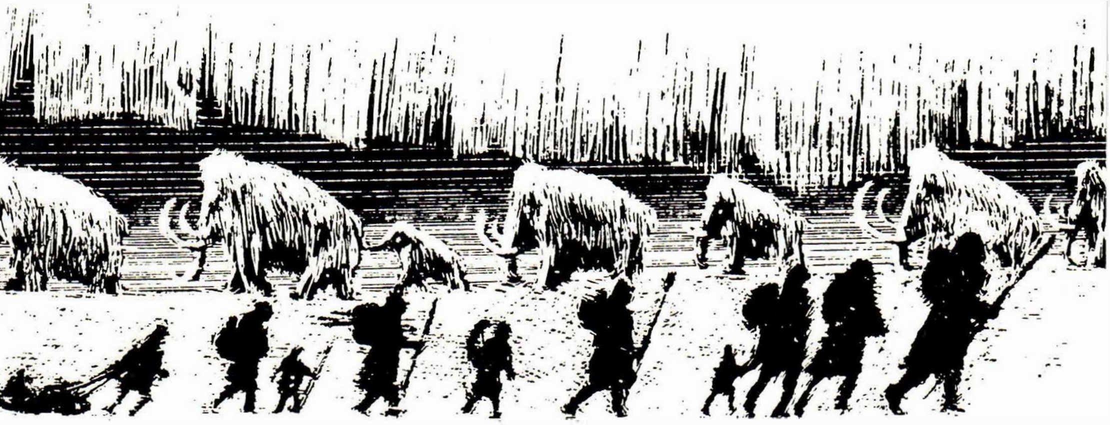
CURRENT RESEARCH IN THE PLEISTOCENE

Volume 3 1986



A Peopling of the Americas Publication

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CURRENT RESEARCH IN THE PLEISTOCENE

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News of discoveries, reports on recent conferences, new references and resources and news of current issues are invited. Contact editor Marcella Sorg at the Center.

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CURRENT RESEARCH IN THE PLEISTOCENE

Volume 3 1986

Editor
Jim I. Mead

Department of Geology
Northern Arizona University
and the
Museum of Northern Arizona
Flagstaff

A Peopling of the Americas Publication

Center for the Study of Early Man
University of Maine
Orono, Maine

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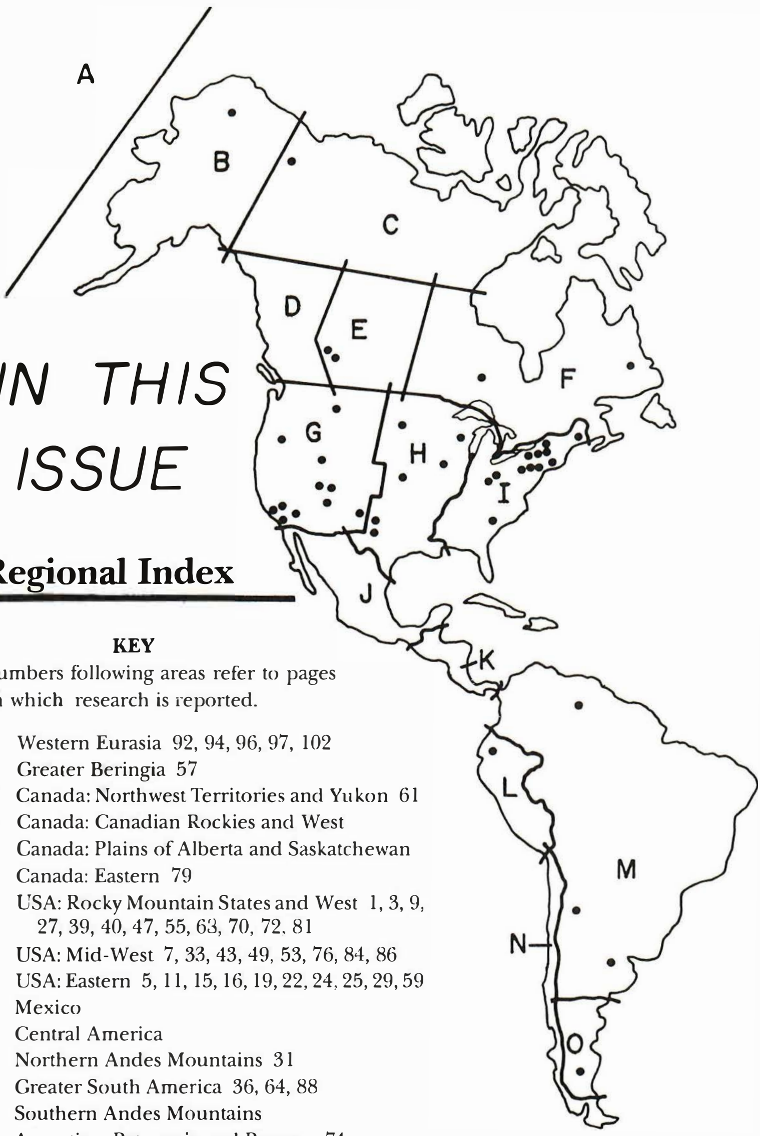

KEY

Numbers following areas refer to pages on which research is reported.

Map of the Western Hemisphere locating sites discussed in this issue.

From the Editor

This is the third 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. *CRP* focuses on the broad, interdisciplinary topic of the peopling and environments of the Western Hemisphere before 10,000 yr B.P. Other geographic areas important to this theme, particularly northeastern Asia (northeastern China, Korea, Japan, and eastern Siberia, USSR) are also included. Specialists from all over the world are invited to submit for publication short statements on their current research. Because of the international scope of the topic, the Center will publish articles in languages other than English together with an English translation. Collectively, these concise, state-of-the-art reports provide an overview of trends and developments in New World early human studies and allied fields, all in a single volume.

Starting with this issue, each volume will include a special section focusing on a particular geographic region. Within the featured section, longer-than-usual articles will be permitted. This year the focus is on Asia and five articles are included. Note that the article by Zhang and Chen is in both Chinese and English, and that the article by You, Xu, Li, and Ho contains additional information in table format. Similarly, the Regional Focus section in future volumes will be used to present additional maps, tables, figures, and bibliographies related to that region.

CRP is designed to speed the flow of information about new research. Our four-month turnaround time and multidisciplinary scope allow us to bridge the temporal gap between the initiation of new research and its eventual publication in peer-reviewed journals upon completion. Authors are encouraged to present new ideas and research goals and to report on work in progress as well as newly completed projects.

The success of *CRP* rests on the specialists who provide regular up-dates of their current research as well as the readers in many disciplines who want to stay on top of a wide range of inquiry and efficiently expand their knowledge. With such participation, everyone interested in the study of the peopling and paleoenvironmental reconstructions of the Western Hemisphere should be able to keep abreast of this fast-changing, interdisciplinary topic.

Archaeology

The Lime Ridge Clovis Site

William E. Davis and Gary M. Brown

Most knowledge of the Clovis complex is derived from investigation of mammoth kill and butchering sites. Until now, little information was available on Clovis campsites and their cultural material inventories. Fieldwork at such a site was recently completed on Lime Ridge, located 15 km southwest of Bluff, Utah. The Lime Ridge site (42SA16857) was originally discovered and recorded in 1978 by Laurie Blank-Roper, conducting an archaeological clearance survey (Green 1978). The report was subsequently absorbed in the "gray zone" of cultural resource management literature until brought to the attention of Abajo Archaeology which was engaged in research on a Folsom lithic scatter in southeastern Utah. Field inspection revealed that the Lime Ridge site was a similar surface manifestation that had not been seriously disturbed or mixed with later materials. Subsequent inspection was intensive enough to yield a 100% surface collection comparable to that from the Montgomery Folsom site (Davis 1985).

The Lime Ridge site consisted of a fairly light dispersed 108 m north-south by 78 m east-west scatter with one moderate 50 m^2 concentration. The site is situated on a high finger ridge commanding an uninterrupted 360° view, and, notably, overlooking a canyon head to the west. The canyon drains south-southeast towards the confluence of Comb Wash and the San Juan River, 4 km away, creating a potential corridor for movement of animals between the Lime Ridge upland and the lower riparian ecozone. This supports the suggestion by Davis *et al.* (1985:82) that mammoths and other megafauna in southern Utah "may have been concentrated along streams and other mesic sites in an otherwise arid landscape."

The Lime Ridge assemblage consists of 294 lithic artifacts. With the exception of four flakes recovered during subsurface testing, all materials were collected from the site surface. Together the remains are believed to represent close to a 100% inventory, though some artifacts may have been previously collected. The assemblage is characterized by a high ratio of tools and implements to debitage—1:1.63, compared to 1:3.92 at the Montgomery site (Davis 1985). At Lime Ridge, unutilized debitage makes up only 60% of the collection

William E. Davis and Gary M. Brown, Abajo Archaeology, P.O. Box 100, Bluff, UT 84512.

(n=176). Simple flake tools account for 25% (n=72); most are distinguished only by obvious use retouch. Formal tools comprise 12% of the collection (n=36); the remainder consists of 10 cores (3%).

Formal tools include four side scrapers, ten end scrapers, three notched flake tools, eight other unifacial tools, two *pièces esquilles,* three bifaces, and six projectile point fragments. In addition to the two Clovis point bases illustrated in Figure 1, the distal end of a lanceolate biface made of the same gray quartzite was found, along with another distal segment from a chalcedony point which bears the remnant of a step-fractured channel flake termination. Two chert tip fragments were probably also derived from broken points. Additional biface fragments include two small pieces and a "pie-shaped" fragment from a large, radially-fractured biface. One of the scrapers was also shattered by a radial fracture.

As with most Paleoindian scrapers, those from the Lime Ridge site are quite standardized. All of the end scrapers were made on expanding flake blanks, generally thicker toward the distal end. Blanks differing from this morphology were retouched into this shape. Abrupt dorsal retouch formed the primary working edge of the tool, generally decidedly convex. Three of the end scrapers have pronounced corners, but the classic "spurred" end scraper represented at the Montgomery site and other Paleoindian sites are lacking at Lime Ridge.

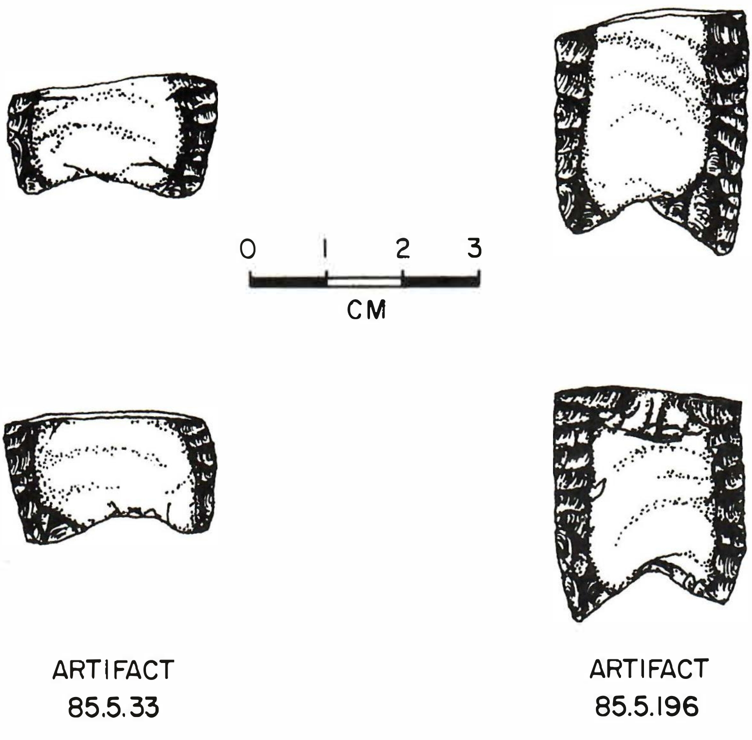

Figure 1. Projectile point bases from Lime Ridge site.

One interesting trait not previously reported in Clovis assemblages is a tranchet technique represented by four large flakes struck obliquely from the edge of large, thick bifaces. Although one of the flakes exhibits use retouch, they appear to be debitage from manufacturing tranchets or similar tools (Schafer and Hester 1983).

The assemblage in general appears to be less specialized than those reported from kills and butchering sites. Despite the large number of tools, nearly all of the debitage is wastage from hard-hammer core reduction. The relative paucity of debitage might suggest a special use site, but the composition and character of the assemblage does not indicate butchering activity. Pending further analysis, we feel the site was occupied briefly as an encampment, perhaps used as a hunting stand. Rather than stone tool manufacture, the number and types of tools seems to reflect non-lithic tool fabrication.

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Western Clovis Occupation in Southcentral Oregon: Archaeological Research at the Dietz Site 1983 to 1985

John L. Fagan

In the fall of 1982, Mr. Dewey Dietz found a site in southcentral Oregon which contained several basal fragments of fluted points. Mr. Dietz recognized the importance of his find and contacted me in hopes that professional investigations would be undertaken. I arranged for a meeting with Mr. Dietz and William Cannon, archaeologist for the Bureau of Land Management, Lakeview District.

In the early spring of 1983, Mr. Dietz took Mr. Cannon and me to the location where the fluted points were found. We located a large site with several concentrations of flakes and artifacts exposed along the bottom and edge of a small playa. On this first visit we located and recorded 17 Clovis artifacts. The site was much more extensive than Mr. Dietz had imagined. It consisted of a series of lithic workshops and campsites scattered over an area 1,000 m long by 500 m wide.

Volunteers mapped artifact concentrations, conducted controlled surface collections, and tested for subsurface deposits during the spring and summer of 1983. An additional 49 Clovis artifacts were found on the surface of the site. In

John L. Fagan, 300 N.E. 104th Avenue, Portland, OR 97220.

addition, gravers, scrapers, biface fragments, and prismatic blades were found associated with concentrations of fluted point fragments, flute flakes, and blanks which had been broken during fluting attempts.

The Clovis artifacts were situated on the floor and edge of the playa and were separated horizontally from similar concentrations of debitage and stemmed points which were slightly higher in elevation and extended from the playa edge up a small ridge which formed the western shore of a former pluvial lake. The horizontal distribution of these distinctive artifacts suggested that the playa had been a marsh or shallow lake during Clovis occupation and that the basin had filled by the time that people using stemmed points arrived. The Western Pluvial Lakes Tradition which is characterized by stemmed points dates between 8,000 and 10,000 yr B.P. in the region.

The information obtained during 1983 was incorporated into a grant proposal which was submitted to the National Science Foundation. The grant was awarded and paleoenvironmental and archaeological field work continued during 1984. Block excavations and backhoe trenches established the presence of stratified subsurface deposits which were rich in faunal remains and obsidian debitage. Since most of the artifacts and flakes were obsidian, trace element studies were conducted and a temperature probe was emplanted to determine the effective temperature needed for obsidian hydration dating.

During 1984, with support from the National Science Foundation, site mapping and controlled surface collection was continued in addition to block excavation and backhoe trenching. Obsidian sources within 100 km of the site were sampled and 100 artifacts were subjected to trace element analysis. At least five obsidian sources are represented at the site. The 1984 work resulted in the recovery of additional Clovis artifacts including points broken during use, points and blanks broken during manufacture, reworked points, and broken points which had been recycled into other tools.

During the summer of 1985, volunteers assisted with additional site mapping, recorded stratigraphy in backhoe trenches, and conducted controlled surface collections of additional Clovis and stemmed point concentrations. Laboratory analysis has included trace element studies of obsidian artifacts, establishment of an effective temperature rate for obsidian hydration dating, debitage analysis, technological analysis of Clovis and non-Clovis artifacts, replication studies of fluted and stemmed points, and residue analysis.

By the end of the 1985 field season, over 120 Clovis artifacts had been recovered from the site. A preliminary examination of 20 specimens for microscopic residues yielded evidence of blood, pollen, and sinew on the surfaces of the fluted points. In one case, a pollen grain was overlain by a filament of sinew near the base of a fluted point which had been broken in use.

The Clovis points examined so far show a wide range of flaking styles and size. Variation in workmanship from refined to crude suggests that individuals made their own points.

The fluted points which have been broken through use are characterized by heavy edge grinding of the basal and lateral edges, and have scratches in the flute scars. The scratches which are parallel to the flutes are interpreted as hafting modifications suggesting that glue or mastic was used to secure the point to the shaft.

Work at the site and in the laboratory continues, with an emphasis on dating, analysis of excavated specimens, identification of residues, recognition of activity areas, determination of technological relationships between stemmed and fluted points, analysis of faunal remains, and paleoenvironmental reconstruction of local conditions for each period of occupation.

Geoarchaeological Investigations at Nipper Creek, Richland County, South Carolina

Albert C. Goodyear, Donald J. Colquhoun, Ruth Y. Wetmore, and Patricia A. Cridlebaugh

The Nipper Creek site (38RD18) is a stratified, multicomponent site exhibiting diagnostic artifacts from the Paleoindian through Woodland periods. In the fall of 1985, archaeological testing and geological studies were done, indicating that the site possesses an intricate stratigraphic record containing 11,000 years of prehistory within a meter of colluvium. The site is located 15 km northwest of Columbia near the juncture of Nipper Creek and the Broad River. Of the approximately 98 ha of the original site, 30 ha were stripped of sand in 1970 for commercial uses. Screening of this sand yielded hundreds of diagnostic Archaic artifacts. Thirty-two ha of the site remain in woods and old fields.

The Nipper Creek area lies within the Carolina Slate Belt of the Piedmont Province of South Carolina. Sediments occur in the hills adjacent to 38RD18 as sands and stringers of coarse gravels of uncertain age. Mapping (Colquhoun *et al.* 1983) indicates they are Miocene or possibly Pliocene river terrace sediments. The site occurs in clean porous sands above a large granite pluton which has invaded the Slate Belt rocks. Roadcuts and other exposures above the site show a thinning of the sand mantle proceeding upslope. Slow mass-wastage is responsible for burying artifacts continuously over approximately 11,000 years, a system still active today.

