	晚更新世末	15,000—10,000	冷	北——→南
小南海动物群		13,075±220		
神仙洞动物群		11,200±100		
殷墟动物群	全新世	3,000	暖	北←——南
下王岗动物群		6,000		
丁家堡动物群		3,830±85		

Editor's Note: See Huang's preceding article for the English translation of this article.

Finds of Mammoth Fauna Remains in the Area of the Lower Indigirka River Northern Yakutia

P.A. Lazarev

Well-preserved skeleton and carcass remains of Pleistocene mammals are widely found in Yakutia due to the ubiquitous development of permafrost. Highly promising in a search for fossil animal remains is the lower Indigirka River area densely inhabited by numerous herds of mammoth (*Mammuthus*), bison (*Bison*), horse (*Equus*), and reindeer (*Rangifer tarandus*) at the close of the Pleistocene.

The well known Berelekh mammoth "cemetery" is located in the lower reaches of the Indigirka. More than 8,000 bone remains, mostly of mammoths, an intact mammoth hind leg with skin and woolly coat, a half-decayed body of a glutton (*Gulo*) were recovered there during the 1970 field season. A radiocarbon age of 12,240 ± 160 yr B.P. (LU-149) has been determined on a mammoth tusk from a bone-bearing horizon by Kh. A. Arslanov in the Laboratory of Geochronology at the Leningrad University. One of the northernmost Paleolithic camp sites has been found in close proximity to the mammoth "cemetery" at the level of the bone-bearing horizon. Also found in these localities were burials of skeleton and carcass remains of the Shandrin mammoth (1971), Tirekhtyakh mammoth (1971), Allaikha mammoth (1973), Mylakhchyn bison (1971), and Moichoon horse (1976). Of special interest are the Moichoon horse remains having an absolute age of 2,310 ± 80 yr B.P. (LU-1084, Arslanov). This horse's skeleton was buried in Holocene highly peaty loams on the Moichoon Lake side at a depth of 0.8 - 1.0 m. This find suggests that in northeastern Asia horses did not become extinct together with mammoths at the close of the Pleistocene, but survived throughout the Holocene.

During the 1982 field season we studied mammoth bone accumulations on the left bank of the Achchygyi Allaikha River, a left-hand tributary of the Indigirka. Here the river erodes a high side of an ancient plain that cuts an exposure about 80 m long and 20-25 m high. Two different-aged units are discerned in it. The upper unit with an apparent thickness of 10-15 m consists of late Pleistocene loess-like loams intercalated with peaty horizons. The lower unit 8-10 m thick is composed of middle Pleistocene sandy loamy deposits. On the downstream end of the outcrop the exposed sod-covered slope deposits contain abundant bone remains of mammoths. The bone-bearing horizon is traced from loess-like loams of the upper unit at a height of 7-8 m down the ancient slope to the river level. The thickness of the slope deposits increases from 2 to 3 m from top to bottom.

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Excavation of slope deposits has yielded 193 mammoth bone remains belonging to 14 individuals. Bones of young and juvenile individuals are predominating (70%). Many bones are broken, some show evidence of gnawing. On the last molars, plate density is 9 per 10 cm. Other mammalian remains include solitary bones of bison, horse, and reindeer. Interestingly, in 1973 we unearthed an almost complete skeleton of a large young mammoth in the same exposure 60 m upstream in loess-like loams of the upper unit at a height of 15-17 m.

A Natural Trap for Pleistocene Animals in Snake Valley, Eastern Nevada

Jim I. Mead and Emilee M. Mead

The Great Basin of North America is an area that comprises about 50% of the Basin and Range Province. Centering in Nevada, the Great Basin has much to offer for reconstructing late Pleistocene biogeography. Grayson (1982) reviewed the late Pleistocene mammalian history of the Great Basin. The paleoenvironmental and paleoecological records from this region are beginning to emerge (Thompson 1984; Thompson and Mead 1982). However, most paleontological studies have been on the periphery, leaving the interior a near void except for the Snake Range. Recently the interior has received some additional due attention (Heaton 1984; Thomas 1983). These reports are important in that they are records about sites in the mountain environments; the valleys have received very little attention in previous studies.

A limestone ridge outcrop at the lower portion of the eastern flank bajada of the Snake Range produces an ecologically critical location in Snake Valley, a coarse substrate "island" surrounded by alluvium. When Lake Bonneville was at its highest stand, during the Wisconsin age, its beach region was within 5 km of this rock "island". At least two caves having paleoecological significance are known to occur in the ridge. A 1984 preliminary test examination in one cave, Snake Creek Burial Cave (a natural trap sinkhole), has produced a wealth of vertebrate remains. In a 1 m test pit, over 5,000 fish, amphibian, reptile, bird, and mammalian remains were recovered. Although these remains have received only the most preliminary sorting and identification, some interesting trends are already emerging: 1) the fox (*Vulpes*) is found almost throughout the entire vertical sequence; 2) extinct fauna are found near the base of the profile, and include the camel (*Camelops*) and horse (*Equus*); 3) there is a very high proportion of carnivores such as: skunk (*Mephitis*), weasels (*Mustela* spp.), marten (*Martes*), badger (*Taxidea*), wolf (*Canis lupus*), and large cat; and 4) there appears to be taxa which are currently extralocal included in units with no extinct fauna, implying that not all faunal changes occurred at the end of the late glacial and the time of megafauna extinction. This last hypothesis is in agreement with a pattern discussed by Grayson (1982).

Future work will hopefully include two more field seasons in the natural trap cave and one field season in a nearby owl roost-carnivore den shelter, also containing extinct fauna. Together, the comparison of these two sites will provide a great deal of information for reconstructing the vertebrate communities that occurred above the Pleistocene lake level but below the forested and glaciated mountain valleys.

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Editor's Note: See related articles in this issue by K. Turnmire and R. Birnie.

Late Pleistocene Vertebrates from a Packrat Midden in the South-Central Sierra Nevada, California

JIM I. MEAD, THOMAS R. VAN DEVENDER, KENNETH L. COLE, AND DAVID B. WAKE

Since the 1960s detailed reconstructions of Wisconsin age vegetational changes in the arid western United States have been derived from fossil plant remains preserved in packrat (*Neotoma* spp.) middens (Van Devender and Spaulding 1979). Cole (1983) provided the first report of late Pleistocene packrat middens from the western side of the Sierra Nevada. Plant remains along with dung pellets of the packrat are the dominant fossils recovered from *Neotoma* middens. Often these deposits also contain bones, epidermal scales, teeth, and/or dung of other animals from the local (less than 100 m) community. The skeletal elements recovered from the hardened *Neotoma* deposits may be from commensal inhabitants in the middens or transported to the locality by raptorial birds, small mammalian predators such as the ringtail cat (*Bassariscus astutus*), or the packrat. Faunas from packrat middens have greatly increased our understanding of the zoogeography of ice age amphibians and reptiles (Van Devender and Mead 1978).

Here we report on the fauna recovered from a *Neotoma* midden discussed in Cole (1983). Although fossil plants from seven midden units were discussed, only Kings Canyon No. 8a produced identifiable skeletal remains. The fossil *Neotoma* midden was collected from a shelter in lower Kings Canyon, south-central Sierra Nevada, California at 1,280 m elevation. The locality has a western slope aspect and is within the present chaparral-oak (*Quercus*) woodland vegetation zone. The present climate is Mediterranean with 90% of the precipitation falling between November and April. The locality today is inhabited by eagles which bring in a variety of prey from the canyon area. Radiocarbon dates on the water-soluable (amberat: crystalized and cementing *Neotoma* urine) and insoluable (plant remains) fractions produced infinite ages of >45,000 yr B.P. (A-2339) and >30,000 yr B.P. (A-2338) respectively.

The following animals were recovered from the packrat midden: web-toed salamander (*Hydromantes* sp.), southern alligator lizard (*Gerrhonotus* cf. *multicarinatus*), western fence lizard (*Sceloporus* cf. *occidentalis*), garter snake (*Thamnophis* sp.), pocket gopher (*Thomomys* sp.), and bushy-tailed packrat (*Neotoma*

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cf. *cinerea*). The identification of the web-toed salamander was based on the shape of the transverse process and the height and division of the crests on the posterior portion of the neural arch. The keel on the anterior part of the arch is like that in *Hydromantes,* and unlike the other plethondontid salamanders in the area. The vertebral characters match those of both Mount Lyell salamander (*H. platycephalus*) and limestone salamander (*H. brunus*). Both species presently live in the central Sierra Nevada Range. Although neither occurs in the immediate vicinity of the fossil packrat midden, *H. brunus* today occurs at about the same elevation in mixed chaparral-oak woodland along the Merced River to the north of this site. This is the first known fossil of *Hydromantes.*

Associated with the animal remains is a plant macrofossil assemblage dominated by western juniper (*Juniperus occidentalis*), incense cedar (*Calocedrus decurrens*), and ponderosa pine (*Pinus* cf. *ponderosa*) (Cole 1983). These trees are present only during the late Pleistocene and are not in the modern local community. Two less abundant species in the midden, little leaf mountain mahogany (*Cercocarpus intricatus*) and single-needle pinyon pine (*Pinus monophylla*) were present in the middle and early Wisconsin, and although rare, are still in the modern community (Cole 1983). The pollen of the giant sequoia (*Sequoiadendron* sp.) (growing today at higher elevations) also was identified from the midden.