Subsurface testing included 51 20 cm bucket auger tests done in 15 cm levels placed over an area 200 x 700 m. These revealed the horizontal and vertical distributions of human occupations which are confined to the upper 100 cm of the colluvium. An area 2 x 4 m excavated in a protected wooded area produced excellent evidence of stratification based on lithic artifacts. The unit was dug in 10 cm levels and all recognized or suspected worked objects were mapped three-dimensionally.

Albert C. Goodyear, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia, SC 29208.

Donald J. Colquhoun, Department of Geology, University of South Carolina, Columbia, SC 29208.

Ruth Y. Wetmore, Department of Anthropology, University of South Carolina, Columbia, SC 29208.

Patricia A. Cridlebaugh, South Carolina Department of Archives and History, Columbia, SC 29211.

From the ground surface to 30 cm, only occasional flakes were found. At 45 cm, a densely deposited Savannah River Late Archaic (5,000-4,000 yr B.P.) midden was encountered. Consisting of hearths, firecracked rock, a perforated steatite disk, debitage, three Savannah River stemmed points, and one Otarre-like point, this deposit graded into a Late-Middle Archaic Guilford (6,000-5,000 yr B.P.) horizon at about 52 cm below surface. Six Guilford points were found between 52-62 cm. In the level of 60-70 cm, a stratigraphically discrete Middle Archaic Morrow Mountain (7,500-6,000 yr B.P.) horizon was discovered. Eleven Morrow Mountain stemmed points were plotted between 64 cm and 71 cm. Firecracked rock and debitage occurred abundantly from 40 cm to 70 cm. Beginning at 80 cm, and ranging to 89 cm, nine well-made unifacial tools appeared. Two side-notched Early Archaic (10,000-9,000 yr B.P.) points were found, one at 85 cm and the other at 86 cm. Below the notched points at 88 cm, a Dalton point was recovered, indicating an age of 10,500 to 10,000 yr B.P. (Goodyear 1982). Flakes of welded vitric tuff and quartz crystal, favored raw material for fluted points in the Carolinas, were found from 80 cm to 110 cm. The base of a fluted point was also found on the surface in the sand stripped area.

Charcoal, primarily burned hickory shells, was found in decreasing quantities in levels from 40 cm to 90 cm. Four radiocarbon dates were obtained: 40-50 cm, 4,150±70 yr B.P. (Beta-14846); 50-60 cm, 4,190±90 yr B.P. (Beta-14847); 60-70 cm, 4,710±60 yr B.P. (Beta-14848); and 70-80 cm, 5,520±150 yr B.P. (Beta-14849). An accelerator radiocarbon date is now being run on charcoal taken from the 80-90 cm level containing the notched points and the Dalton. Charcoal was taken from throughout the 10 cm levels to attain datable amounts. The dates 4,150 and 4,190 on the Late Archaic midden seem correct. The lower two dates are too late given the tight artifact stratigraphy and the well-dated ages recorded for these horizons elsewhere in the Southeast.

In the field, no depositional structures were apparent in the profiles. A plowed A horizon extending to 30 cm was present, related to the historic period. The profile face consisted of fine- to medium-grained, slightly (trace) clayey sand from the surface to below 2 m. A continuous soil peel (using a mixture of glyptol and acetone) was taken to a depth of 2.2 m, a full meter below the earliest human occupation (110 cm). Faint structural bands indicated by subtle changes in color and minor changes in silt-clay content were observed on the peel between 43-48 and 53-92 cm. At all other depths the sand appeared homogeneous or massive. The bands varied in sequences from a few mm to 2 cm in width and were parallel to ground surface. Textural analyses were done in 5 cm intervals and subsequently refined according to deviations from the norm. The clearest pattern was the association of increased silt and clay with human occupation. Above 40 cm and below 90 cm to at least 205 cm, silt and clay remained below 5%. Also, coefficients of sorting (>1.2) and skewing (<1.0) stratigraphically coincide with zones of greater than normal (>5%) clay and silt.

Because of the clear artifact stratigraphy, the primary colluvial depositional system, and the presence of charcoal, the site offers great potential for refining early Holocene prehistory in the Carolinas through geoarchaeological strategies. The Early Man (11,000-9,000 yr B.P.) occupation is technologically prominent and well buried. The late Quaternary pollen site of White Pond (Watts

1980) lies 30 km northeast of Nipper Creek providing a continuous record of floristic and climatic change for the last 20,000 years. Preliminary work suggests that changes in sedimentation rates at Nipper Creek may be correlated with major vegetation changes recorded at White Pond. More work focusing on sedimentation rates, site formation processes, and lithic assemblage definition is planned.

This research was funded by a U.S. Department of Interior Survey and Planning Grant with matching funds supplied by the South Carolina Institute of Archaeology and Anthropology, University of South Carolina, administered by the South Carolina Department of Archives and History.

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The 1949 Bone Bed from the Carbonaceous Unit at Blackwater Draw Locality #1

Eileen Johnson

During a 20-year period (1936-1956), the University of Texas Bureau of Economic Geology and Texas Memorial Museum (TMM) sponsored periodic field work on late Quaternary deposits of the Southern High Plains in part as a quest to improve the record of Early Man in the New World. The sites involved in that program formed much of the basis for the now classic or historical view of Paleoindian lifeways (Sellards 1952; Sellards and Evans 1962; Wormington 1957). Blackwater Draw Locality #1 (BWD#1) was one of the sites involved in that quest.

A reinvestigation of the TMM BWD#1 collection has concentrated initially on the material generated during the 1949 TMM field work under the direction of Glen L. Evans. The currernt focus is on materials recovered from a bone bed in the Carbonaceous unit (Stratum 5, Sellards 1952; Unit E, Haynes 1975). The *Bison antiquus* (bison) bone bed was undated but the deposits are considered to

Eileen Johnson, The Museum, Texas Tech University, Lubbock, TX 79409.

have a general age range of 10,000 to 8,000 yr B.P. (Haynes 1975; Holliday 1985). The variety of projectile points recovered from the bone bed formed the basis for Sellards' (1952) Portales Complex.

The Carbonaceous unit is discontinuous at BWD#1 due to erosion. Where it does occur, it is an organic-rich lacustrine deposit representing an aggrading marsh (Haynes 1975; Holliday 1985). The Carbonaceous unit in the stratigraphic section exposed in the 1949 work exhibited erosional surfaces at the top and bottom. The bone bed was over 15 m in extent and between ca. 15-46 cm thick. Neither separation nor layering could be distinguished in the bone bed as the bones were jumbled and the deposit appeared trampled upon. The bones were in very poor condition (Glen L. Evans, pers. comm. 1985). Where bone could be recovered, small sections of the bone bed were removed in blocks. The five extant blocks contain not only the best preserved bone but what data there are on the bone bed itself. Other selected elements were brought back to TMM, so that the assemblage is a highly biased one. The occurrence of occasional articulated units of vertebrae, or ribs, or lower legs were noted in the field (Glen L. Evans, pers. comm. 1985) but the bone blocks show disarticulated and disassociated elements. Data from the assemblage indicate a minimum of three individuals (adult and subadult) that represent both sexes.

Carnivore damage is lacking and none of the elements from the extant assemblage are marrow-processed. Although trampling marks (Fiorillo 1984) have not been confirmed on the elements, the thickness of bone deposit is evident in two of the bone blocks. Furthermore, at least two episodes of surface weathering are evident on the elements which indicates that the bone bed represents more than one event and underscores the original field observation (Glen L. Evans, pers. comm. 1985) of an accumulation of bones from several events rather than a single event. Where recorded, the lithic tools and points have a depth range of from 5 to 23 cm below the top of the Carbonaceous unit. Although that eroded surface undulates, it generally parallels the bone bed.

Hester (1972) noted that this bone bed was the largest recorded for BWD#1. It would seem, however, that small kills were involved and that they were the common occurrence at the site. Sellards (1952) considered the Portales Complex to represent a new culture on the Southern High Plains with affinities to the Northern Plains based on the occurrence of Eden and Scottsbluff designs yet continued affinity to the Southern High Plains with the presence of a Plainview like design. Wheat (1972) reexamined the projectile points and concluded that most were resharpened variants of the Firstview design which had a long time span. However, because of the jumbling, the primary association is gone and the artifact assemblage may be mixed. Therefore, the Portales Complex does not appear to form a homogeneous unit nor have integrity, as it would not be a discrete unit from a single event. In light of the questions raised by the nature of the bone bed, the validity and usefulness of Portales Complex needs to be reexamined. If indeed the bone bed is a multiple event and underwent trampling, those circumstances could explain the variety of projectile points (albeit all were resharpened) and, more importantly, the apparent time spread of the assemblage and the confusion concerning the late Paleoindian sequence at BWD#1 (Wheat 1972).

The author would like to thank Glen L. Evans (Austin, Texas) for sharing his BWD# 1 data and his wealth of knowledge on late Quaternary deposits and archaeology and for his support; Dr. William Reeder, Director of Texas Memorial Museum, and his staff for access to the BWD# 1 collection; and Dr. Ernest L. Lundelius Jr. (University of Texas, Austin) for his interest and help. This investigation was funded by The Museum, Texas Tech University.

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The Milnesand and Ted Williamson Paleoindian Sites, East-Central New Mexico

Eileen Johnson, Vance T. Holliday, James Warnica, and Ted Williamson

Milnesand is a Paleoindian bison kill site on the Southern High Plains of eastern New Mexico (Sellards 1955; Warnica and Williamson 1968). The Ted Williamson site (Sellards n.d.), also a Paleoindian bison kill, is strikingly similar to and located within several hundred meters of Milnesand. Both sites are in an unnamed east-west trending dune field and within several hundred meters of Sulphur Draw (mostly obscured by Holocene sand dunes). Wind deflation during the 1950s had exposed the sites and subsequently destroyed most of the known extent of the bone beds. Sand dunes adjacent to each bone bed area were augured but did not reveal any intact bone deposits. Milnesand is the type site for the Milnesand point, an undated Paleoindian design. Around 100 projectile points come from this site. The vast majority fit the Milnesand type

Eileen Johnson, The Museum, Texas Tech University, Lubbock, TX 79409.

Vance T. Holliday, Departments of Geography and Anthropology, Texas A & M University, College Station, TX 77843.

James Warnica, P.O. Box 525, Portales, NM 88130.

Ted Williamson, General Delivery, Milnesand, NM 88125.

but a few are Plainview (Wheat 1972; Knudson 1983). Ted Williamson is an undated Plainview site. Over 130 projectile points were located in and around the bone bed and are Plainview in design. A Milnesand point was excavated from an adjacent apparent camping area.

The stratigraphy of the two sites is quite similar. The bone beds at each site did not seem to be associated with any discrete, clearly identifiable zone. The bone rested on top of a reddish (5YR hues), sandy clay loam with considerable illuvial clay (the "Reddish Brown sand" of Sellards 1955). A sandy clay with more olive hues commonly is located within a few to several tens of centimeters below the surface of the sandy clay loam. Below both these zones is a calcic horizon (pedogenic accumulation of $CaCO_3$; the "Caliche" of Sellards 1955). The calcic horizon and sandy clay loam are part of a late Pleistocene soil profile in the local equivalent of the upper Blackwater Draw Formation (Pleistocene) which mantles much of the Southern High Plains (Gustavson and Holliday 1985). The zone of olive hues represents local reduction or gleying of the Blackwater Draw Formation following pedogenesis. This condition suggests that a high water table was present in the region for some time in the late Pleistocene, probably feeding Sulphur Draw and supporting abundant plant growth. This situation may have attracted bison into the area at the time of the kills. However, neither marsh sediments nor zones of organic matter accumulation are at either site and other evidence for the age of the high water table is lacking.

The bone beds were buried by dune sands (the "Yellow Sand" of Sellards 1955). At least some of the sand probably accumulated shortly after the kills, otherwise the bone probably would have been destroyed by weathering. This initial burial indicates early Holocene eolian activity which also is seen at Lubbock Lake prior to 9,000 yr B.P. (Holliday 1985). Judging from the stratified nature of and weak soil development in the dunes, the sand accumulated episodically throughout the Holocene.

A few individual bison (*Bison antiquus*) elements were retained from each site and five display blocks taken from Milnesand (Sellards 1955). This small, admittedly skewed, sample and Sellards' notes (TMM files) indicate a probable widespread bone disposal pattern that appears characteristic of large-scale Southern Plains bison kills as opposed to the bone stacking pattern seen for small-scale kills (e.g., Johnson and Holliday 1980). Elements are disarticulated and disassociated but not marrow-processed. Cut marks were not observed but carnivore and marked rodent gnawing are evident on a few elements from the sites.

Although morphologically different, the production technology is the same for Plainview, Milnesand, and an unnamed design from Lubbock Lake (Johnson and Holliday 1984). The three designs appear as variations on the same theme, a primary difference being base shape which appears to be related to the hafting system (Knudson 1983; pers. comm.). Plainview and the unnamed design from Lubbock Lake are contemporaneous (ca. 10,000 yr B.P.) at Lubbock Lake (Johnson and Holliday 1980, 1984, 1985). The data from Milnesand and Ted Williamson suggest that the Plainview and Milnesand designs are contemporaneous. Therefore, it is proposed that these three designs are point design alternatives within the Plainview culture.

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The Paleoindian Occupation of the Central Muskingum River Basin, Coshocton County, Ohio

Bradley T. Lepper

Coshocton County long has been recognized as a major center of Paleoindian activity (Prufer 1971). The quarries of Upper Mercer chert in this area often are claimed to be the source of raw material for Paleoindian artifacts strewn across the entire northeast. The widespread use of this material by Paleoindians has led some scholars to the conclusion that these people were exceedingly wide ranging and mobile. Alternatively, Gardner (1977) has proposed that Paleoindians had a much more restricted range centered upon particular outcrops of high quality cryptocrystalline materials. Meltzer (1985) has reconciled these views with the recognition that the two models represent two distinct adjustments to different environments. Large ranges coupled with the extensive use of non-local raw materials characterized the Paleoindian settlement pattern in the

Bradley T. Lepper, Department of Anthropology, The Ohio State University, Columbus, OH 43210-1324.

glaciated portion of eastern North America; in unglaciated areas ranges were more restricted and tethered to locally available high quality raw materials.

Coshocton County is located in the unglaciated Appalachian Plateau within the reentrant angle in the Ohio glacial boundary. It is approximately 8 km south of the terminal moraine of the Killbuck lobe and 16 km east of the Wisconsin ice margin of the Scioto lobe. This proximity to the ice margin and the abundance of Paleoindian remains documented from this area afford the opportunity to examine the applicability of the various models of Paleoindian settlement to this transition zone.

From 1983 to 1985 data on fluted projectile point occurrences within Coshocton County were obtained from private and public collections. This survey recorded 354 fluted points from 67 localities within the county. Most of these points were surface finds from multicomponent sites. Therefore, it was not possible to establish associations between the diagnostic fluted points and other types of artifacts. In order to use these data for understanding settlement patterns, a typology was developed for describing isolated or clustered fluted point occurrences in terms of hunter-gatherer land use.

Three general types of "settlement" were defined which are presumed to reflect the distinction between extraction and maintenance activities proposed by Binford and Binford (1969):

Chert processing loci: clusters or isolated occurrences of unfinished fluted points or points broken-in-manufacture;

Food procurement/processing loci: clusters or isolated occurrences of points broken-in-use or points exhibiting traces of use-wear;
Workshop/occupations: clusters of unfinished fluted points or points broken-in-manufacture with points broken-in-use or points exhibiting traces of use-wear.

Preliminary results suggest that these localities articulate in a pattern very similar to the Flint Run model proposed by Gardner (1977). Raw materials represented in the Coshocton sample are almost exclusively local Upper Mercer chert and the large workshop/occupations tend to be associated with chert outcrops and intermediate chert-processing loci. Food procurement/processing loci are dispersed widely throughout the diverse ecological contexts of the Appalachian Plateau. Following Meltzer's (1985) arguments, these results imply that the Paleoindian occupation of east-central Ohio was not directed to the exploitation of low diversity parkland environments. The paleoecological interpretations of Taggart and Cross (1983) and Adovasio *et al.* (1984) offer independent support of this conclusion. The scattered finds of Upper Mercer chert artifacts in Paleoindian contexts from Wisconsin to New York may reflect a gradual northward dispersion of populations through Ohio rather than the range limits of highly mobile big game hunters.

This study would not have been possible without the contributions of data from Dr. O.H. Prufer, Department of Anthropology, Kent State University, Dr. N.L. Wright, Coshocton, Ohio, and numerous other individuals. The analysis benefitted greatly from the technical advice and support of Mr. S.M. Carter, Department of Computer and Information Science, Ohio State University.

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Paleoindian Site Density Within Bradford County, Pennsylvania

Richard J. McCracken

Since 1979 the author has been conducting an intensive cultural resource survey of a 32 km segment of the Sugar Creek Valley in Bradford County, Pennsylvania. Purpose of the survey is to determine the archaeological potential and establish a cultural inventory outline of secondary stream valleys within this section of the glaciated Allegheny Plateau, and to compare artifact inventories evidenced in these valleys with those of the primary drainage, the Susquehanna River. A secondary purpose is to attempt to outline settlement and, to a lesser degree, subsistence patterns for these valleys.

Previous desultory surveys of the region have all dealt with the major river valley; very little data are available from the Susquehanna's convergent secondary streams. Prior to undertaking this study, it was postulated that the prehistoric occupational inventory of the smaller stream valleys would provide data considerably different from that of the main river valley.

While the survey is not yet complete, one unexpected result has been the discovery of six Paleoindian sites in the Sugar Creek Valley, with a seventh site located on the Susquehanna River, 1 km south of the mouth of Sugar Creek. One of these sites, Trojan (36BR149), is believed to be a multi-occupation locus of nearly pure Paleoindian provenience. Twenty-three lithic artifacts, including five fluted projectile points, have thus far been recovered from the surface of this site. Additional recovered artifacts include: six beveled end scrapers, five with one or more graving spurs; one multi-purpose scraper with graving spur; three prismatic blades; one knife/sidescraper; one discoidal biface with three graving spurs; one saw-toothed wedge; one biface knife, a stage two preform; one exhausted core used as a scraper; one flake/scraper, possibly with two graving spurs; one drill; and one utilized flake. A comprehensive preliminary

Richard J. McCracken, R.D. #1, Box 93, Rome, PA 18837.

report on the Trojan site has been prepared (McCracken n.d.). The five additional sites on Sugar Creek appear to be multicomponent.