The fossil faunal and floral assemblage indicates a mosaic of the present and more mesic habitats. An alternative is that some of the elements were introduced to the midden locality by a raptor, thereby mixing local and extralocal taxa. In either case, the fossil assemblage contains a significant middle or early Wisconsin record.

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A Preliminary Analysis of Fossil Vertebrates from Owl Cave No. 2, Nevada

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Owl Cave No. 2 is located in east-central Nevada, White Pine County. The small shelter (1,700 m elevation) is a solution cavity in the Guilmette Formation, a Devonian age limestone and dolomite outcrop located well below the base of the eastern flank of the Snake Range. Test excavations, conducted in 1984 by the Center for the Study of Early Man (University of Maine at Orono) resulted in the discovery of a rich source of fossil vertebrates.

The cave entrance is almost totally filled with sediments and at present is approximately 6 m wide by 2 m in depth. Cave fill appears to be predominantly of aolian and colluvial clasts, the latter forming the talus cone that is sealing the cave entrance. A trench 1 by 4 m was excavated in 10 cm levels, largely in the talus cone, but also including a portion of the cave entrance area. Most of the sediments were screened through 6 mm and 3 mm mesh screens. The stratigraphy of the site is not fully determined at this time.

Most of the fauna is comprised of mammals, but birds, reptiles, and fish are also commonly recovered. Some of the fauna is of Pleistocene origin as inferred by the presence of at least two species of horse (*Equus* sp., large and small) and a large ovibovid. Other large animals include deer (*Odocoileus* sp.), pronghorn (*Antilocapra americana*), and a canid (*Canis lupus* or *C. latrans*). Small mammals comprise the majority of the assemblage. Lagomorphs presently identified include the pygmy rabbit (*Sylvilagus idahoensis*), jack rabbit (*Lepus* sp.), and pika (*Ochotona princeps*). The latter is presently absent from the Snake Range region. Small sciurids (squirrels) appear to be the most abundant rodent taxa. Marmot (*Marmota* sp.) has been found throughout several strata. The geomyids are well represented by the pocket gopher (*Thomomys* sp.). Cricetines are common and include the woodrat (*Neotoma* spp.) and several as yet unidentified microtines.

Although the analysis is in a preliminary stage, it is hoped that the identification of the Owl Cave No. 2 fauna will provide an increased understanding of past mammalian distributions. Other Great Basin fossil localities, particularly Smith Creek Canyon (Miller 1979; Mead *et al.* 1982), Crystal Ball Cave (Heaton 1984), and Gatecliff Shelter (Grayson 1982), provide a comparative basis for this work. Additionally, the fauna will be analyzed for evidence of the taphonomic processes (i.e., raptor roost, carnivore, human, woodrat) that resulted in their deposition.

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Editor's Note: See related articles in this issue by J. Mead and E. Mead and R. Birnie.

Paleoenvironmental Studies at Bush Shelter, Washakie County, Wyoming

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The University of Wyoming Anthropology Department and the Wyoming State Archaeologist's Office have been conducting joint archaeological excavations at Bush Shelter (48WA324) in the southern Bighorn Mountains since 1977. At the present time, approximately 19 m^2 have been excavated to an average depth of 4 m. Most of these excavation units bottom out on roof fall, thus the total depth of the deposits in the shelter are not known; however, the lowest deposits excavated to date are several thousand years older than 9,000 yr B.P. (see Fig. 1) based on the micromammal faunal remains and cultural materials recovered.

Archaeological material is not as prevelant in this shelter as is found in other caves in the region (Frison 1978), but a detailed cultural sequence is documented. This occupation, as presently known, begins with a late Paleoindian occupation dated approximately 9,000 yr B.P. (RL-1407), followed by an extensive early Plains Archaic occupation. Middle and late Plains Archaic cultural materials are present, but in lesser quantities. To date, no late Prehistoric occupation has been documented.

A primary focus of the investigations at Bush Shelter has been on the opportunity to observe paleoenvironmental changes as indicated by the mammalian fauna of the southern Bighorn Mountains throughout the depositional history of the site. Chomko and Gilbert (n.d.) discuss environmental change in the northern Bighorn Mountains based primarily on faunal remains from Natural Trap Cave and Prospects Shelter. At Bush Shelter however, an extensive mammalian fauna begins near the top of the depositional sequence and will provide detailed information on faunal changes throughout the Holocene and late Pleistocene of the same mountain region, but in a different ecological and geomorphic setting.