Sources of bedded cryptocrystalline quartzes are not locally available. The primary source of lithic materials used by most cultures represented in the Bradford County lithic tool inventory is glacially transported drifts and tills; therefore, exotic lithics, as well as tool form, are often diagnostic of early occupation. At the Trojan site, 35% of all recovered artifacts are made of imported materials. The near-total absence of remnant cortex on finished artifacts, and the total absence of decortication flakes among debitage, indicate the possibility of 100% import of either materials or finished tools.

Use of exotic lithic materials by Bradford County Paleoindians is significant in the study of band mobility and mobile range. At the Trojan site, at least 7 lithic sources are represented: Eastern Onondaga chert, probably from an area in the general vicinity of Syracuse, NY; Western Onondaga chert, of the Diver's Lake variety; Upper Mercer flint and Coshocton chalcedony from southeastern OH; yellow jasper, most likely from the Berks/Lehigh County areas of southeastern PA; Bald Eagle jasper from the Houserville Formation, Centre County, PA; and Gunflint Formation taconite, probably glacially transported from its original source near the Thunder Bay area of Ontario's Lake Superior region. These same materials were used in the production of diagnostic artifacts from the other Paleoindian sites within the Sugar Creek Valley and are the most common materials used in tool production at all Paleoindian loci in this area. Based on probable lithic sources observed at Trojan, a mobility range of 800 km is suggested for the Paleoindians who occupied Bradford County.

Prior to the initiation of this survey, two fluted projectile point find locations had been reported from within the county. The Sugar Creek Valley survey has resulted in the identification of 15 Paleoindian sites now inventoried within this political subdivision, a total consistent with the number of sites reported for counties located in the western Pennsylvania survey conducted by Lantz (1984). Additional similarities to Lantz's findings include: location of Paleoindian sites at or near the confluence of first and second order streams with a larger stream; location of sites within 9.15 m elevation of present water sources; an absence of sites in upland settings; and a preference for well-drained glacially deposited benches.

Also of interest is the apparent absence of parallel findings from the other two major secondary stream valleys within Bradford County. Most of the information derived from the Sugar Creek Valley survey has come about as the result of collector interview and the observation of their collections. Collections from the other two major valleys do not show nearly as much apparent evidence of Paleoindian utilization as does Sugar Creek, an indication that any predictive model established for one secondary valley may not be valid for an adjacent system.

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Late Pleistocene-Early Holocene Land-Use Patterns at Robbins Swamp, Southwestern New England, USA: 1983-1985 Field Season Results

George P. Nicholas

Systematic survey and testing of late Pleistocene-early Holocene landforms (14,000-7,000 yr B.P.) associated with a glacial lake/wetland system in northwestern Connecticut has revealed an extensive record of Paleoindian and early Archaic occupation. Research emphasis has been directed not only to locating sites, but to identifying the behaviors represented by local land-use patterns of this period to better define early social, settlement, and subsistence systems (e.g., generalist vs. specialist economies). Early site-directed field work was begun in Robbins Swamp in 1983, under the supervision of the writer, as part of the Robbins Swamp Project (Russell G. Handsman [AIAI]: Director), and is expected to continue for several more years. In addition to archaeological field investigation, a program of geological mapping and wetland coring is providing additional resolution in paleoenvironmental reconstructions.

The research design is focused by the glacial lake mosaic model (Nicholas 1982, 1983; see also Curran and Dincauze 1977) to plot the distribution of archaeological sites across specific parts of the landscape. The model postulates that extremely rich biotic mosaics existed within many of the glacial lake basins which are present across much of the northeastern United States. Following initial drainage of these lakes, usually by the end of the Pleistocene, basin composition would generally have been characterized by lowered lake levels, ponds, wetlands, and an emerging riverine system, each supporting a variety of biotic communities. The levels of resource productivity, diversity, and reliability associated with these basin mosaics is expected to have been significantly higher than those of non-mosaic landscapes throughout much of the early postglacial period, which would serve as one focus for early settlement/subsistence systems. A strong correlation between lake basin and Paleoindian site is indicated by this model, although the greatest contrast in mosaic/non-mosaic resource productivity would not occur until the early Holocene (Nicholas 1986). Such an association is revealed in site distribution data from across a broad area of New England; e.g., a comprehensive study of the distribution of Paleoindian and early Archaic sites in New Hampshire indicates a very strong correlation between glacial lake basins and early sites (Nicholas 1983).

To date, over 40 Paleoindian and early Archaic sites have been positively or tentatively identified in Robbins Swamp on the basis of bifacially and unifacially fluted points, gravers, scrapers, *pièces esquillés,* and by Hardaway Side-notched, Bifurcate-based, and Kirk/Palmer projectile points, and other diagnostic tool types. Site/landform associations are diverse and include lake shorelines, wetland margins, upper river terraces, and upland areas. Both large, multiple early

George P. Nicholas, University of Massachusetts, Amherst, MA 01003 and American Indian Archaeological Institute, Box 260, Washington, D.C. 06793.

component sites and small, apparently single component sites have been identified and tested. The "background noise" produced by the hundreds of middle and late Holocene-aged sites in the area has complicated early site work; in several cases, late components are intrusive into Paleoindian and early Archaic sites.

The emphasis on explanatory, paleoenvironmentally-based models to direct field work, and on field methods sensitive to the fragmentary nature of the early postglacial archaeological record, is, to a very large degree, responsible for the success of this project. Site preservation has been maintained by the absence of extensive alluviation or down-cutting in most of the 150 km^2 study area. Additional site survey and excavation is planned to provide additional resolution in interpreting Paleoindian and early Archaic land-use patterns. Analysis of lithic artifacts, macrofossils, excavation records, and other data sources is currently underway. Intensive studies on early postglacial local land-use patterns from other regions at the local scale will do much for the interpretation of the regional archaeological record.

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A Late Pleistocene and Holocene Archaeological Sequence in Central Maine

James B. Petersen

Recent archaeological investigations at two multicomponent stratified sites in Milo, Piscataquis County, Maine, are of great potential significance in light of the incomplete knowledge of late Pleistocene and early Holocene human lifeways in northeastern North America. The Brigham site (ME 90-2C), as the more intensively studied of the two sites is known, preserves a 2 m deep sequence of human occupation in 11 natural strata (Figure 1), with an underlying three strata to a total depth of over 3 m. These strata span the late Pleistocene and entire Holocene epochs, before and after ca. 10,300 yr B.P. as known from six available radiocarbon dates. The other site, known as the B&A

James B. Petersen, Department of Social Sciences and Business, University of Maine, Farmington, ME 04938.

Derby site (ME 90-2B), is located near the Brigham site at the confluence of the Sebec and Piscataquis rivers. The Derby site preserves a near 2 m deep sequence of 10 natural strata, of which at least 7 contain cultural remains; no radiocarbon dates are yet available for the Derby site. These and over 70 other archaeological sites fall within the study area of the Piscataquis Archaeological Project (PAP), a long-term research endeavor based upon the cooperation of amateur and professional archaeologists (e.g., Cook and Spiess 1981; Doyle *et al.* 1985; Hamilton *et al.* 1984; Spiess *et al.* 1984).

The Brigham site was brought to the attention of the archaeological community when the landowner demonstrated the presence of deep strata after excavation of a small test pit; the Maine Historic Preservation Commission (MHPC) subsequently supported the cost of a single radiocarbon date from the deepest cultural deposit (10,290±460 yr B.P., Beta-7183, on stratum II). This date and the clear stratigraphy led to a MHPC survey grant to the University of Maine at Farmington (UMF), in part to initiate test excavation at the Brigham

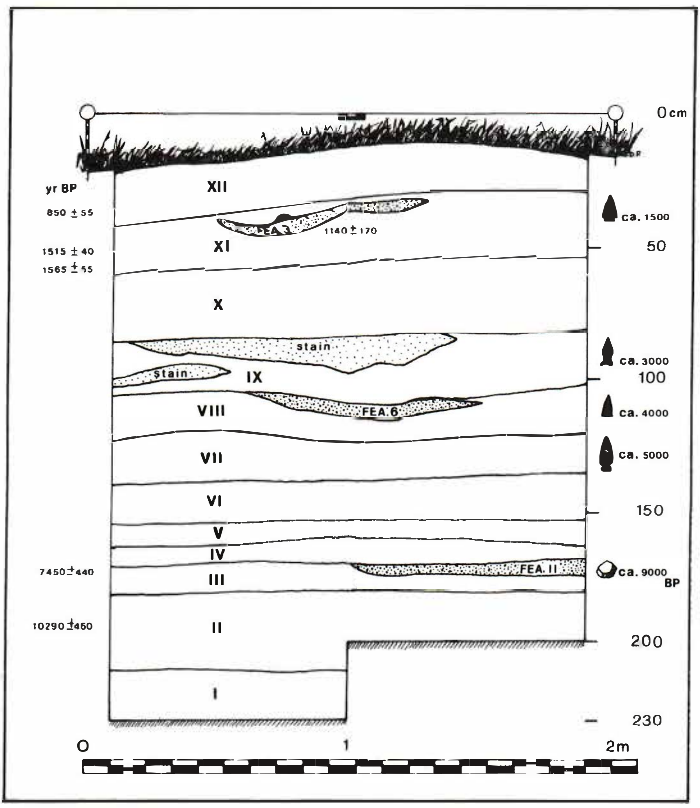

Figure 1. Excavation profile at the Brigham site (ME 90-2C), with composite dates and diagnostic artifacts in their respective strata.

site. Using a trained volunteer crew, 14 days were spent in the excavation of two 2 m X 2 m test units in September, 1984. In 1985, two additional 2 m X 2 m units and one 1 m X 2 m control unit for geological analysis were excavated, in 20 days, to sterile depths at the Brigham site by a UMF field school and over 20 trained volunteers. A single 2 m X 2 m unit was also excavated at the Derby site in 1985 to verify the presence of deep stratigraphy there too. The 1985 work at both sites, in conjunction with broad scale regional survey, was again supported by the MHPC. To date, a combined area of 18 m^2 (out of an estimated total area of 750 m^2) and a volume of 37 m^3 have been removed at the Brigham site using a systematic technique (e.g., Petersen, Wolford, Hamilton, LaBar, and Heckeberger 1985); an area of 4 m^2 and a volume of 8 m^3 have been likewise removed at the Derby site (Petersen, Hamilton, Spiess, and Stuckenrath 1985; Petersen, Hamilton, Spiess, Stuckenrath, and Brigham 1985).

A total of 14 natural strata have been defined at the Brigham site, labeled in ascending order from the uppermost late Pleistocene deposit (Thayer *et al.* 1985). Of these, in situ cultural remains were present in at least 11 strata, which vary in thickness from 2 to 45 cm and often show incipient paleosol formation. Additional radiocarbon dates for the Brigham site have been provided by the Radiation Biology Laboratory of the Smithsonian Institution (7,450±440 yr B.P., SI-6690, on stratum III; 1,565±55 yr B.P., SI-6691, 1,515±40 yr B.P., SI-6687, and 1,140±120 yr B.P., SI-6693, all on stratum XI; 850±55 yr B.P., SI-6692, on the XI/XII interface). Additional data on stratigraphy and dates for the Brigham, Derby, and other sites are expected.

Cultural remains at the Brigham and Derby sites reflect numerous and repeated human usage of the area. Calcined faunal remains and occasional floral materials are present throughout the human sequence at Brigham and on a preliminary basis indicate broad spectrum usage, including that of anadromous fish, almost from the earliest occupations onward. A later emphasis on a more restricted resource base, particularly beaver, seems evident in the late prehistoric occupations (Spiess 1985). Wood charcoal reveals the early presence of oak (*Quercus* sp.) along with various conifers and birch (*Betula* sp.) in strata II and III, and a later presence of additional hardwoods, including hickory (*Carya* sp.) in stratum VIII; the latter species is rare in the modern local forest. Phytoliths and less frequent pollen also indicate the long-term presence of a mixed conifer and hardwood forest (Pinello 1985).

To date, diagnostic projectile points are known for only four of the six uppermost strata at the Brigham site (Figure 1), but at both Brigham and Derby the earliest documented tools include steeply retouched unifaces and fragments of various groundstone forms. Future research will seek to refine the cultural chronology and the industrial, subsistence, and settlement systems using these and other sites within the PAP study area. Expected data should provide a relatively unique opportunity to test hypotheses about prehistoric cultural systems in this intermediate area between the seaboard lowlands and interior uplands of northeastern North America.

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Late Paleoindian Remains from Maine

James B. Petersen, Nathan D. Hamilton, Richard A. Doyle, and David Sanger

Recent archaeological surveys and collections analyses across Maine have led to the identification of 11 sites attributable to the late Paleoindian period. The late Paleoindian period remains inadequately understood across the broad span of northeastern North America despite the steady accumulation of information about the Paleoindian period in general (Gramly 1982). At present our research has focused on understanding the context and distribution of site locations, the associated cultural remains, regional paleoenvironmental conditions, and temporal placement of the sites and remains (Doyle *et al.* 1985; Hamilton *et al.* 1984).

James B. Petersen, Department of Social Science and Business, University of Maine at Farmington, Farmington, ME 04938.

Nathan D. Hamilton and Richard A. Doyle, Department of Geography/Anthropology, University of Southern Maine, Gorham, ME 04038.

David Sanger, Department of Anthropology and Institute for Quaternary Studies, University of Maine at Orono, Orono, ME 04469.

The known sites include both riverine and lacustrine locations in the Appalachian interior uplands and seaboard lowlands, but do not include any coastal locations at present (Spiess *et al.* 1983). Several sites in the Sebago Lake region of southwestern Maine are situated in topographical settings that underwent a marine transgression at the end of the Pleistocene (ca. 13,800-11,000 yr B.P.) (Crossen 1983; Yesner *et al.* 1983), others are located along the margin of the seaboard lowlands and uplands and still others lie within the uplands (Doyle *et al.* 1985). One specimen was recovered at the Vail Kill site 1, a classic Paleoindian site in northwestern Maine and helps confirm a suspected relationship between sites and "strategic" resource intercept locations.

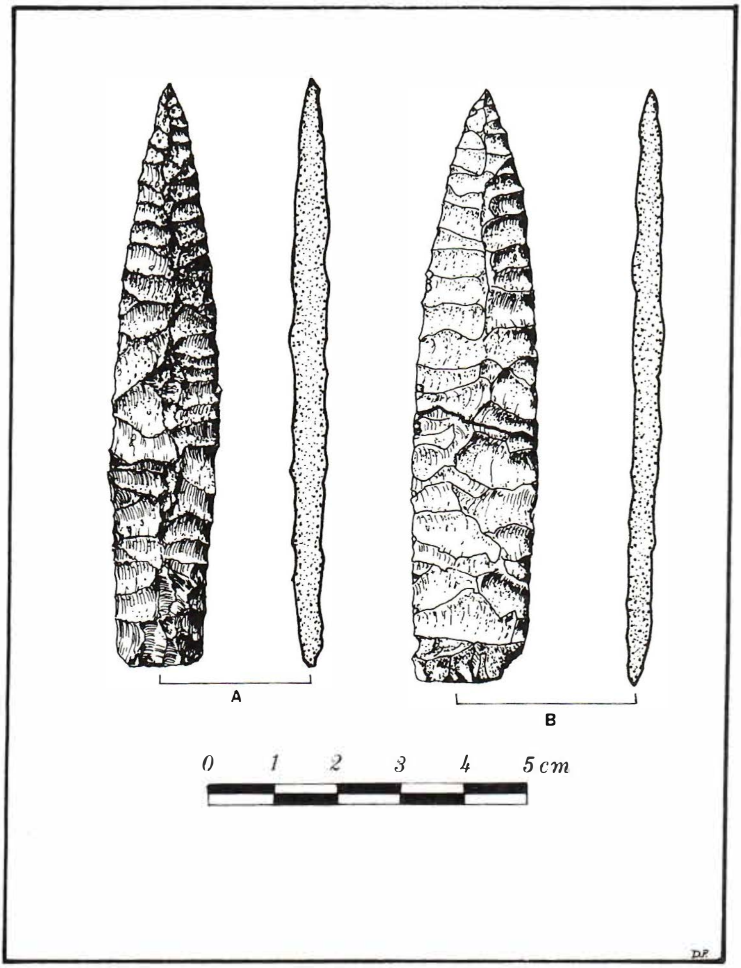

Figure 1. Parallel lancolate projectile point: a) Brassua-Moose River site; b) West Grand Lake site.

The paleoenvironmental conditions suggest that this portion of the Northeast was well on the way to postglacial recovery by 10,000 yr B.P. (Davis and Jacobson 1985). The area was fully deglaciated and a boreal vegetation generally well established. We cannot assume modern conditions, however, in drainage pattern development, in sea levels, or in vegetative cover. Although several sites reflect modern drainage and lake levels, areas in northern Maine suggest a retarded evolution. Detailed local reconstructions are necessary to understand the distribution of people and their culture in the Northeast. As best currently understood, the vegetation between 10,000 yr B.P. and 8,000 yr B.P. was undergoing a transition as species continued to colonize from the south and west (Davis and Jacobson 1985). The vegetation was clearly not an exclusive tundra or steppe biome at the time of the late Paleoindian period and was likely patchy or heterogenous in nature.

The associated cultural remains are defined on the basis of diagnostic lithic artifacts, primarily lancolate parallel-flaked projectile points (Figure 1) and other related forms, notably small triangular concave base points (Keenlyside 1985a, 1985b). Although we currently lack radiocarbon dates on these sites, the cultural remains can be related to other material known throughout the Northeast for the late Paleoindian period, ca. 10,000 yr B.P. to 8,000 yr B.P. The recovered materials lead to tentative recognition of a distinctive, but inadequately understood, northeastern late Paleoindian manifestation centered on the Great Lakes-St. Lawrence drainage. We postulate that these late Paleoindian populations, at least in the Maine study area, were hunter-gatherers who depended to some degree on the exploitation of gregarious game animals and a mix of other resources. This reconstruction is based on our understanding of earlier Paleoindian subsistence patterns, paleoenvironmental conditions, particular site settings in our sample, and other settings in the broad Northeast.