Excavations in 1980 resulted in the recovery of a large amount of small mammal material directly below the 9,000 year level. Several species present in this collection are no longer extant in the vicinity of the rockshelter and some, like the collared lemming (*Dicrostonyx*), are no longer extant in Wyoming. One meter below the 9,000 year level, *Dicrostonyx* appears to dominate over pika (*Ochotona*), heather vole (*Phenacomys*), red-backed vole (*Clethrionomys*), and other microtones. Thirty-five centimeters below the 9,000 yr B.P. level, *Phenacomys* and *Clethrionomys* have become dominant and *Dicrostonyx* has almost disappeared. At the 9,000 year level, *Dicrostonyx* has disappeared and *Ochotona* and *Phenacomys*

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are rarely found. As stated above, the 1984 excavations concentrated on the Holocene deposits for recovery of small mammal remains for paleoenvironmental purposes. The 2 m long area from E3 to E1 on Fig. 1 was excavated in 5 cm arbitrary levels to provide a detailed sequence of any changes in species composition that might have occurred during the time of deposition of the materials.

Excavations ceased upon reaching rockfall; the 1984 work was not able to extend into the Pleistocene deposits sampled in 1980. We feel this can be possible in other portions of the shelter. However, a very large amount of small mammal remains were recovered from each arbitrary level through the Holocene sequence. Analysis of this faunal material has begun. One item of interest found to date concerning the Holocene deposits is that the pika was still present in the vicinity until around 7,000 years ago. This is much later than has been previously documented for this and other shelters in the southern Bighorn Mountains and suggests a much later development of modern environmental conditions than previously thought. Analysis of the material will continue through the winter of 1984-1985.

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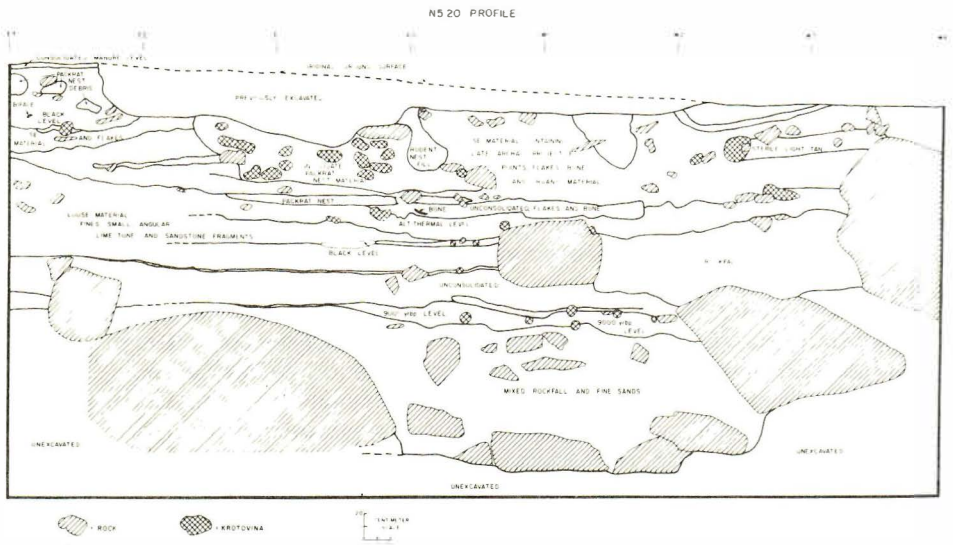

Fig. 1. Stratigraphic profile along North 5.2 m excavation wall at Bush Shelter (48WA324), Washakie County, Wyoming. Pleistocene deposits begin at stratigraphic break 1.7 m below the present ground surface.

Paleoenvironments: Geosciences

Geoarchaeology of the Snake Range and Snake Valley, Nevada: An Introductory Statement

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The work to be undertaken is incorporated within the goals of a larger project entitled, "The Pleistocene Peoples of the Snake Range." This project is directed by Robson Bonnichsen (Center for the Study of Early Man, University of Maine, Orono). The focus of the project is directed toward discovering evidence of pre-10,000 yr B.P. humans in the Snake Range and adjacent Snake Valley of east-central Nevada and western Utah.

The Snake Range is a north-south trending mountain range approximately 80 km in length. Elevations within the area range from about 1,520 m above sea level, on the valley floor, to 3,980 m at Wheeler Peak. The dominant lithological material extant within the Snake Range is a series of Paleozoic limestones and dolomites, although a quartz monzonite, quartzites, and some granodiorites also occur in relatively large quantities.