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The Late Quaternary Hiscock Site, Genesee County, New York: Progress Report

David W. Steadman, Richard S. Laub, and Norton G. Miller

The Hiscock site, located in Genesee County, New York, 15 km northeast of Batavia, is a small, shallow, seasonally inundated peatland and associated springhead that is bordered on three sides by a cultivated field. Holocene peat and underlying inorganic sediments of latest Pleistocene age have yielded abundant, stratigraphically associated plant and animal fossils. These provide an opportunity to trace the development of late Quaternary biotic communities in a region that was covered by glacial ice or glacial lake waters until approximately 12,500 yr B.P.

The Hiscock site was first reported by Heubusch (1959) who briefly noted the remains of mastodont (*Mammut americanum*), elk (*Cervus canadensis*), and deer (*Odocoileus virginianus*) in a "swamp" deposit. The only radiocarbon age for the site is 10,450±400 yr B.P. on wood associated with the mastodont (Ives *et al.* 1964). Following a second exploratory dig in 1982 by R.M. Gramly (Buffalo Museum of Science), one of us (RSL) excavated there in 1983-1984, yielding a variety of plant and animal remains. In 1985, RSL and DWS worked at the site for 15 days, obtaining a large collection of plant macrofossils, zoological specimens (insects, mollusks, and vertebrates), and cultural remains (a Clovis-type fluted point and a bifacial flint knife or scraper). Brief visits to the site were made in 1985 by R.M. Gramly and NGM, the former to examine the lithic artifacts and the latter to obtain a pollen record.

The Hiscock site consists of two well-defined, major stratigraphic units: a lower unit of reworked glacial deposits with various combinations of rounded pebbles, cobbles, and boulders in a matrix of sandy, silty clay with woody plant fragments; and an overlying woody peat with localized sandy pockets. Spring action seems to be evident in both major units, as seen by the horizontal variation in sediment particle size, especially the occurrence of sandy pockets or "pipes" that indicate the intermittent vertical movement of water. Where the sandy pockets are absent, sedimentation appears to have been continuous. This obvservation is being evaluated by pollen analysis.

The Clovis point was recovered in situ at the interface of the two major units, resting just above a cobble of the reworked glacial debris, and associated with pieces of wood and elk bones. The flint knife or scraper was collected in situ in a different quadrat within the sandy clay of the lower unit, about 20 cm above mastodont bones from the same unit.

Most of the several thousand bones from the Hiscock site have not been studied in detail. Nevertheless, the taxa identified thus far include many new

David W. Steadman, Biological Survey, New York State Museum, The State Education Department, Albany, NY 12230.

Richard S. Laub, Buffalo Museum of Science, Humboldt Parkway, Buffalo, NY 14211.

Norton G. Miller, Biological Survey, New York State Museum, The State Education Department, Albany, NY 12230.

records for the late Pleistocene-early Holocene of New York state. Twenty-two taxa of vertebrates have been identified, including amphibians, reptiles, birds (both bones and feathers), and mammals. Other taxa may be anticipated once the entire collection is prepared and studied. Several species of vertebrates from the site are either extinct (mastodont, passenger pigeon—*Ectopistes migratorius*) or are regionally extirpated (caribou—*Rangifer* sp., elk, raven—*Corvus corax*). The most unexpected finds are the humerus and coracoid of the "California" condor (*Gymnogyps californianus*), a large scavenger confined in historic times to western North America. The condor fossils are from the lower unit, thereby apparently indicating that *Gymnogyps* was able to live in a forest or parkland of spruce and jack pine, an environment quite different from that previously associated with this species, whose nearest Quaternary records are from Florida and Texas (Lundelius *et al.* 1983).

Cones of several conifers and fruits of two deciduous forest tree species are present in the sediments. Cones of *Larix laricina* (tamarack) and *Picea glauca* (white spruce) are abundant in the lower unit, where cones of *Pinus banksiana* (jack pine) and *P. strobus* (white pine) are also present. Nuts of *Carya* sp. (hickory) and *Fagus grandifolia* (beech) occur in the overlying peats. Radiocarbon dating of these macrofossils will produce evidence independent of the pollen record for the presence of vegetationally significant species of trees in northwestern New York.

Less than 1% of the area of the Hiscock site has been excavated thus far. An expanded field program is planned for 1986 and beyond. We plan to date the site much more thoroughly, so that the artifacts, fauna, pollen record, and plant macrofossils can be placed in a chronological framework that portrays the changing communities. The entire stratigraphic sequence is fossiliferous, although we do not yet know the upper or lower age limits of the two major units, nor do we know if there are any significant hiatuses within or between the two major units.

We gratefully acknowledge the cooperation and enthusiasm of Charles and Charlotte Hiscock, who allowed us to work on their property. We also thank the many persons who have volunteered their labor or other resources. The George G. and Elizabeth G. Smith Foundation, Inc. of Buffalo has most generously funded a large portion of the field and laboratory studies. This preliminary note is published in part as contribution number 486 of the New York State Science Service.

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The Sycamore Site 1985: an Update

Harry J. Tucci

The Sycamore site, 36BK571, located in Union Township, Berks County, Pennsylvania was first reported last year (Tucci 1985). This paper will serve as an update of that project, focusing on the 1985 field season.

36BK571 is an upland Paleoindian site located in the Schuylkill River Valley of southeastern Pennsylvania. The 1985 work consisted of 20 2 m squares. These squares were excavated to a depth of 100 cm below surface to make sure that nothing was being missed below the Paleoindian occupational level at roughly 45-60 cm below surface. A major goal of the 1985 work was to establish what stratigraphy, if any, existed. Unfortunately the soil was so homogeneous in color and texture that no stratigraphy could be discerned. Soil chemical tests will be required to establish the stratigraphy. This year's excavations did establish the presence of a previously unidentified Archaic component from roughly 5-35 cm below surface.

The Paleoindian component is represented by four Clovis points of Pennsylvania jasper. An additional two bifaces of New York chert exhibit possible flutes. A possible late Paleoindian component of the Sycamore site is seen in a recently recovered Folsom-like point made of black chert. This fluted point is similar in manufacturing technique to the Enterline Chert Industry identified by John Witthoft from the Shoop site in Pennsylvania (John Witthoft, pers. comm.). The artifact assemblage from Sycamore is dominated by small endscrapers made of a variety of Pennsylvania jaspers. The rest of the tools in the typical Paleoindian toolkit are to one extent or another manifested in the artifact assemblage from the Sycamore site (Tucci 1985). It would appear likely that the features discovered in 1984 (Tucci 1985) are Archaic in age, although feature analysis has been exceedingly difficult due to plow truncation of all but the very bottom portions of these features.

The size of the existing site is roughly 3,000 m^2. However, part of the adjacent Blackwood Golf Course seems to have destroyed what was perhaps the major occupational area of the site. With that in mind, the original site size is postulated to have been somewhere in the neighborhood of 10,000-12,000 m^2.

The Paleoindian inhabitants of the Sycamore site were probably exploiting the abundant nut resources available as the result of the upland setting. Fish would have been available locally in the surrounding upland streams, while deer and bear would have been the large mammals hunted. There is no evidence at the present time to indicate an association with extinct Pleistocene mammals. Recently discovered outlying sites would seem to represent the procurement sites associated with the subsistence activities performed by the inhabitants of the Sycamore site. If the apparent clustering of these sites along a circumference 3 km from the Sycamore site is confirmed, then this 3 km circle may represent the Sycamore site's catchment area.

Harry J. Tucci, Center for Prehistoric Archaeology, R.D. 1, Box 414, Spring City, PA 19475.

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Archaeological Investigations of Durham Cave #2

Harry J. Tucci

Durham Cave #2, located on the Delaware River in Bucks County, Pennsyslvania, is situated immediately above Durham Cave #1, which was the focus of work done by the American Museum of Natural History in the 1890s. It is the relationship between the two caves which gives importance to the archaeological investigations of Durham Cave #2.

The archaeological potential of Durham Cave #2 was brought to the attention of the author in 1984 by Terry Burlinghame, a local amateur archaeologist. Mr. Burlinghame had recovered several bones from the cave, including a fairly complete skullcap and mandible of a human. Dr. Anthony Ranere (Temple University) studied the human remains, and wrote Mr. Burlinghame that they were probably of prehistoric origin. In September of 1984 Mr. Burlinghame took two knowledgeable amateur archaeologists to visit the cave, however, their unfamiliarity with cave sites led to uncontrolled test excavations. Fortunately, 56 bone fragments were turned over to the author for analysis. One of the participants, a Mr. Thomas Waters, attempted to recreate what had been done since no records were kept during the excavation.

The author at that time was studying at the University of Maine at Orono, so, with the assistance of Dr. Jim I. Mead, he utilized the University's comparative collection to facilitate the faunal analysis. Several genera were identified, including: rattlesnake (*Crotalus* sp.), deer (*Odocoileus* sp.), skunk (*Mephitis* sp.), fox (*Vulpes* sp.), and woodchuck (*Marmota* sp.). The most surprising find, though, was the proximal end of a right tibia from a human.

Durham Cave #2's sister cave, Durham Cave #1, was famous as a paleontological site producing bones from several extinct Pleistocene mammals including short-faced bear (*Arctodus* sp.) and dire wolf (*Canis dirus*); interestingly, the site is also the type site for the woodland musk ox (*Symbos cavifrons*) (Kurtén and Anderson 1980). It was with this in mind, and with the results of the faunal analysis in hand, that the author decided to visit the site in September of 1985. That visit showed that most of what had been Durham Cave #1 had been quarried away, and that the area to the south of Durham Cave #2 had seen a whole mountain, and perhaps part of the cave itself, removed by quarry operations. However, it is the author's opinion that enough remains of both caves to produce information which could establish an association between the extinct Pleistocene mammals of Durham Cave #1, and the human remains of

Harry J. Tucci, Center for Prehistoric Archaeology, R.D. 1, Box 414, Spring City, PA 19475.

Durham Cave #2. Incidentally, it would appear that at one time the two caves were connected by some sort of a passage which has since been sealed by rock fall.

Recently it came to the author's attention that the landowner intended to permanently seal the cave. After discussions with the office of the State Archaeologist, an agreement was reached that would provide for archaeological excavations of Durham Cave #2 before it is destroyed, with the intent of establishing the link between the Pleistocene mammals and the human remains. Future reports will detail the results of these excavations.

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Lithic Studies

Age and Source Analysis for Obsidian Hell Gap Complex Artifacts in the Montana Rockies

Leslie B. Davis

Obsidian artifacts excavated from a deeply buried Hell Gap complex component at the Indian Creek occupation site (24BW626) in west-central Montana (Davis *et al.* 1980; Davis 1984) were analyzed to identify the obsidian sources, to date the associated deposits, and to test for integrity within this apparently single-component culture stratigraphic depositional unit. This cultural stratum in the Upstream Locality at Indian Creek, located beneath 8 m of channel and overbank deposits and tributary alluvium, was dated at 10,010±110 yr B.P. (Beta-5118) and 9,860±70 yr B.P. (Beta-5119). The preceding Paleoindian occupation, dated at 10,630±280 yr B.P. (Beta-13666), which is underlain by Glacier Peak, Layer G, tephra, was dated locally at 11,125±130 yr B.P. (Beta-4951).

A time span of from 9,950 to 9,450 yr B.P. suggested earlier for the Hell Gap complex (Irwin-Williams *et al.* 1973) in the Northwestern Plains has since been confirmed and extended by dates of 9,600±230 and 9,650±250, 9,830±350, and 10,445±110 yr B.P. for Hell Gap at the Sister's Hill, Casper, and Agate Basin sites in Wyoming (Agogino and Galloway 1965; Frison 1974, 1982; respectively).

Analysis by atomic absorption spectroscopy attributed the five obsidian artifacts to two source areas. The Hell Gap point mid-section (260-28) and the uniface (260-1013) were produced from Obsidian Cliff obsidian (Michels 1981) obtained from the Yellowstone Rhyolite Plateau in northwestern Wyoming: (expressed in %/weight values) Na_2O 3.79/3.74, K_2O 4.90/4.88, $Fe_2O_3^T$ 1.34/1.29, CaO 0.33/0.33/0.35, and MgO 0.04/0.05. The three waste flakes (260-1020, -1016, -1019) were formed from Camas/Dry Creek obsidian (Michels 1983) from the Centennial Mountains in Clark County, Idaho: Na_2O 3.54/3.64, K_2O 5.34/5.39, $Fe_2O_3^T$ 1.64/2.03, CaO 0.60/0.61, and MgO 0.14/0.16. These source areas are located 230 km south and 350 km southwest of the Indian Creek site, respectively.

Using hydration rate constants computed by Michels for each obsidian type, hydration thicknesses (in microns) were measured and the ages calculated. Measurements of 6.71±0.09 and 6.78±0.09 for the point fragment and the

Leslie B. Davis, Department of Sociology (Anthropology), Montana State University, Bozeman, MT 59717.

uniface were dated (hydration rate of 4.65) to 9,850±278 and 9,650±248 yr B.P. Applying a rate of 5.18 to thicknesses of 7.11, 7.11, and 7.12 microns obtained for the flakes yielded ages of 9,735±78, 9,735±102, 9,752±183 yr B.P. The derived hydration ages agree with the associated radiocarbon dates (10,010±110 and 9,860±70 yr B.P.), at one sigma. The derived hydration ages support the typologically determined cultural affiliation as being Hell Gap. The tight group presented by the five hydration measurements in aggregate supports the single-component interpretation. This is the first in situ Hell Gap complex deposit yet studied and dated in Montana.

These data supplement the known spatial distribution of surface-collected Hell Gap points in southern and southwestern Montana. Hell Gap points, with the possible exception of Agate Basin complex points, are the most common early Paleoindian type found around Montana, particularly in the Gallatin Valley and Canyon and along the Madison and Missouri River floodplains. In nearby northwestern Wyoming, Yellowstone National Park has yielded fairly numerous Hell Gap points from the surface at both low and high-altitude locations.

With the obsidian sources and hydration constants established by Michels (pers. comm. 1985), similar analyses of obsidian artifacts from other cultural strata at Indian Creek will be undertaken. The suggested but previously unsuspected lithics-exchange networks involved in obsidian procurement and distribution in west-central Montana can be tested by applications of these instrumental techniques to archaeological obsidian recovered from temporally, spatially, and culturally diverse sites in the Northwestern Plains and middle Rocky Mountains.

I wish to thank Dr. Joseph Michels (MOHLAB) for a productive dialogue regarding obsidian analysis. Research at the Indian Creek site has been supported by grants from the Montana State University Office of Research and Creativity, the Museum of the Rockies, the Historic Preservation Office, the MONTS Program at Montana State University, Joseph and Ruth Cramer (Denver), and the National Science Foundation (BNS-8508068).

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A Chert Sickle from the Arc Paleoindian Site, Western New York

Richard Michael Gramly and Stanley Vanderlaan

Archaeological reconnaissance during 1984 in the townships of Alabama and Oakfield, Genesee County, New York, by one of us (SV) resulted in the discovery of the Arc Paleoindian site. The site, which is kept under continuous cultivation, occupies a set of gentle knolls rimming the south edge of Oak Orchard Swamp.

Oak Orchard Swamp today covers 60-70 km^2 and its marshes and shallow ponds are refuges for migratory wildfowl, deer, and other game. Oak Orchard Creek and its tributaries drain the swamp and flow in a generally northern direction towards Lake Ontario, approximately 30 km distant.

Collecting from the surface of the Arc site has yielded a varied flaked stone tool assemblage, including numerous fluted projectile points, trianguloid endscrapers, sidescrapers, *pièces esquillées,* varieties of gravers, tool fragments, and several thousand flakes. Nearly all the fluted points are shallowly concave in the fashion of specimens from eastern Great Lakes Paleoindian sites such as Potts (Ritchie 1965; Gramly and Lothrop 1984) and, further east, Corditaipe (Funk and Wellman 1984) and West Athens Hill (Ritchie and Funk 1973).

Tools and debitage at the Arc site are thinly scattered over an area of at least 6,000 m^2. Several concentrations have been noted. Neoindian remains are very rare anywhere on the site, and in the central artifact concentration vestiges of more recent occupations are absent altogether.

The central artifact concentration is noteworthy for a chert sickle that was discovered there. The raw material of this rare implement is mottled gray and tan Western Onondaga chert, which is identical in every respect to the chert most often used for Paleoindian tools at the Arc site. A likely source of this stone is an ancient quarry at Divers Lake, only 11 km to the southwest. Fluted points have been reported from workshops associated with this quarry (Prisch 1976).

As seen in Figure 1, the sickle is a small ovate biface (80 mm long) with sharp, sinuous edges. No part of the edge has been ground or intentionally been dulled. At one end of the implement (proximal end) there is a remnant of a striking platform formed, it seems, by the original angled face of the chert block fresh from the quarry.

Of particular importance is a well-developed gloss or polish that is present on the dorsal face of the tool. The proximal quarter of the biface, likewise the ventral or obverse face, lacks this pronounced sheen. Gloss is thickest within 10 mm of the edge. It has the appearance of a glaze that has flowed upon the chert. Modern damage, perhaps by farm tools, has cut into the heavy polish and isolated parts of it from the edge of the biface.

Not well seen in the figure is continuous step-flaking along the distal two-thirds of the sickle's edge. The step flakes originate from the ventral face. They

Richard Michael Gramly, Curiatorial Department, Buffalo Society of Natural Sciences, Humboldt Parkway, Buffalo, NY 14211. Stanley Vanderlaan, Albion, NY 14411.

are absent on the recently damaged section of the edge. These removals likely resulted from resharpening.

Gloss or polish on sickles results from fusion of opal phytoliths with the tool face when large frictional heats are generated (Witthoft 1967). Opal phytoliths are found in grasses and other plants and are the product of normal metabolism. Their presence as a glaze on the sharp working edge of a Paleoindian biface suggests that inhabitants of the Arc site harvested plants.

The absence of milling stones on Great Lakes Paleoindian sites indicates that ground plant foods were not an important part of the diet. Still, it may have been necessary to collect reeds and certain fibrous plants for making basketry, mats and domestic paraphernalia. Oak Orchard Swamp, then as now, may have abounded in cattails and other useful species. A sickle would have been indispensable for cutting their tough stalks.

It is interesting to note that at the Vail Paleoindian site in northwestern Maine the only phytoliths with archaeological associations that have been identified to date belong to the genus *Typha* (cattails) (Gramly 1982; Coughlin and Claassen 1982; Coughlin, pers. comm.).

Figure 1. Chert sickle from the Arc Paleoindian site, Genesee County, New York. Sickle sheen or gloss is indicated as whitened areas on the dorsal face of the implement (toned gray).

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Early Man Lithic Studies at San José, Ecuador

William J. Mayer-Oakes and Alice W. Portnoy

The San José site was discovered in 1965. A preliminary analysis (Mayer-Oakes 1970) documented major similarities and differences between San José and the nearby El Inga fluted point site. In 1982, general summary statements about San José were published (Mayer-Oakes 1982a, 1982b). In 1982 a series of 13 source-specific, induced rate obsidian hydration dates were obtained for the 1971 San José excavations. The dates were consistent with site stratigraphy; they indicated an occupation span of ca. 2,000 years from 9,300 to 11,300 yr B.P. (Mayer-Oakes 1986). In 1985 the authors began a study of a sample of the excavation collection.

The original cataloging of the 1971 San José excavation materials indicated that there were 8,157 lithic specimens from the surface collection of 50,723 lithic specimens from the 18 excavation units (E.U.s), a total of 58,880 in all. These 18 E.U.s covered 184 m^2 of the site and had a maximum depth of 45 cm. For the 1985 lab project, we chose for study three E.U.s (10, 17, 18) that together covered 28 m^2 of the site (15.2% of the area covered by all E.U.s). The original catalog showed 9,334 lithic specimens for these three E.U.s (18.4% of the lithic specimens in all E.U.s).

The specimens collected in E.U.s 10, 17, and 18 are 91.5% chippable stone and 8.5% other materials. Of the chippable stone only (8,591 specimens), 96.4% is obsidian, 3.4% is basalt, 0.3% is chert. When estimates of 1,708 unnumbered (because too small to catalog) obsidian pieces, based on a 15% sample study of

William J. Mayer-Oakes and Alice W. Portnoy, Department of Anthropology, Texas Tech University, Lubbock, TX 79409.

this group, are included in the figures, there are 806 (9.4%) tools, 558 (6.5%) non-tool products (retouched or "utilized" pieces, 7,205 (83.9%) by-products (unretouched pieces), and 22 (0.3%) pebbles. Intensive individual studies were made of each of 777 tools, 540 non-tool products, and 5,795 by-products. There were also a brief examination and tabulation of the 802 specimens made of other materials.

Study I placed 777 tools (complete tools and tool fragments combined) in 15 classes which can be grouped into five general categories: burins (7.6%), scrapers (47.1%), perforators and denticulates (34.2%), composites (10.6%), other (0.5%). In order to account for both complete and fragmentary tools, a simple formula for estimating the minimum number of individual tools represented in each class was devised by Portnoy. This formula is Co+Fr=MN: Co= number of complete tools; Fr=number of proximal *or* center *or* distal segments, whichever is largest, *or* if none of these segments is identifiable, but there is at least one fragment, then the number "one"; MN=the minimum number of individual tools represented in the class. These estimates for the tool class groups are burins—28MN, 7.1%; scrapers—159MN, 40.1%; perforators and denticulates—166MN, 41.8%; composites—42MN, 10.6%; other—2MN, 0.5%.

If we assume that blades are more likely to break than flakes (being by definition longer and thinner), these estimates are consistent with a quick comparison of the two largest tool classes, side scrapers and blunt tip perforators. Side scrapers have 13.9% flakes, 63.6% blades, 16.2% complete tools, 173 total number of tools and tool fragments, 70 estimated minimum number. Blunt tip perforators have 63.4% flakes, 29.6% blades, 59.2% complete tools, 142 total number of tools and tool fragments, 116 estimated minimum number. These "blunt tip perforators" are especially interesting to the authors because of their distinctive form, large numbers, and seeming uniqueness (Mayer-Oakes and Portnoy 1986; Portnoy and Mayer-Oakes 1986).

More than 95% of the tools, non-tool products, and by-products are made of obsidian; about 85% of the items in each of these domains show no cortex. The tools demonstrate more use of blades and blade segments (53%) than either the non-tool products (30%) or the by-products (18%). The greatest percentage of complete flakes (45%) is found in the by-products. The largest complete specimens (with greatest dimension up to 17 cm) are found among the tools. Tools tend to be a bit larger in general (12% are larger than 4 cm, whereas only about 4% of non-tool products and fewer than 1% of by-products are larger than 4 cm). There were two major types of retouch found on the non-tool products: almost 70% show limited areas of apparently deliberate unifacial retouch and about 30% shows areas of probable use-wear retouch.

At this stage of our studies, we can characterize the San José lithic assemblage as one of abundant high quality obsidian, with almost exclusively unifacial working; a developmental blade industry; some distinctive specialized tools; many utilized "expediency tools"; and a great deal of unutilized waste. Bifacial tools and projectile points (bifacial or unifacial) were probably not manufactured at San José; if the people used them they must have procured and utilized them elsewhere. We characterize the San José site as a long-occupied, general workshop area where stone tools were manufactured and probably also used to process other materials, such as bone and wood, which were not preserved.

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A Study of Texas Clovis Points

David J. Meltzer

As part of a larger research program on the late Pleistocene occupation of the southern High Plains, I recently undertook a study of the abundance, spatial distribution, stylistic, and functional variability of Texas Clovis points (for the complete report, see Meltzer 1986). One particular aim was to compile information on the many scattered, isolated finds of Clovis points (one of the most striking facets of the Clovis record is the substantial number of isolated points not situated in a site context). The data for the analysis was gathered by examination of private and public collections across the state, and through a questionnaire to the membership of the Texas Archeological Society.

The study tallied 203 Clovis points statewide (80% of which were isolated finds, the remainder occurring in a site context). Clovis points occur in 94 of the 254 counties in the state, but do not appear to cluster in any single county. Interestingly, the distribution of Clovis remains by county does not correlate with the distribution of other Paleoindian sites by county, raising the possibility that Clovis land was distinct from that in later Paleoindian times.

A frequency map of Clovis points by county reveals certain broad spatial trends (Figure 1). The High Plains of west Texas yielded the greatest density of Clovis materials, which reflects both the extensive late Pleistocene occupation of the area, and the almost yearly scrutiny the region receives from archaeologists and collectors. Based on site data and information from this survey, points appear to cluster around fossil lakes and marshes, and along the draws. Because of a thick blanket of Quaternary sediments, exposures of lithic resources in this area are limited and highly localized at a few major outcrops such as the Alibates quarries (Holliday and Welty 1981). Not surprisingly, more

David J. Meltzer, Department of Anthropology, Southern Methodist University, Dallas, TX 75275.

Clovis points in this area exhibit point reworking and reuse, attrition, and use damage, than is evident in points from other, stone-rich areas of the state.

An elliptical, north-south concentration of Clovis points through central Texas follows the eastern edge of the Edwards Plateau, the Balcones Fault line. This fault line has extensive exposures of Cretaceous age, chert-bearing limestone of the Fredericksburg Group (Edwards chert). While the presence of this abundant stone source did not determine Clovis settlement patterns in the region, these chert deposits would have served as one of the focal points in the settlement system, and, more important, would survive as a highly visible, spatially concentrated component of the archaeological record. Oddly enough, the survey produced very few instances of points broken in manufacture, though this may well reflect difficulty on the part of survey respondents in identifying Clovis manufacturing failures. Points in this area were often situated alongside or on stream and river terraces, and at spring heads that emerge where aquifers breach the fault.

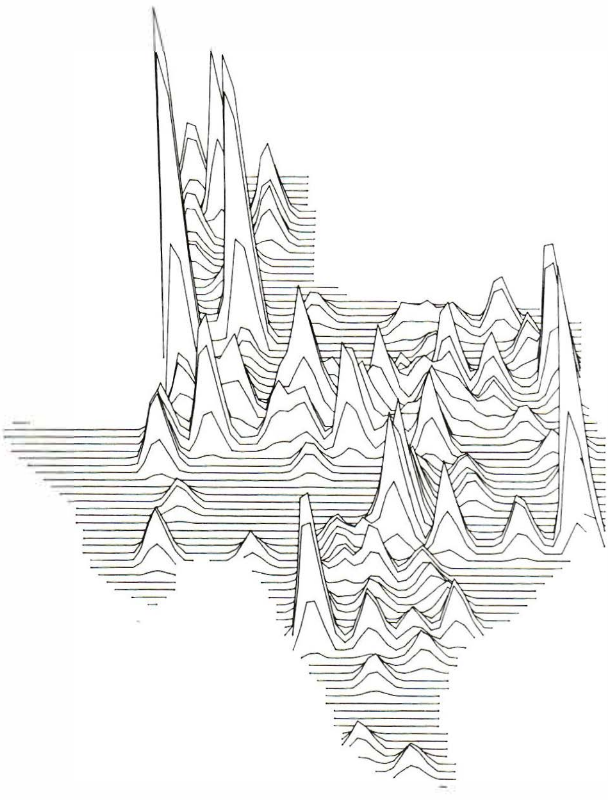

Figure 1. Three-dimensional frequency map of Clovis points in the state of Texas. Spikes indicate the number of Clovis points by county. The largest of the spikes—in Gaines County, west Texas—represents 16 Clovis point occurrences.

The abundance of Clovis points from the coastal region is somewhat misleading, as most of the data comes from a single site. Holocene sea level rise makes any spatial association with the present day coast fortuitous. Nonetheless, the abundance of material from this region hints at the archaeological potential of the Pleistocene coast now submerged by Gulf waters. Most of the Clovis points in this area are manufactured of Edwards chert, which may have been carried in as gravels in the many drainages which traverse the Edwards Plateau before emptying into the Gulf.

The high number of points from east Texas seems more apparent than real: only a few are well documented, and the locations of the remainder are imprecise.

Clovis points are scarce in a long, north-south swath just east and below the caprock of the Llano Estacado and in the Trans-Pecos region. In each case, the low density of Clovis materials may be a sampling phenomena, related to incomplete survey of these regions or low archaeological visibility of late Pleistocene remains. However, in the Trans-Pecos, the low density of Clovis remains may not be a vagary of the sample: Clovis remains are scarce even in the more intensively surveyed parts of the region, suggesting the area did not support a substantial Clovis occupation in the late Pleistocene.

With manufacturing failures rare, there are few clues to Clovis point technology. Notable, however, is a remarkable precision in the manufacture of these points (indicated by significant uniformity in basal width and thickness dimensions). This precision suggests points were made to fit hafts—and not vice versa (Judge 1973).

Texas Clovis points exhibit in equal numbers both straight-based (classic Clovis) fluting, and fluting from a prepared nipple (Folsom fluting). Yet neither fluting techniques, nor other morphological or technological attributes of these points, appeared to show any significant spatial variability, which might indicate variation in the age of the Texas Clovis occupation. Nonetheless, it was clear that the dominant Clovis point styles in Texas differ from those in the eastern United States, and from the classic Clovis type. The temporal significance, if any, of this difference is as yet unclear.

The nature of the survey precluded detailed wear analysis; however, indirect lines of evidence were suggestive of Clovis point function. Nearly all of the points in this sample were ground, often heavily, along the base and especially the sides. The latter is indicative of the use of a hafted tool in a cutting mode (Frison 1978). Lateral snaps were the most common form of breakage in these points, with the break point corresponding to the furthest extent of the lateral grinding. These breaks do not appear to have resulted from impact or end shock, but rather the levering of a point in a haft. In fact, impact fractures, common in bison kills sites, are extremely rare in this sample of points: only four points exhibited this feature (all of which were found on the High Plains). None of the points I was able to examine had the extremely sharp point and blade edges characteristic of points in kill sites.

Based on these observations, and macrowear patterns on a number of points I was able to study, I would suggest that there is a strong possibility that many of the Texas Clovis points had multiple uses: as long-handled hafted knives, as well as projectiles.

The archaeological record of scattered, isolated Clovis points is anomalous: why are there vast numbers of isolated points, in Texas and across the eastern United States? Is this record simply the result of ten thousand years of erosion that irretrievably destroyed late Pleistocene sites? Or is it a more meaningful representation of Clovis subsistence and settlement strategies? The latter possibility is intriguing. If the large numbers of isolated Clovis points, many of which may be multifunctional, are not simply a vagary of taphonomic processes, this implies that Clovis groups may have only rarely participated in the highly structured spatial behavior that produces sites. Which, in turn, suggests that Clovis groups were predominantly generalized foragers, whose toolkit centered around a hafted, multifunctional knife—the Clovis point.

Further, more detailed documentation of isolated Clovis points, their paleotopographic and paleoenvironmental context, wear patterns and stylistic features will help resolve this issue.

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Preliminary Analysis of the Lithic Collection of the La Moderna Site, Argentina

Gustavo G. Politis and Dario M. Olmo

Recent archaeological research in the Pampa region of Argentina has recorded several previously unknown archaeological sites (i.e., Arroyo Seco 2, La Moderna, Cerro La China) that shed new light on the early peopling of the southern cone of South America.

La Moderna is a multicomponent site buried in the banks of Arroyo Azul (Buenos Aires Province); the precise location of the site is 60° 05′ W. long. and 37° 07′ S. lat. The first field work at the site was carried out in the 1972 and 1973 seasons by F. Palanca (Palanca *et al.* 1972; Palanca *et al.* 1973; Palanca and Politis 1979) while a second series of field seasons were directed by the senior author between 1982 to 1984 (Politis 1984, 1985). The Early Man component is a

Gustavo G. Politis, Fellowship of CONICET, Argentina, and Visiting Scholar, Department of Anthropology, 211 Lafferty Hall, University of Kentucky, Lexington, KY 40506.

Dario M. Olmo, Facultad de Ciencias Naturales y Museo de La Plata, 1900 La Plata, Argentina.

Doedicurus clavicaudatus (glyptodon) kill site located on the banks of a late Pleistocene-early Holocene swamp. Cultural materials and faunal remains were associated in Unit (a′), a transitional layer deposited between the Guerrero and Río Salado Members of the Lujan Formation (Zetti *et al.* 1972). In addition to the osteological remains of *Doedicurus,* scutes of *Glyptodon* sp. and *Sclerocalyptus* sp., dermal bones of Mylodontinae (ground sloth) and a few small bones of *Lama guanicoe* (guanaco), *Rhea americana* (nandu), and *Myocastor coypus* (nutria) were also recovered in the Early Man level. Only the presence of *Doedicurus* at the site can be related to human activity. The lithic assemblage recovered from the Early Man component is comprised of crude quartz flakes. The 1972-1973 field seasons yielded 258 flakes, 690 chips, and more than 1,000 small pieces of waste debris. Although it is difficult to determine whether the quartz flakes represent initial or secondary stages of reduction, 12 flakes show some evidence of retouch (Palanca *et al.* 1973). In 1982-1984, a few quartz flakes were excavated, including 4 secondary flakes with retouch, 35 waste flakes of different sizes, 2 quartzite flakes, and 1 chert flake.

The chronology of the Early Man component is unclear; the geological context and the associated faunal remains suggest a late Pleistocene to early Holocene occupation. One radiocarbon date, processed from a *Doedicurus* bone, yielded an age of 6,550±160 yr B.P. (Politis 1984); this date is thought to be too recent. The sample is considered to have been contaminated by a high water table that saturated the cultural level. This date can perhaps be taken as a minimum age of the cultural level (see discussion in Politis 1984). Microscopic edge wear analysis has been performed on the lithic materials recovered during the 1982-1984 field campaigns. An Olympus BH metallurgic microscope with 50X, 200X, and 400X magnification of the Department of Anthropology, University of Kentucky, was used to study the lithic collection. A procedural method employing a comparison of morphological and use-wear traits on natural and cultural stones (developed by Tom Dillehay for the stone collections from the Monte Verde site, see Collins and Dillehay 1986) was used to examine the La Moderna collection. This method includes the simultaneous study of four collections made up of the same primary stone sources from the site environs: 1) freshly fractured natural stone without modification; 2) freshly fractured stones subjected to experimental modification; 3) natural stones subjected to modification by natural forces (i.e., weathering, water transportation); and 4) the archaeologically recovered stones. The experimental collection consisted of 102 quartzite and quartz flakes, which were used to perform basic actions such as cutting, scraping, boring, planing, and sawing. The flakes were used on different materials, including meat, bone, hide, antler, wood, and shell and each experiment was repeated for 200, 500, and 1,000 strokes. Two thousand strokes were reached when the flake was used on meat; additional experiments were carried out with chert. This collection yielded a basic reference for comparison with the archaeological lithic assemblage of La Moderna. It also demonstrated that several kinds of use-wear patterns may be found even on very hard stones such as quartz and quartzite.

The 42 lithics recovered during the 1982-1984 field seasons were studied for the presence of microdamage, polish, and striation. Among them, 12 showed clear evidence of use. The principal activity was meat-cutting, which was represented primarily, but not exclusively, on six tools. Meat-cutting was defined by a distinctive pattern of short, perpendicular, and parallel striae on an additive polish with very little microdamage. The same complex pattern was identified in replicative experiments consisting of cutting meat for 1,000 and 2,000 strokes. Scraping wood was the second most frequent activity registered in this assemblage.

The data recovered through microwear studies along with the study of the lithic reduction stages of manufacture, the contextual information, the faunal assemblage, and the topographical position of the site confirm that the Early Man component of La Moderna was a glypotodon kill site where hunters probably butchered the prey and scraped wood. Other, yet undefined, activities are indicated by some of the multifunctional tools found at the site. Some quartzite and chert artifacts may represent curated items (Politis 1985), since numerous worked features along their edges show different types of action. It is probable that the later stages of use masked the earlier use of these tools. In any case, it is clear that with these kinds of studies we can begin to recognize with a certain degree of accuracy the last activity performed with the tool, but we cannot determine the whole range of uses for each artifact. Finally, independent studies performed by Sussman (1985) and the senior author show that in spite of its irregular fracture pattern, high reflectivity, and hardness, quartz is a suitable material for microwear analysis. This material apparently formed a large percentage of the lithic assemblage of several Early Man sites the world over. The identification of diagnostic use patterns will be an important source of knowledge for understanding early human technology and economy.