During the late Pleistocene the Snake Range was mantled by a series of mountain glaciers which reached elevations as low as 2,900 m (in Snake Creek Canyon). Also during the late Pleistocene, one of the arms of pluvial Lake Bonneville in this area has been calculated as approximately 1,580 m (Drewes 1958; Whitebread 1969). If the late Wisconsin glacial maximum in the area coincided with the high stand of pluvial Lake Bonneville, the biotic communities that would have been available for use or exploitation by early humans would have been restricted to an elevational range of less than 1,320 m.

At present the major vegetational communities around the Snake Range are part of the Inter-mountain Salt-Desert Shrubland and the Great Basin Colorado Plateau Sagebrush Semi-desert (West 1983). As elevation increases the vegetational communities undergo changes, from a sagebrush zone (1,370-1,980 m), to a Pinyon Pine-Juniper zone (*Pinus-Juniperus*) (1,980-2,895), a Limber-Pine-Bristlecone Pine zone (*Pinus flexilis-Pinus longaeva*) (2,895-3,660 m), and finally an alpine zone above 3,660 m. Quaking aspen (*Populus tremuloides*) and mountain mahogany (*Cercocarpus* spp.) also occur at higher elevations within the Snake Range.

During the late Pleistocene and the Holocene, the area was one of great climatic, geologic, and biological changes. The mountain glaciers receded, with only a small rock glacier active in the Wheeler Peak cirque today. The environment, in terms of effective moisture, became more arid resulting in the evaporation of the pluvial lakes (Bonneville, Spring, and Maxey). With the increasing aridity there is a corresponding upward shift in vegetational zones. Bristlecone pine existed near Smith Creek Cave during the late Pleistocene,

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today it exists only above 2,800 m. Along with the climatic change there is a change within the resources available. Camel (*Camelops*), horse (*Equus*), and other megafauna became extinct, while other species retreated upslope and/or became locally extirpated.

My thesis, one component of the project, is focused upon the geoarchaeology of the study area. The emphasis of the thesis will be placed upon relating the geologic record, as expressed in the landforms, with the archaeological record. The project has been organized into five phases: 1) air photo interpretation aimed at defining the landforms within the study area; 2) foot reconnaissance of those landforms aimed at collecting archaeological and geological data; 3) archaeological testing of promising sites; 4) laboratory analysis including more intensive air photo and Landsat MSS imagery interpretation, artifact analysis, and sediment analysis; and 5) thesis preparation. The initial three phases have been completed, however the air photo interpretation has not advanced beyond the initial stage.

During the survey portion of the project, a total of 55 separate areas were discovered. A total of 46 isolates/small lithic scatters and 9 archaeological sites were documented. Eleven sites that had been previously documented were also visited in order to evaluate them in terms of the research potential for recovering information on pre-10,000 yr B.P. humans within the area. Two of these sites have some good potential. Three sites were tested during the project: Owl Cave 1 and 2 (Turnmire 1985) and Snake Creek Burial Cave (Mead and Mead 1985). Owl Cave 2 provided a sequence of Holocene to late Pleistocene vertebrates. The testing at caves 1 or 2 did not yield evidence of pre-10,000 yr B.P. humans within the excavation area. Several other sites were found on shoreline features of Lake Bonneville and are currently undergoing analysis to determine their age.

The goals of the air photo and Landsat interpretation are as follows: 1) to corroborate field interpretations of geological data with specific reference to the history of the pluvial lake within the area and to the glacial history of the Snake Range; 2) to identify geological formations within which caves and rockshelters may be present; 3) to accurately locate known archaeological sites on the air photos and hence to more accurately define the context of those sites; and 4) to provide a regional view of the interrelationships between the landforms within the study area, specifically with reference to the sequence of events during the late Pleistocene and early Holocene (i.e., glacial moraines, meltwater channels, and shoreline features of the pluvial lake).

The geoarchaeological framework being developed within the thesis will provide a temporal-spatial framework for other studies undertaken on this multidisciplinary project. Emphasis will be placed upon identification of late Pleistocene and early Holocene landforms within and upon which archaeological remains of pre-10,000 yr B.P. humans may be located.

The author appreciates the tremendous logistics aid provided by Donald Tuohy and the Nevada State Museum, Carson City.

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Re-Evaluation of the Lubbock Subpluvial

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In the late 1950s and early 1960s, considerable research was conducted in the late Quaternary paleoecology of the Southern High Plains of northwest Texas and eastern New Mexico (Wendorf 1961; Wendorf and Hester 1975). A particularly significant result of the research was the definition of the Lubbock Subpluvial. This period was dated to between ca. 10,600 and 10,300 yr B.P., coinciding with the local Folsom occupation, and characterized by a climate cooler and more moist than that which immediately preceded or followed it, resulting in the invasion and recolonization of the area by a dense pine (*Pinus*) and spruce (*Picea*) forest (Wendorf 1970). This conclusion was drawn from pollen and some diatom and invertebrate faunal assemblages from the Lubbock Lake site and Blackwater Draw Locality #1, particularly the former. Continuing research at Lubbock Lake, begun in 1973, warrant a re-evaluation of the Lubbock Subpluvial, based on radiocarbon ages and soil-stratigraphic, paleontological, and palynological data not available to the earlier investigators.