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Methods

San Diego Research and Chronology Revisited

G. W. Berger and D.J. Huntley

The report by Reeves (1985) refers to thermoluminescence (TL) apparent ages obtained in our laboratory. Since the apparent ages he quotes are pre-Holocene, we would like to provide some clarification.

Referring to a site in coastal La Jolla on a high marine platform, Reeves (1985:27) states "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." We presume Reeves is referring to the Scripps Tower site of which his description to us includes three occupations. Occupation 3 is at approximately 10 cm depth. Occupation 2 is at about 50 cm and a C-14 date on charcoal gave an age of 9,910±140 yr B.P. (BETA-4883). Occupation 1 is around 80-100 cm below surface. The thermoluminescence apparent age we obtained from sediment from occupation 2 was approximately 20,000 yr B.P. This measurement was made as a check on our method; the check clearly failed and thus it would seem unwise even to quote any other TL apparent ages we obtained on sediments from this site.

Referring to a secondary site in the El Cajon Valley, Reeves (1985:27) states "Thermoluminescence dating of the latter suggest an age of ca. 20,000 yr B.P." This appears to be the site "Fletcher Wash" for which we obtained thermoluminescence apparent ages of 9,000 and 28,000 yr B.P. on sediment respectively above and below the artifact-bearing gravel layer. In view of the result obtained at the Scripps Tower site we have rather little confidence in these figures but note that even if they are right, the age of the artifact layer could be anywhere in the range. There were in fact two check dates, but one was ephemeral.

TL dating of sediments is still very much in the experimental stage. Our objective in working on these samples was in part to test our techniques with which we had had some success elsewhere, particularly on the A horizons of buried soils and on lacustrine silts and clays.

G.W. Berger, and D.J. Huntley, Physics Department, Simon Fraser University, Burnaby, B.C. V5A 1S6.

The sediments at the Scripps Tower and Fletcher Wash sites represent different depositional environments from those we have previously studied. Specifically, the sediments at Occupation 2 of the Scripps Tower site were indurated sands purportedly from a buried Ah soil developed on what was probably a mixture of colluvial and eolian material; those at the Fletcher Wash site represent slopewash and alluvial deposits. One sample we dated at the latter site was purportedly an Ah soil. Experience gained by TL workers since this project was completed (1983) suggests that humus rich A horizons developed on eolian and some fluviatile (and lacustrine) deposits are preferred. Further testing of TL dating techniques on soils developed on sandy alluvium and colluvium is required before such TL results can be considered to be reliable. Thus, the discrepancy between one of our TL results (±20,000 yr B.P.) and the radiocarbon date of ±10,000 yr B.P. may indicate a characteristic violation of the "zeroing" assumption in TL dating for such deposits.

Referring to a third site, a fire hearth in terrace sediments of the Otay River, Reeves (1985:27) states "A thermoluminescence date was obtained ca. 14,000 yr B.P." This date was obtained on burnt clay using conventional (pottery) techniques and should be reliable. Because this date would make it one of the oldest dates in the Americas it would be most valuable to have, for comparison, an accelerator mass spectrometer radiocarbon date on charcoal that was collected from the same hearth.

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A Reassessment of a Hearth-like Feature at the Calico Site Using Thermoluminescence, Electron Spin Resonance, Paleomagnetic, and 40-39 Argon Techniques

Fred E. Budinger, Jr., Janet L. Boley, and Alan R. Gillespie

The Calico site, located in California's Mojave Desert, is a lithic quarry-workshop and campsite that has been dated to 200,000 yr B.P. or earlier (Bischoff *et al.* 1981; Budinger 1983; Budinger and Simpson 1985; Leakey 1970). In Master Pit 2 at a depth of 8.5 m a quasi-circular arrangement of cobbles was uncovered that Berger (1979) thought might have been a hearth. Similarity of clast size among the large cobbles, a radiating pattern of long axis directions, similarity of

Fred E. Budinger, Jr., Calico Early Man Site, Box 535, Yermo, CA 92398.

Janet L. Boley, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125.

Alan R. Gillespie, Department of Geological Sciences, University of Washington, Seattle, WA 98198.

dip to the center, and an alternating pattern of three large and two small cobbles suggested this arrangement might be of human origin. Such uniformity of pattern was not encountered in earlier excavation and has not been seen in subsequent work. A paleomagnetic study of one of the cobbles that was conducted by Dr. Vaslov Bucha (Institute of Geophysics, Prague) and reported by Dr. Rainer Berger (UCLA) indicated a significantly higher degree of magnetism on the inner or proximal end and was interpreted to mean that at some time in the past the cobble had been heated to about 360°C (Berger 1979). We now think that the conclusions drawn from that study are in error; our reappraisal of the quasi-circular feature indicates it was not used as a hearth.

Early in 1982 Dr. James Bischoff (USGS, Menlo Park) began thermoluminescence (TL) testing, and Dr. Motogi Ikeya (Yamaguchi University, Ube, Japan) conducted electron spin resonance (ESR) tests. These two techniques measure essentially the same phenomenon. Temperatures normally attained by cobbles which encircle a campfire (more than 200°C) are high enough to destroy radiation-induced defects in the crystals from the proximal ends of the cobbles. That phenomenon could be measured by TL (May 1979; Wintle 1978) and by ESR (Ikeya 1978). Both TL and ESR measurements were made of the proximal and distal portions of four cobbles of siliceous marl and chert from the "hearth" and on a control cobble of similar composition from a nearby excavation wall. All samples from the feature were found to be at full TL and ESR saturation. Progressive heating of the control cobble indicated destruction of the TL/ESR signal occurs at 200°C in rock of those lithologies. Determination of the dose rate at the Calico site indicates at least 400,000 years are needed for a previously annealed rock to attain full TL/ESR saturation. Thus both studies indicate that the cobbles from the "hearth" were not heated above about 200°C during the last 400,000 years, twice the minimum age of the Calico site (Bischoff *et al.* 1984).

In light of the initial paleomagnetic work by Dr. Bucha, these results surprised us. To check on the Bucha results one of us (JLB) and Dr. Joseph Kirschvink (California Institute of Technology) analyzed five cobbles from the "hearth" using a SQUID (super-conducting quantum interference device) magnetometer technique (Collinson 1983; Kirschvink 1980; Tarling 1983) and also analyzed a series of cobbles from a monitored "experimental" campfire as controls.

One advantage of the paleomagnetic analysis is that very little decay occurs in the magnetization of the rock through time. If the rocks from the Calico "hearth" had been heated by a fire the proximal ends would have remagnetized in the ambiant magnetic field of that time (i.e., ca. 200,000 yr B.P.) while the cooler distal ends would have retained their original random magnetic directions.

The Caltech investigators found the feature cobbles showed significantly random directions in their magnetic moments, indicating they had not undergone heating remagnetization. Furthermore, the cobble initially studied by Dr. Bucha showed an upward magnetic vector, rather than the downward vector expected for realignment due to heating during a period in which the terrestial field is normally polarized.

Temperatures of cobbles in the control campfire were measured over a period of three hours using a thermal interferometer. Lithologies of the control cobbles matched those of the Calico "hearth." Rock temperatures ranged from 273°C-300°C on the proximal ends, 90°C-125°C on the distal ends, and 200°C on the bottoms. Magnetic analyses of these control hearth stones are on-going. It has been observed that volcanic rocks are the most sensitive indicators of thermal remagnetization.

The most recent study of the Calico feature is by a method that is commonly used to radiometrically date rocks: 40-39 argon analysis (Merrihue and Turner 1966). This technique is a variant of conventional potassium-argon dating (Dalrymple and Lanphere 1971). In $^{40}Ar/^{39}Ar$ analysis, samples are neutron-irradiated to create ^{39}Ar from ^{39}K; ^{39}Ar does not occur naturally. ^{40}Ar results from the natural radioactive decay of ^{40}K. Thus the amount of ^{39}Ar measured is an indication of the potassium left in the sample while the amount of ^{40}Ar indicates how much potassium has decayed, and the ratio $^{40}Ar/^{39}Ar$ specifies the age of the rock.

The sample can be degassed of its argon by heat. By heating at progressively higher temperatures and calculating the $^{40}Ar/^{39}Ar$ ratio at each step one can determine if a specimen has experienced heating in the past (Gillespie *et al.* 1982). Heating (before irradiation) will cause diffusive loss of ^{40}Ar from the rock, resulting in low apparent ages. Heating a cobble of volcanic tuff in a campfire could result in such diffusive loss of ^{40}AR, resulting in significant differences between apparent and actual ages. This effect would only be observed in argon diffused from the sample at low temperatures in the laboratory. Argon extracted at temperatures greater than those produced in the hearth would yield the higher age of the rock itself; this pattern is diagnostic. If it is observed in the volcanic rocks that were found in the Calico "hearth" it is likely that the rocks were re-heated sometime after deposition in the alluvial fan gravels of the Calico site.

$^{40}Ar/^{39}Ar$ analyses are currently underway on two specimens of volcanic tuff recovered from the center of the Calico "hearth." Specimen removal and preparation was done by two of us (FEB and ARG) and the analyses are being conducted by Dr. Igor Villa (University of Pisa, Italy). Additional tuff samples taken from the Calico excavations were heated in the monitored fire mentioned above, for use as controls in Dr. Villa's work.

Dr. Villa's preliminary results for the specimens taken from the Calico feature indicate high ages on the order of 21 to 24 million years all the way across the temperature spectrum. This suggests that the subject specimens have not been heated since their formation during the Miocene. Results on the control tuff samples heated in the monitored fire are not yet available.

In light of the new TL, ESR, paleomagnetic, and $^{40}Ar/^{39}Ar$ studies it appears that the Calico feature is not a hearth as originally believed.

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Replication and the History of Paleoindian Studies

Richard A. Rogers and Larry D. Martin

The replication of results is a widely used tool in science for resolving scientific controversies. A single discovery, especially if it is one that challenges well-entrenched scientific belief, is usually not considered sufficient to overturn the previously accepted orthodoxy. However, if the discovery is replicated by different researchers, the importance of the discovery increases enormously. A single discovery might well be the result of bad research technique, chance, error, or even fraud. These interpretations become much less plausible when the discovery is replicated several times. This common sense approach has been a key method used by scientists when choosing between competing theories.

This approach has generally lacked influence in Paleoindian studies. A number of virtually identical discoveries of extinct bison in association with projectile points were largely ignored by the archaeological establishment in

Richard A. Rogers and Larry D. Martin, Department of Anthropology, University of Nebraska, Lincoln, NE 68504 and Museum of Natural History, Department of Systematics and Ecology, University of Kansas, Lawrence, KS 66045.

the early part of the twentieth century, and were not at the time widely considered valid evidence for the presence of Ice Age human populations in the Western Hemisphere. This was despite the remarkable similarities of the finds and the replication of discovery by various researchers.

The 12 Mile Creek site was discovered in 1895 (Williston 1902; Rogers and Martin 1984). A fluted projectile point was found associated with extinct bison. The site was discovered by a non-professional and excavated by a paleontological crew.

The Meserve site was excavated in 1923 and a projectile point was discovered associated with extinct bison. The site was found by a non-professional, and worked by a biologist, and later by paleontologists (Barbour and Schultz 1932).

The Lone Wolf Creek site was found in 1923 by a non-professional and was excavated in 1924 by paleontologists. Several projectile points were found associated with the bones of extinct bison (Figgins 1927).

The Folsom site was found by a non-professional and first excavated in 1926 by paleontologists. Projectile points were discovered associated with the bones of extinct bison (Figgins 1927).

The Custer County site was excavated in 1929 by paleontologists. The site yielded a projectile point in association with the remains of an extinct bison (Schultz 1932).

The Scottsbluff site was found by a non-professional. It was excavated by paleontologists in 1932 and one anthropologist, Loren Eiseley (Barbour and Schultz 1932). This was the only one of the Paleoindian bison kills discussed here that had an anthropologist take part in the excavation. It should be noted that Eiseley begged to be sent elsewhere, out of fear of what involvement with a Paleoindian site would do to his career as an anthropologist (Schultz 1983).

Most of these sites were found by non-professionals, excavated by paleontologists, and yielded projectile points in association with extinct bison. These sites constituted a remarkable series of scientific discoveries and each discovery closely replicated the discoveries made previously. All of these sites are now accepted as valid and have yielded the basis for much of Paleoindian projectile point typology. It is amazing to note what little effect these somewhat repetitious discoveries had on the archaeologist of that time. After these discoveries were made, some colleagues were advising that the artifacts should be destroyed and not reported (Schultz 1983). Paleoindian sites became non-controversial only after the development of radiocarbon dating.

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Taphonomy—Bone Modification

Spiral Fractures and Cut Mark-Mimics in Noncultural Elephant Bone Assemblages

Gary Haynes

Recent severe drought in Southern Africa (1981-1984) resulted in both large-scale but localized die-offs of free-roaming elephants (*Loxodonta africana*), as well as more widespread but less severe mortality throughout many wild areas. Between 1982 and 1986, field studies of the drought's effects on elephants and other large mammals were carried out in Zimbabwe, Namibia, Botswana, and South Africa. The die-offs created massive bone accumulations around water sources in remote protected areas, and these have been periodically re-inspected to monitor growth and changes in the bone assemblages.

In these studies, fractured elephant long bones are abundant in locales where they are deposited at the same time as live elephants congregate in search of water and food. In one major die-off locale, where over 250 elephants died, an area of 250 m x 95 m contains bones from 31 elephants and 2 buffalo (*Syncerus caffer*); 21% of the long bones are spirally fractured. In another locale, a 40 m x 40 m central die-off area contains the bones of 10 elephants, and 62% of the long bones are broken spirally. The term "spiral fracture" is used here descriptively and refers to bones with these features:

1. Radial pattern of fracture fronts circle diaphyses helically.
2. Fracture fronts do not crosscut epiphyseal ends.
3. Fracture surfaces are relatively smooth, but "pebbly," showing microscopic cleavage-breaks of collagen bundles.
4. Where fracture surfaces intersect cortical surfaces, both obtuse and acute angles are formed.
5. Tooth marks are absent or extremely rare on diaphyses.
6. Epiphyses (when present) are rarely or never gnawed and tooth-gouged by scavenging carnivores.
7. "Impact" or "loading-point" features are present on some fragments. These are created by elephant-trampling, which causes the initial fracture of diaphyses, followed by collapse of isolated parts of fracture edges under later pressure as new waves of trampling occur.

Gary Haynes, Anthropology Department, University of Nevada-Reno, Reno, NV 89557.

Articulated bones may occur in direct association with broken and disarticulated elements. "Piles" of bones are common in some sites. Completely buried, articulated whole or partial skeletons have been found through test excavations of the die-off areas.

Sharply incised scratch marks are found on many bones in these locales. These marks (mainly inflicted by elephants trampling bones against relatively fine-grain substrates) are grossly similar to cut marks made by tools; some marks are isolated and more deeply incised than other, more "typical" trampling marks.

Broken tusks and tusk tips are abundant in die-off locales where elephants competitively struggle for access to water. In the bone deposits, broken tusks are in fact the least ambiguous post-mortem indicator that elephants were crowding and fighting for water.

Scavenging carnivores rarely disturb die-off carcasses beyond a minimal removal of soft tissue; they eat parts of the trunk, anus, vulva, and penis, and sometimes muscle meat of the limbs. However, I have found that in certain locales where die-offs are only temporary, scavengers such as hyenas return to elephant skeletons following the passage of several years and chew the bones. Many bones are still greasy, even after 36 months or longer, especially if they have lain in thick vegetation or have been relatively protected from weathering by the presence of dried-on soft tissue. Spotted hyenas can break solid flakes off long bone shafts, with lengths ranging up to 25 cm. The flaking is achieved by the hyenas first chewing off bone epiphyses, then using their cheek teeth to grab and pull back along the remaining shaft edge until fragments detach. These flake fragments are swallowed, gnawed, carried away, or simply abandoned. The flaked shafts may also be abandoned uneaten.

Some of the larger fossil proboscidean collections of late and middle Pleistocene ages share many features in common with the assemblages created by recent elephant die-offs. For example, age profiles at terminal Pleistocene sites are often similar to age profiles from modern die-offs. Tusk tips are found at sites such as Torralba and Ambrona, Spain, and appear to be morphologically similar to the modern specimens, if allowances are made for differences in size and curvature of modern *Loxodonta* tusks and tusks of the fossil taxa. Fractured long bones are found in Old Crow, Yukon collections, as well as collections from Lamb Spring, Colorado, and Volchya Griva, USSR. In these fossil cases, the breaks have been interpreted by some analysts as cultural modifications.

These characteristics should not be considered only "noise" in the fossil record, simply because they appear to mimic the end-effects of human actions such as butchering (seen in scratch-marks on bones), selective killing (seen in age profiles in death assemblages), or tool manufacture (seen in fractured bones and tusks). These features in fact can reveal a great deal about the life conditions of proboscideans in the past.

Scanning Electron Microscope Studies of Bone Modification

Eileen Johnson and Pat Shipman

Scanning electron microscopy (SEM) was used to study bone modifications on experimental, archaeological, and paleontological specimens. SEM was chosen as an independent means of: 1) distinguishing hominid-caused cut marks from tooth scratches and other non-hominid modifications; 2) assessing butchering modification and accuracy of identifying such marks by eye or light microscopy; 3) determining the temperature of heating of burned bones as a means of identifying the source of fire (hominid or non-hominid); 4) distinguishing utilization wear on bone tools from other types of damage and exploring links between wear patterns and function; and 5) investigating the usefulness of microscopic morphology of fracture surfaces as a means of identifying wet versus dry bone fractures. Shipman (1981, 1985; Shipman, Fisher, and Rose 1984; Shipman, Foster, and Schoeninger 1984) demonstrated the validity of SEM in uses 1-4. Its potential application to fracture studies is based on Johnson's (1985) work and observations by Shipman (1981).