The evidence for the Lubbock Subpluvial came from a geologic deposit termed Unit 2 by Wendorf (1970) and characterized by diatomite and diatomaceous mud. Folsom artifacts were found in the unit and a radiocarbon age on charred bone and one on shell were available. The zone of increase in pine and spruce pollen was near the top of Unit 2. Almost 40 reliable radiocarbon ages and considerable geological and pedological data significantly refine earlier descriptions of the unit (Holliday n.d.; Holliday *et al.* 1983, n.d.). The diatomite, containing the Folsom material, comprises the lower half of the stratum 2 (substratum 2A) and dates from ca. 11,000 to around 10,000 yr B.P. The upper half of stratum 2 (substratum 2B) is clayey, organic-rich marsh sediment (sapropelic, not diatomaceous, mud). Much of 2B accumulated between 10,000 and 8,500 yr B.P. From 8,500 to less than 6,500 yr B.P., little deposition occurred and a soil (Firstview Soil) formed in upper 2B. The pine-spruce pollen peak coincides with the A horizon of the Firstview Soil.

The pine-spruce pollen peak in upper 2B may have been the result of differential pollen preservation. In re-analyzed samples pine and spruce pollen grains comprise all or most of the pollen assemblage. However, all the grains are corroded or degraded and the total pollen concentration is low. The differential preservation of the pollen combined with the effects of concentrating

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the pollen on a stable surface for 2,000 years probably resulted in the high percentages of pine and spruce pollen.

Finally, the microinvertebrate paleontology does not show evidence for forested conditions at any time during stratum 2 deposition. Woodland-dependant vertebrates are absent from the faunal assemblages of stratum 2 despite 12 years of intensive testing and use of microvertebrate recovery techniques. A few of the snake remains recovered indicate the probable presence of scattered trees; also confirmed by the recovery of "hardwood" (deciduous) remains from 2B (Murry 1980). Furthermore, the snail fauna from stratum 2 is not indicative of a forested environment (Pierce 1975).

The pine-pollen peak from Blackwater Draw Locality #1 does come from the lower diatomite and is associated with the Folsom occupation of the site. As such, it clearly cannot be correlated with the Lubbock Lake pollen spectra. The significance of the pollen data from Blackwater Draw is not clear, but given the very limited data on the locations of the pollen columns and considering the problems of differential pollen preservation at Lubbock Lake, the data should be interpreted with considerable caution.

In summary, radiocarbon, geological, pedological, palynological, and paleontological data from Lubbock Lake now indicate that the concept of the Lubbock Subpluvial as defined by Wendorf (1970), is invalid. Furthermore, the pine-spruce pollen peak associated with the Lubbock Subpluvial has not been found in other local and regional pollen analyses (Hafsten 1961; Bryant and Holloway n.d.).

This investigation is part of the continuing research of the Lubbock Lake Project funded by: National Science Foundation (SOC75-14857; BNS7612006; BNS7612006-A01; BNS778-11155), City and County of Lubbock, Center for Field Research (EARTHWATCH), The Museum, Texas Tech University, and the West Texas Museum Association.

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Late Quaternary Deposits and Paleohydrology of the Saltville Valley, Southwest Virginia

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Saltville Valley is located in the Valley and Ridge Physiographic Province of the Appalachian Mountains in Smyth and Washington counties, southwest Virginia. Since current research in this valley was initiated in October, 1980, most attention has been devoted to a section of the valley bottom near the southwest end of "The Flat" known as the **musk ox site** (McDonald and Bartlett 1983). The stratigraphy of valley-bottom deposits near this site was studied to develop a working model of the late Quaternary history of the valley. Vertical profiles of the unconsolidated sediments were exposed by 11 backhoe cuts and the excavation at the musk ox site. Seven late Quaternary stratigraphic units were recognized (Fig. 1), including fluvial, lacustrine, peat, and colluvial deposits, and at least two paleosols. These sediments range in age from the (?)Sangamon to the very late Holocene, and include a continuous column spanning the last 15,000 years or so. The units recognized are:

Unit H1: The historic surface: natural soil and historically altered surficial sediments (13-88 cm thick).

Unit H2: Lentic clay: lower, middle, and (?)upper Holocene. Medium gray; relatively few macrofossils. A weakly developed paleosol occurs about midway through this unit across part of the valley (to 174 cm thick).

Unit W1: Organic rich mud/soil/peat at the Wisconsin-Holocene boundary. Normally thin (6-15 cm thick); contains abundant macroremains of plants and insects. The mud facies contains microvertebrates. ^{14}C dated at 10,050 ± 110 yr B.P. (paleosol:Beta-5056) and 10,690 ± 130 yr B.P. (peat:Beta-5055).

Unit W2: Lacustrine and (?)marsh clay; about 14,000 to 10,000 yr B.P. Medium gray; contains, especially in the lowest 20-40 cm, abundant remains of plants and animals, including pelycepods, gastropods, ostracods, fish, amphibians, reptiles, and mammals (58-120 cm thick).

Unit W3: Fluvial sediments dated at 14,480 ± 300 yr B.P. (woody stems: Beta-5701). Contains several, silt, sand, and gravel deposits up to 15 cm thick lying beneath W2 and above W4 or P1. Faunal and floral remains are common.

Unit W4: A pebble/cobble stratum dating between about 27,000 and 14,500 yr B.P. Widely distributed over the valley bottom; consists of sub-angular to rounded pebbles and cobbles with occasional lag boulders. Composition and distribution suggest fluvial origin. Numerous remains of large mammals occur. Lies uncomformably on Maccrady Formation (to ca. 15 cm thick).

Unit S1: (?) Sangamon valley fill. Terrace-like colluvial deposit 200 cm thick

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appears to be formed of insoluble weathered residue from the adjacent Little Valley Limestone hills. Lies uncomformably on Maccrady Formation.

Unit P1: Maccrady Formation, Mississippian Age, primarily shales. Occurs as massive bedrock or pebble-sized saprolite where it was scoured by the late Wisconsin Saltville River. Elsewhere, the upper surface has weathered to clay to depths of several centimeters.

The stratigraphic data and radiocarbon dates obtained from deposits in the vicinity of the musk ox site provide a general outline of the late Quaternary paleohydrologic history of Saltville Valley. The valley was scoured by flowing water at least once before late Wisconsin time. Sangamon(?) age colluvial deposits accumulated on top of this erosional surface. The Saltville River coursed the valley during the late Wisconsin, between at least 27,000-14,000 yr B.P. Around 14,000 yr B.P. the Saltville River was diverted by headstream piracy and a lake formed, eventually filling all of the valley bottom (McDonald and Bartlett 1983). This lake is here named **Lake Totten**, in honor of the Totten family of Saltville, ardent supporters of the current research at Saltville. Sedimentation reduced the area and volume of Lake Totten, and subsurface perturbations caused by the dissolution of evaporites in the Maccrady Formation could have changed the local water level periodically. A shallow lake of some 120 ha remained when European colonists arrived in the valley in the mid-18th century. This lake was drained during the late 1840s.

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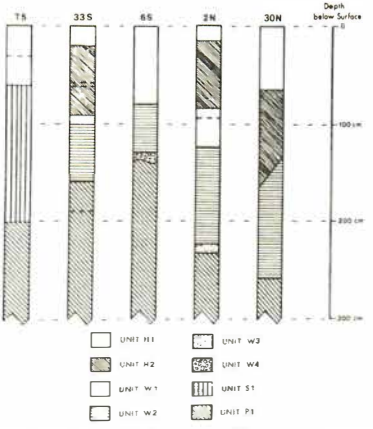

Fig. 1. Representative stratigraphic profiles measured at five locations near the musk ox site. T5 was measured through the terrace-like colluvial deposit immediately northeast of the musk ox site. The other four profiles were measured through the late Wisconsin deposits southeast of the musk ox site (from McDonald 1984).

Early and Late Wisconsin Age Missouri River Fill Terraces in South Dakota

MICHAEL MCFAUL

A field geomorphic examination was done in 1983, on 12 archaeological sites along the left (eastern) bank of the Lake Francis Case reservoir in south-central South Dakota for Larson-Tibesar Archaeological Associates of Laramie, Wyoming. Each of the archaeological sites was associated with two elevationally distinct Missouri River fill terraces. The terraces occur along the margins of the Missouri and are approximately 6 to 12 m and 30 to 39 m above the 1947 Missouri River floodplain. Both terraces are best seen where the river is or was joined by tributary streams and in the bottom lands associated with pre-Missouri River drainages. Coogan and Irving (1959) adopted the designations Mt-1 (Missouri terrace 1) for the lower surface and Mt-2 (Missouri terrace 2) for the upper surface in the Big Bend, South Dakota area.