Archaeological and paleontological specimens from the Southern Plains were selected for inclusion in the study because they either were controversial by virtue of their antiquity or setting, had ambiguous marks, or had what seemed to be readily identifiable marks. The 31 archaeological specimens were from 41LU35 and five Paleoindian sites dated from ≥11,500 to 10,000 yr B.P.: Lubbock Lake, Blackwater Draw Locality #1, Miami, Plainview, and Bonfire Shelter. Six species were represented: *Arctodus simus* (short-faced bear), *Camelops hesternus* (camel), *Bison antiquus* (bison), *Equus francisci* (horse), and *Mammuthus columbi* (Columbian mammoth). The two paleontological specimens (*E. scotti*, horse) came from Cueva Quebrada (41VV162A) and date ca. 14,000 yr B.P. (Lundelius 1984). Eight experimental specimens were from bone fracture studies (*B. bison*, bison) and tool use investigations (*Bos taurus*, cattle; *Odocoileus hemionus*, deer). The specimens are housed at Texas Memorial Museum (Austin) and The Museum, Texas Tech University (Lubbock). The SEM replicas and micrographs are housed at The Museum with duplicates at The Johns Hopkins University School of Medicine.

Cut marks and carnivore tooth scratches were identified using SEM criteria defined by Shipman (1981). Cut marks were confirmed on specimens from Plainview and Lubbock Lake. The Lubbock Lake material included specimens from the Clovis age megafaunal processing station (Johnson and Holliday 1985a) and from a high terrace deposit that predates the station (Johnson and Holliday 1985b). Cut marks were rare on Plainview bones, due to the frequent removal or damage of cortical bone surfaces by field cleaning techniques. Similarly, surface damage caused by erosion rendered marks on specimens

Eileen Johnson, The Museum, Texas Tech University, Lubbock, TX 79409.

Pat Shipman, Department of Cell Biology and Anatomy, The Johns Hopkins University School of Medicine, 725 North Wolfe Street, Baltimore, MD 21205.

from Miami and Bonfire unidentifiable by SEM, although the marks do conform to macrovisual criteria for cut marks. Marks on specimens from Cueva Quebrada proved to be carnivore tooth scratches (contra Lundelius 1984).

Insufficient data precluded drawing any significant conclusions about possible burned bones. Use of a proposed expediency tool from the Lubbock Lake Clovis-age station was confirmed by the presence of differential smoothing and obliteration of microscopic features immediately adjacent to areas of pristine, sharp detail (Shipman 1985; Shipman, Fisher, and Rose 1984). The use of fracture surface morphology to assess bone condition at the time of fracture proved complex. Tentatively, we conclude that the microscopic morphology of fracture surfaces varies with moisture content. However, how that variation relates to force or to predominant fiber direction (grain) is not yet clear, nor are the altering effects (if any) of burial conditions on the microstructure of exposed fracture surfaces. Additional experiments are needed before firm conclusions can be reached or archaeological specimens analyzed.

Resolution of fine scale detail is a major advantage of SEM. However, natural damage and excavator or preparator treatment of bones can render them unsuitable for SEM analysis. Optimum results are obtained by selecting only very well-preserved and carefully stored and treated specimens. The questions investigated here are basic to developing criteria that distinguish between the various agencies that modify bones. With more extensive studies of materials of known origin, SEM promises to be of great value in identifying assemblages modified by hominids in either the New or Old World.

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The Giant Bear *Arctodus* as a Potential Breaker and Flaker of Late Pleistocene Megafaunal Remains

M.R. Voorhies and R.G. Corner

Recovery of two well-preserved lower jaws of the large extinct short-faced bear *Arctodus* during the 1985 field season prompts us to review the paleoecological role of this impressive animal. We estimate that large males probably weighed 1000 kg or more. Even if Nelson and Madsen's (1983) more conservative estimate of 660 kg is correct, *Arctodus* would still be, by a large margin, the largest terrestrial carnivore known, living or extinct. The two jaws, UNSM 50348 and 50528, are from locality Rw 104 which has yielded part of the Red Willow local fauna in southwestern Nebraska (Corner 1977). A high incidence of spirally-fractured long bones of large ungulates (*Camelops,* camel; *Bison,* bison; *Equus,* horse) was reported from the Red Willow sites by Myers *et al.* (1980). The causative agent(s) for such concentrations of bones with green-bone breaks remains a controversial issue (see various articles in LeMoine and MacEachern 1983).

All researchers agree that a variety of carnivores can and do break fresh bones, sometimes from animals an order of magnitude larger than themselves, but it is still unclear whether carnivore damage can be unequivocally distinguished from breakage induced by early humans. Data on bone-breakage patterns characteristic of a variety of modern carnivores are beginning to accumulate (Haynes 1983a) but the subject is still incompletely investigated. Bone damage by African hyaenids (Brain 1981; Richardson 1980) and North American canids (Haynes 1980, 1982; Binford 1981) is relatively well documented but much less is known about the habits of bears in this regard. We are intrigued by Haynes' (1983b) observation that black bears (*Ursus americanus*) are capable of breaking long bones of adult bison. Black bears are not only the smallest extant North American ursids (mean adult weight less than 100 kg) but are also less carnivorous than brown (*U. arctos*) or polar bears (*U. maritimus*) which average two or three times heavier (Chapman and Feldhamer 1982). Polar bears reportedly scavenge whale and walrus carcasses to supplement their regular diet of seals but we have been unable to learn what, if any, damage they inflict on the skeletons of these massive animals.

What did *Arctodus* eat? Kurtén (1967) proposed that the giant short-faced bear was a cursorial predator, basing his conclusion on the morphology of the skull and on the extraordinarily long limbs of the animal. Emslie and Czaplewski (1985) have challenged Kurtén's view and propose instead that *Arctodus* was primarily herbivorous. Although they concede that the animal "retained bone-crushing capabilities," the latter authors argue for herbivory on the basis of 1) analogy with *Tremarctos ornatus,* spectacled bear (a known herbivore/frugivore) and 2) the proposition that large size alone precluded *Arctodus* from carnivorous habits. Our examination of *Arctodus* fossils leads us to prefer Kurtén's

M.R. Voorhies and R.G. Corner, Division of Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, NE 68588-0514.

hypothesis although we agree with Emslie and Czaplewski that this entails a dramatic upward revision of the size limit for the "terrestrial carnivore macroniche" as defined on the basis of extant mammals. Our primary reason for rejecting the herbivore model is that the skull of *Arctodus* (Figure 1) fails to show such anatomical features as an elevated cranio-mandibular articulation and a reduced angular process that Davis (1955, 1964) has shown to be associated with herbivory in modern ursids (*Tremarctos ornatus* and pandas, *Ailuropoda*). Similar features in an extinct tremarctine (*T. floridanus*) and an extinct ursine (*U. spelaeus*) have been interpreted by Kurtén (1966) as adaptations to a vegetable diet. When analyzed by the method of Miller (1984) the jaw mechanism of *Arctodus* appears to have been capable of delivering an exceptionally strong bite at the canines. We calculated the force of the temporalis muscle ($M^1/a \times 100$ in Miller, 1984: Table 9) to be 29.49 in *Arctodus* which is higher than in modern *Ursus* and canids in Miller's data but comparable to that of large cats (*Panthera*

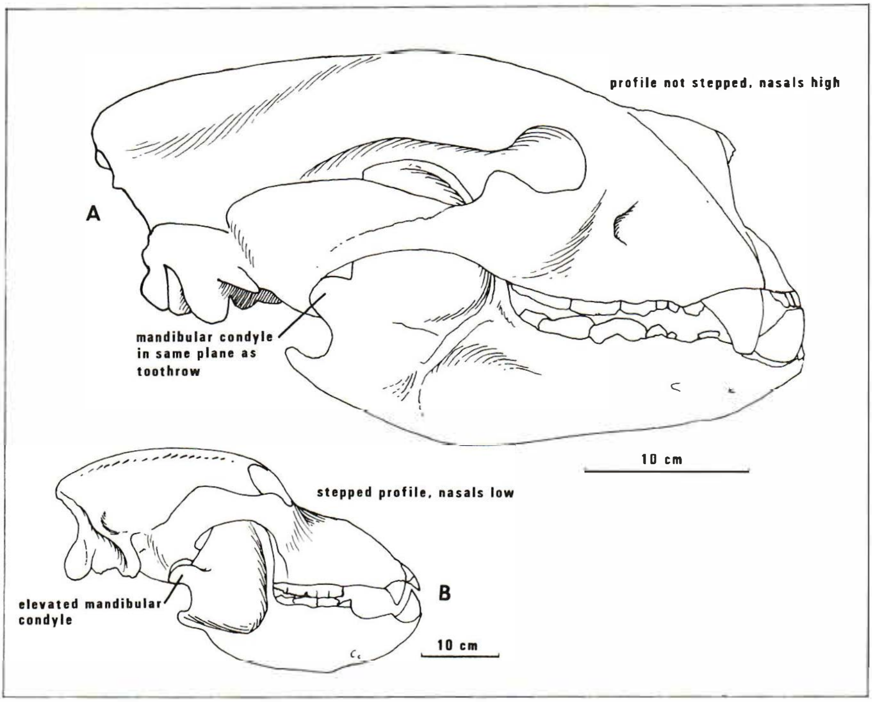

Figure 1. Skulls of extinct Pleistocene bears showing possibly diet-related functional differences. A. *Arctodus simus* (F:AM 25531 from Hay Springs Quarry, Nebraska, Late Irvingtonian). Low position of mandibular condyle, prominent angular process, and strong, posteriorly-placed sagittal crest suggest primarily carnivorous habits. B. *Ursus spelaeus* (Bärenhohle, Hartlesgraben bei Hieflau, Austria, Pleistocene. Drawn from photograph in Müller 1970: 144). Elevated mandibular condyle, weak angular process, and forward position of sagittal crest are thought to correlate with herbivorous diet (see Kurtén 1966).

atrox and *P. leo*). We believe that the similarities of the *Arctodus* skull to that of the great cats first pointed out by Kurtén (1967) may have a functional basis and that the reconstruction of the animal as primarily a predator cannot be rejected without further analysis.

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Paleoenvironments: Plants

Late Pleistocene Vegetation of the Southern High Plains: A Re-appraisal

Vance T. Holliday

The late Quaternary paleoecology of the Southern High Plains was the subject of considerable research in the late 1950s and early 1960s (Wendorf 1961; Wendorf and Hester 1975). Pollen data from several lake basins were used to establish a sequence of late Pleistocene "pollen-analytical episodes". One of the most significant conclusions from this work was the interpretation that during portions of the Tahoka Episode (18,000-12,000 yr B.P.) the Llano Estacado was covered by a boreal forest dominated by pine and spruce (Wendorf 1975). A critical examination of the data from the lake-basin sites and consideration of regional soils raise doubts about the validity of the pollen-analytical episodes and the vegetation reconstruction.

Twenty radiocarbon ages were used to date the pollen-analytical episodes (Oldfield and Schoenwetter 1975). However, only three of these assays pertain to the late Pleistocene sequence from the lake basins; the rest are from the younger valley-fill deposits. The three lake-basin samples are, however, from freshwater carbonates and may be subject to the "hard water" effect which would produce inaccurate dates (Bradley 1985). There appears to be, therefore, little firm age-control for the late Pleistocene pollen-analytical episodes based on the lake samples.

Some of the dating and correlation of pollen data was based on correlations of lake stratigraphy. However, this is also fraught with difficulties. Sediments in the different lake basins tend to look quite similar (olive to gray clay and lacustrine carbonate) (Reeves 1976), regardless of age, and firm correlations must rely on good age-control or index fossils.

The problems of transportation and preservation of pine pollen must also be considered. Holliday *et al.* (1985) pointed out that the high pine pollen frequencies from the latest Pleistocene and early Holocene valley deposits may be the result of differential preservation of pollen. This possibility must also be considered for the late Pleistocene lacustrine material. Bryant and Holloway

Vance T. Holliday, Departments of Anthropology and Geography, Texas A&M University, College Station, TX 77843.

(1985) also suggest that the high pine pollen frequencies could be due to increases in pine upwind of the Llano Estacado and not necessarily to a forest cover in the area.

Finally, an extensive boreal forest on the Llano Estacado would be expected to produce very distinctive podzolized profiles in the soils of the High Plains surface. Such soils would have an E horizon underlain by a spodic B horizon (Birkeland 1984). Holocene pedogenesis might obscure some of these features, but the E horizon position should still be considerably lower in organic matter, clay, and extractable Fe and Al relative to the position of the spodic horizon. Such is not the case based on laboratory data of Mathers (1963) and the Soil Conservation Service (pedons 81TX-501-001, 81TX-079-001, 81TX-069-002, 81TX-303-001, 79TX-381-003). There is no morphological or chemical evidence whatsoever that the High Plains soils formed under a cover of pine and spruce for any appreciable amount of time.

In conclusion, the observations and data presented above and by Holliday *et al.* (1985) cast doubt on the reconstruction of late Quaternary boreal forests on the Llano Estacado.

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Paleoenvironments: Invertebrates

Ostracode Biostratigraphy and Paleoecology of the Late Pleistocene Manix Formation

George T. Jefferson and James J. Steinmetz

The Manix Formation provides an ideal location for the study of lacustrine ostracode assemblages over much of late Pleistocene time. Statistical analysis of the stratigraphic succession of ostracode populations will allow paleoecological interpretations and definition of paleoclimatic regimes through time. The stratigraphy and age of the formation are well known; (Buwalda 1914; Blackwelder and Ellsworth 1936; Winters 1954; Jefferson 1968, 1985a) and the deposits are well exposed in badlands adjacent to the Mojave River approximately 30 to 50 km east of Barstow, San Bernardino County, California. These lacustrines and fluvial sediments were deposited in and adjacent to Lake Manix (Buwalda 1914) which occupied about 415 km^2 including the present Coyote and Troy playa lake basins and the Mojave River Valley east to Afton Canyon. The deposits yield a rich vertebrate fauna (Jefferson 1968, 1985b) which represents a significant part of Rancholabrean time (Jefferson 1985a).

The most extensive and thickest exposures of the Manix Formation are found along the Mojave River and Manix Wash, south and southeast of the Manix railroad siding 32 km of east of Barstow. Here, the formation is divisible into four members on the basis of lithologically distinctive lacustrine, fluviatile, and alluvial fan facies. Lateral and vertical distribution of the facies reflects position with the sedimentary basin as well as fluctuations in the depositional system in response to changing climatic conditions. A 39 m thick stratigraphic reference section (Jefferson 1985a) exposed along the Mojave River east of Camp Cady and south of Manix siding ranges in age from approximately 500,000 yr B.P. to about 20,000 yr B.P. based on C-14 analyses of bivalves (Fergusson and Libby 1962; Hubbs *et al.* 1962; Hubbs and Miller 1965; Bassett and Jefferson 1971), uranium/thorium dates on mammal bone (Bischoff pers. comm.; Jefferson 1985a) and tephrachronologic correlation with a potassium/argon

George T. Jefferson, Assistant Curator, George C. Page Museum, 5801 Wilshire Boulevard, Los Angeles, CA 90036.

James J. Steinmetz, Department of Biology, California State Polytechnic University at Pomona, 3801 West Temple Avenue, Pomona, CA 91768.

dated tuff (Sarna-Wojiciki *et al.* 1980). These dates permit a preliminary correlation of major depositional phases with marine oxygen isotope stages.

The western-most exposures, towards the center of the Lake Manix basin, consist primarily of lacustrine clays, silts, and fine-grained sands, and lack lenses and/or tongues of coarse-grained fluvial and alluvial sediments, typical of depositional environments along the margin of the lake. These exposures provide a continuous, 22.5 m thick stratigraphic section of lacustrine deposits, rich in ostracode tests, that is correlated with the dated reference section. A total of 67, 2 kg sediment samples were taken at 0.3 m stratigraphic intervals at this location.

Preliminary analysis of the ostracode assemblages indicates a fauna of low diversity with few dominant species. Of the five tentatively identified taxa, only three occur in statistically significant numbers. These character/abundant and differential/limited-species are members of the genera *Candona* and *Limnocythere*. It is well documented that ostracode species display individual sensitivity to changes in physical and biological lacustrine conditions. Further preparation and analysis of the samples may resolve questions concerning intra-basin fluctuations in water chemistry, trophic state, and lake levels associated with different climatic and depositional sedimentary systems.

This research is one phase of an interdisciplinary study of the Quaternary history of the Mojave Desert.

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Mid-Wisconsin Aridity in Northern Alaska: Incongruity of a Mesic Pollen Record and Xeric Insect Indicators

Robert E. Nelson

The debate over a mid-Wisconsin human presence in North America continues to rage (Morlan and Cinq-Mars 1983; Colinvaux and West 1984). Recent work at a natural exposure along the Titaluk River on the Arctic Slope of Alaska (69°42′ N. lat.; 155°12′ W. long.) sheds some light on the nature of mid-Wisconsin (44,000-30,000 yr B.P.) environments in Alaska north of the Brooks Range, when man was ostensibly present in adjacent Yukon Territory (Morland and Cinq-Mars 1983). The section of interest here consists of 11 m of floodplain silts that are erosionally truncated at the top and overlain by Holocene lacustrine deposits.

The pollen record from this section indicates essentially unchanging, moist conditions following the disappearance of shrubby taxa (birch, *Betula,* and alder, *Alnus*) from the region by about 42,000 yr B.P. Floodplain pollen floras such as this, however, are dominated by valley-bottom vegetation (in this case, sedges with some grass and willow) and not that of the surrounding uplands, as noted by Schweger (1983). Fossil insects from the section (Figure 1), on the other hand, include abundant remains that must have been derived from surrounding upland areas, and indicate the progressive loss through time of mesic and particularly wet-ground (hygrophilous) elements, with an increasing dominance of taxa that prefer dry substrates with discontinuous vegetation. One such species, the ground beetle (*Harpalus amputatus*) is most common today in the high plains from Alberta to Colorado. The pill beetle (*Morychus*) likewise is a dry grassland indicator and is abundant in all but the basal sample. A comparable climatic drying is indicated by a small plant macrofossil flora that records increasing relative abundance of open-ground taxa such as *Taraxacum* (dandelion).