In addition to elevation, the Mt-1 and Mt-2 surfaces can be differentiated by their stratigraphy, morphology, and pedology. The stratigraphy of the lower Mt-1 consists of a strath cut on Cretaceous Pierre Shales covered by approximately 9 m (Brule Bottoms) of weakly weathered Pleistocene glacial fluvial sediments, which are mantled by 2 to 3 m (Prairie Dog Bay and Wolf Creek) of Holocene eolian silts and sands.

The Mt-2 fill sequence rests upon a strath cut on Pierre Shale or deeply weathered and cemented pre-Wisconsin glacial sediments of Illinoian age (Flint 1955, north of Brule Bottoms). Mantling the deeply weathered gravels or shale are varying thicknesses of weakly weathered Pleistocene glacial-fluvial sands and gravels. North of the Crow Creek site along Wolf Creek, these sediments are approximately 9 m thick and are overlain by a 0.8 m thick paleosol (Coogan and Irving 1959). The paleosol is covered by Holocene eolian sands and silts 7 to 8 m thick (Chamberlain and Barthold School) in which numerous dark or humic horizons occur. These eolian silt and sand strata (McFaul 1984) apparently have a history similar to Clayton's Oahe Formation (Moran *et al.* 1976) in North Dakota.

Comparison of the Mt-1 and Mt-2 basal glacial-fluvial sediments with those of apparent Illinoian age suggest a Wisconsin age for the Mt-1 and Mt-2 surfaces. The presence of these two elevationally distinct terraces strongly implies two separate Wisconsin glacial substages were responsible for the creation of the terraces. The higher Mt-2 surface may date from the early Wisconsin substage ≥50,000 yr B.P. (see Nilsson 1983:387-389) while the lower Mt-1 appears to correlate with the late Wisconsin substage. Flint (1955) did not recognize any pre-Wisconsin terraces since he felt the Missouri trench was

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created in Illinoian time and that early river gradients were steep enough to inhibit terracing and outwash accumulations.

Future, planned investigations in the Missouri River trench will map the extent of both the Mt-2 and Mt-1 surfaces as well as correlate surface elevations, build soil-stratigraphic profile indexes, and collect soil-sediment samples along with datable materials for laboratory analysis. Map indexes will include paleoenvironmental reconstructions for the terraces' soil-stratigraphic units. Central to this will be the determination of the age and environmental characteristics of the paleosol which separates the glacial-fluvial sediments from the eolian sediments in the Mt-2 soil-stratigraphic column. This information should help answer questions concerning the occurrence of climatic events in the middle Wisconsin interstadial.

The significance of the Missouri River's Mt-1 and Mt-2 surface to archaeologists is twofold. First, the apparent correlation of the Oahe Formation with the eolian silt and sand sequence seen in the stratigraphic column of both terraces can provide the context for determining the relative ages of cultural materials, excavation locales, test unit depths, and the environmental conditions associated with site occupancy. Second, the presumption of the early Wisconsin age for the Mt-2 surface implies the pre-Holocene units of the terrace's soil-stratigraphic column have the potential to contain *in situ* evidence of pre-Clovis occupations.

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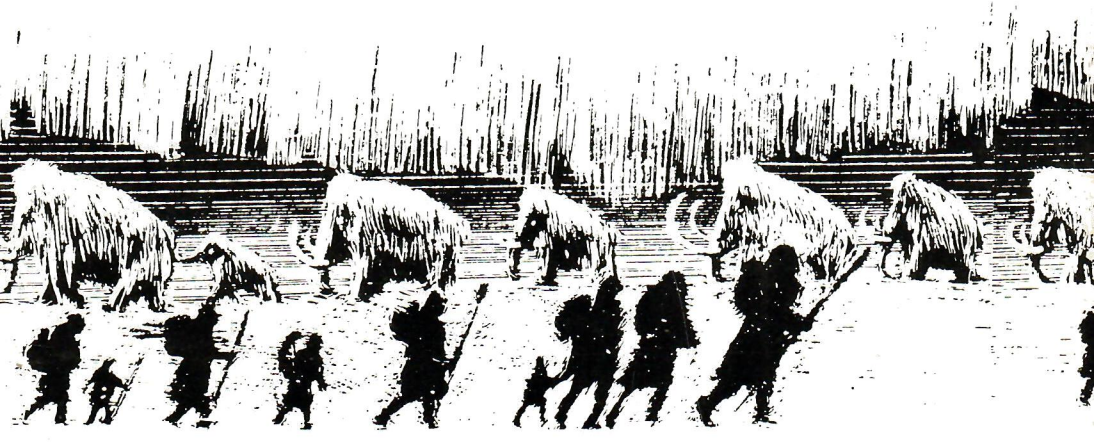

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