The insect fauna at the top of the section (sample 7D15; approximately 30,000 years old) is dominated by the rove beetle (*Micralymma brevilingue*), a species found today almost exclusively on the Arctic coast and member of a genus that is primarily coastal in global distribution. This suggests that substrates were not only dry, but that salts may have been locally concentrated at the soil surface. Presence of remains of the ground beetle (*Blethisa catenaria*) in the basal sample indicates July temperatures comparable to today (11.6°±2.2°C; Nelson 1983); the presence of the ground beetle species *Carabus truncaticollis* in all samples indicates summer (July) temperatures 42,000-30,000 yr B.P. continued to remain warmer than the present coast (4°C), where the species does not occur.

Thus, in contrast to the relatively unvarying pollen profile here, the insect assemblages indicate fairly clearly that landscapes during this interval became

Robert E. Nelson, Department of Geology, Colby College, Waterville, ME 04901-4799.

drier but not frigidly cold in the summer, and that there may have been increased levels of salts at or near the ground surface. This interpretation is consistent with the suggestions of Carter (1981) and Hopkins (1983) that the region was extremely arid during this time.

Since modern resources in this area are limited and the presence of game animals such as caribou highly seasonal, it seems logical and highly likely that drier environments would result in even more depauperate populations of game animals by further restricting available food supplies for those animals. The virtual absence of woody shrubs may have also seriously limited fuel available for heating and cooking. It therefore seems probable that environments in this part of Alaska became too dry to support significant human settlement between 42,000 and 30,000 years ago.

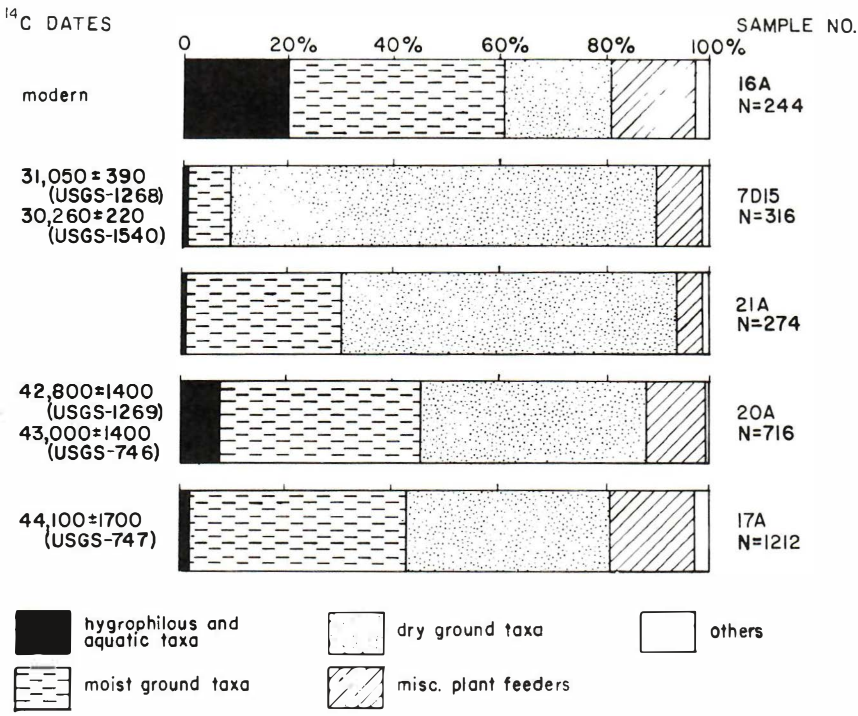

Figure 1. Summary of habitat preferences of fossil insects recovered from the Titaluk River mid-Wisconsin section; N=the number of individual beetles included in each analysis. Sample 16A was a sample of modern river detritus for comparison. Dry-ground taxa are overwhelmingly dominant at the top of the section (sample 7D15). Note that even in sample 17A, from the base of the section, xeric indicators are about twice as abundant as in the modern fauna; much of this increase was due to loss of habitat suitable for hygrophilous (wet-ground) taxa.

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Molluscan Faunas from Radiocarbon-dated Intertill Sites in Southwestern Ohio

Barry B. Miller

Research supported by the National Geographic Society since 1982 (grants 2466-82 and 2984-84), has made possible the collection, dating, and study of intertill molluscan assemblages from near the Wisconsin glacial boundary in Indiana and Ohio. This paper presents that portion of the study which deals with five radiocarbon-dated molluscan assemblages from four intertill sites in southwestern Ohio. Nineteen taxa have been identified from these sites. These include *Carychium exile, Cionella lubrica, Columella alticola, Deroceras laeve, Discus cronkhitei, Euconulus fulvus, Fossaria parva, Gastrocopta armifera, G. pentodon, Hendersonia occulta, Pupilla muscorum, Stenotrema leai, Catinella* spp., *Vallonia albula, Vertigo alpestris oughtoni, V. elatior, V. hannai, V. modesta,* and fragments of a large (?)polygyrid.

The age of these assemblages is documented by 16 radiocarbon dates that in turn are evaluated within the local till-intertill stratigraphic sequences. Two of the faunules are from Doty's Highbank, where they occur in organic silts of the Connersville (20,000 yr B.P.) and Sidney (21,000 yr B.P.) Interstades (Stewart and Miller 1986). The third faunule is from organic silt beneath Shelbyville Till (19,980±500 yr B.P., W-92; 20,430±160 yr B.P., Beta-12580) at Bull Run, Oxford, Ohio. A fourth molluscan assemblage is from organic silt (20,590±190 yr B.P., ISGS-1053; 20,100±265 yr B.P., DIC-2608; 20,480±340 yr B.P., ISGS-1057) beneath till (?Shelbyville) exposed in a high cutbank along the south side of Brown's Run (Wright 1970). A fifth faunule is from a silt (18,090±230 yr B.P.,

Barry B. Miller, Department of Geology, Kent State University, Kent, OH 44242.

Beta-11,549) associated with the Ceasar Till at Bier's Run (Quinn and Goldthwait 1985).

The molluscan faunas from these sites are: 1) remarkably similar in composition; 2) usually depauperate relative to the molluscan assemblages now living near the study sites; 3) characterized by a preponderance of diminutive terrestrial species and a general scarcity or absence of large-shelled deciduous-forest taxa; and 4) frequently include admixtures of boreal-montane and temperate species that no longer are sympatric.

Vertigo modesta and *Columella alticola* form a reoccurring boreal-montane faunal association in these assemblages, that now reach the southern limit of their range in the Great Lakes region near the north shore of Lake Superior at the boundary between the Balsam Fir, Spruce, Birch, White Pine, and the Spruce Balsam Fir Forest (Fremlin 1974: 45-46). These species frequently occur in association with taxa which have distributions that include the area of southwestern Ohio with the fossil sites, and that now approach the southern range limits of the boreal-montane species in the area near the north shore of Lake Huron, near the transition between the Sugar Maple, Yellow Birch, Hemlock, Spruce-White Pine and the Sugar Maple, Beech, Oak, Hemlock, White Pine Forest (Fremlin 1974: 45-46).

The former sympatric association of taxa that now have disjunct ranges within the Great Lakes region requires the assumption of a more equable climate at the time these molluscan assemblages lived in order to explain these anomolous associations. The southern range limit of the boreal-montane taxa appears to be controlled by the summer temperatures, whereas the species with ranges that now include the study area appear to have their northern range limited by the length of the growing season and the severity of the winters. Applying these assumptions to an interpretation of the molluscan fossil assemblages leads to the inference that the climate at the time these assemblages lived may have combined summer month temperatures (June, July, August) of about 15°C and summer months precipitation of about 230 mm, similar to what now occurs along the north shore of Lake Superior (NOAA 1979), with a longer frost-free growing season of about 130 days, similar to that which now occurs along the north shore of Lake Huron (Fremlin 1974).

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Paleoenvironments: Vertebrates

A Mammoth Measure of Time: Molar Compression in *Mammuthus* from the Old Crow Basin, Yukon Territory, Canada

C.S. Churcher

The Old Crow Basin is located in northern Yukon Territory, Canada, and is drained by the Old Crow River which enters the Porcupine River at the Village of Old Crow on the southern margin of the basin. The Old Crow River meanders over the surface of the basin which is filled with many metres of fluviatile and lucastrine deposits (Jopling *et al.* 1981). At each meander bow, the river flows against cliffs composed of permanently frozen unconsolidated sediments. The cliffs, which may be as high as 60 m, contain scattered vertebrate fossils, but their stratigraphy is too complex for it to be easily deciphered or indeed convincingly understood for the benefit of determining the relative stratigraphic positions of the new fossils found in situ.

Most fossils are recovered from the river's strand lines, or on point and gravel bars. However, these specimens essentially lack geological context. Some appear pristine and lightly stained by iron salts, others are waterworn and dark brown, and others may be spalled, fissured or broken as if weathered subaerially. The collected fossils were therefore assumed not to have a single contextual origin, whether taphonomic or stratigraphic. Only the crudest of faunal dating was possible, as all samples were of Rancholabrean land mammal age, on the widespread presence of *Bison* (bison), *Mammuthus* (mammoth), and *Canis* (dog/wolf), and of boreal taxa such as *Rangifer* (caribou), *Bootherium* (musk ox), and *Arctodus* (short-faced bear). Asian elements such as *Saiga tartarica* (saiga), *Bos grunniens* (yak), and *Cuon alpinus* (dhole) are also present to confuse further assignment to a land mammal age.

Examination of the proboscidean second and third molar specimens (M^2/M_2, M^3/M_3) showed that indisputable *Mammuthus primigenius* and *M. columbi* and probably *M. imperator* were present, with another and more primitive taxon scarcely represented. The molars of the older *M. imperator* and those of the most

C.S. Churcher, Department of Zoology, University of Toronto, Toronto, Ontario, Canada M5S 1A1 and Department of Vertebrate Paleontology, Royal Ontario Museum, Toronto, Ontario, Canada M5S 2C6.

primitive taxon were more weathered than those of *M. primigenius* and *M. columbi*, and those of the most primitive taxon were the most badly damaged. Elephants are identified mainly on the skull and molars (Maglio 1973). As molars are generally well preserved and relatively numerous in the Old Crow deposits, such teeth were analyzed for lophar compression, and for thickness of enamel, dentine, and cementum layers. A total of 70 molar specimens was available in the N.Y.R.P. collections, University of Toronto, and the National Museum of Natural Sciences, Ottawa.

Each specimen was measured for maximal and minimal thicknesses of enamel, dentine and cement, care being taken to avoid measuring anomalously thin or thick stations, or where the lophar morphology normally constricts or bulges the cement or dentine. The lophar compression index was calculated as the number of lophs in 100 mm of mesiodistal length on the occlusal surface (Churcher 1972; Maglio 1973). This index is not entirely reliable, as molars are curved buccally, and third molars may be distorted, especially M3's. The occlusal surface is curved, and intersects the lophs at less than 90°, and thus all thickness or mesiodistal measurements are greater than a normal thickness. Mesiodistal lengths over the lophs were measured at the midline of the tooth, and on buccal and lingual stations at about 10 mm from the faces to avoid the curved transverse limits of the lophs. These three lengths were then averaged; the inclusion of the molar midline measurement ensured a figure that reflected the midline morphology more than the margins.

Mesiodistal lengths measured were based on whole lophs, i.e., from the distal margin of the distal enamel ridge on one loph to that of another. Thus all measurements were in the form '7 lophs occupy 72.3 mm'. Such data were then converted to the number of lophs present in 100 mm of molar mesiodistal length (loph frequency or lophar index). The lophar index plotted against enamel thickness has been observed to express molar variation most significantly.

Figure 1 shows a plot of these parameters with boxes representing the observed parametric variations of four taxa of mammoths (Maglio 1973). Individual molars from the Old Crow Basin deposits may be assigned to the elephantid species *Mammuthus primigenius, M. columbi, M. imperator* (*M. trogontherii* or *M. armeniacus*) or *M. meridionalis*. Some plots appear to lie intermediate between two published taxa, but individual recognition is unimportant in considering variation in the Old Crow Basin's mammoth molars. It is evident that the Old Crow Basin's deposits yield molars of a mammoth that may be as primitive as any recorded in North America. Identifications of the plots *fide* Maglio's (1973) ranges were checked against independent subjective identifications of the specimens. About 90% (63/70) of the identifications agreed with those indicated through mensuration and plotting. Thus these systematic treatments appear internally consistent and assess essentially the same phenomena.

The most primitive molars from the Old Crow deposits resemble in proportions and lophar indices those of the late Pliocene *Elephas meridionalis* of the Montavarchi Stage of Europe, between 3.0 and 2.0 myr (million years) ago, but the enamel pattern on their crowns resembles that of *E. africanavus* from the late Pliocene of North Africa.

It is naive to rely on morphological resemblances to provide reliable dates for a faunal age and thus an absolute age because, while the taxon recognized may be correctly identified, taxa may continue as relict populations in obscure places or their time ranges may not be fully recognized. Reliance on single taxa is also unsound, and thus a number of taxa are required to suggest a faunal age. The identification of mammoth molars in the Old Crow Basin that resemble and correspond mensurationally to those of *M. meridionalis* of ± 2.0 myr B.P. from Europe, and resemble in occlusal morphology specimens of *E. africanavus* from Africa at about 3.0 myr ago, suggests that the time depth for the Old Crow deposits that produce fossils eroded by the river is some 2.5 myr B.P. Deep-bore evidence gives a temporal 'bottom' of Paleocene in the Tertiary, with Mesozoic and Paleozoic sediments on Precambian bedrock below (Lawrence 1973).

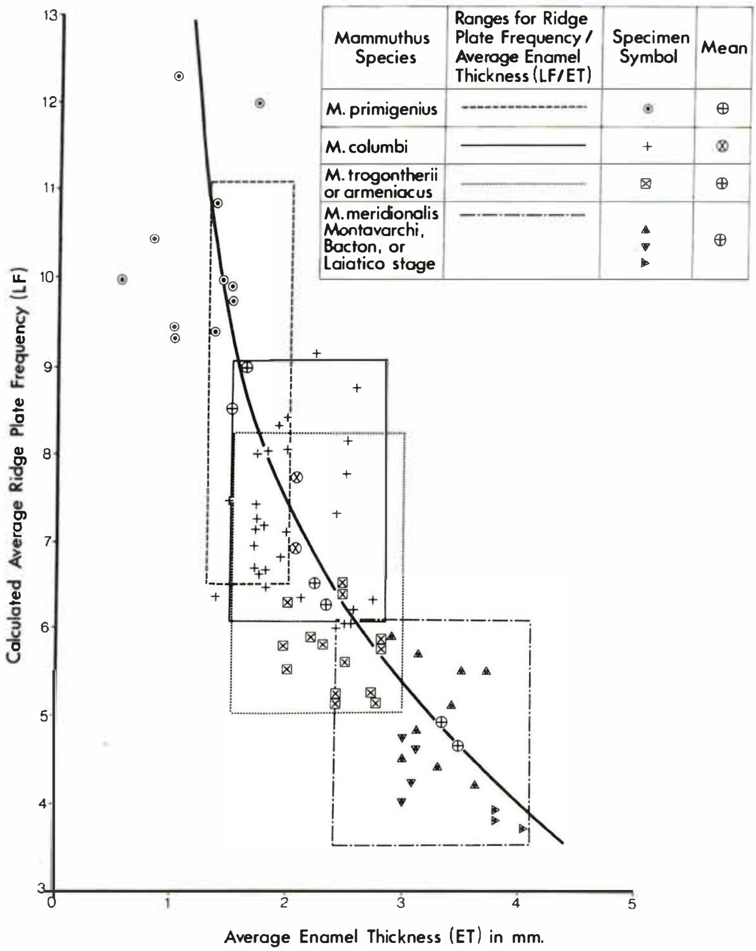

Figure 1. Evolution of lophar compression in Old Crow Basin *Mammuthus* compared with data (rectangles) for Eurasian and North American taxa (Maglio 1973). Triangles represent data for European *M. meridionalis* (from Maglio 1973); other plots represent Old Crow Basin molar specimens.

The derived mammoth molars recovered from the Old Crow Basin reflect late Pliocene and Pleistocene ages, and represent proboscidean taxa beginning at *M. meridionalis* (Montavarchi Stage), but chiefly comprise molars of *M. imperator, M. columbi* and *M. primigenius.* The faunal age for the proboscideans begins between 3.0 and 2.0 myr ago, and ends ca. 10,000 yr B.P. Such a temporal range suggests that the Old Crow Basin may hold a complete sequence of Tertiary and Quaternary deposits which could shed light on the times of entry of many migrant taxa, such as *Homo erectus.*

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Hippidion: New Data on the Now Extinct American Horse in Northwest Argentina: Paleoenvironmental and Paleoclimatic Implications

Jorge Fernandez

Skeletal remains corresponding to five individuals of the extinct American horse (*Hippidion*) (Alberdi *et al.* 1985) were recently discovered in Barro Negro, near Tres Cruces, at 3,820 m elevation (Prov. Jujuy, northwestern Argentina, 22°55′ S. lat., 65°35″ W. long.). The fossil bones were interbedded in the basal 2.50 m thick stratus of a 7.50 m thick sequence encompassing the last 12,000 years. The basal portion is composed of fine-grained sediments with clays, sands, marls, and peats, related to spring activity. The sediments show lateral facies changes, from well-defined peat strata to lenses of marl with the snail *Lymnaea viatrix* and clayey silts.

Jorge Fernandez, Instituto Nacional de Antropología, 3 de Febrero 1370 (1426) Buenos Aires, Argentina.

The fossil bearing stratum was C-14 dated to late Pleistocene age. Five dates limit the presence of the Andean American horse to the interval between 12,530±160 (AC-735) and 10,200±140 (AC-745) yr B.P. Intermediate samples dated 12,300±170 (AC-744), 10,740±140 (AC-677), and 10,200±170 (AC-672) yr B.P. Dated material was peat; details on sample pretreatment, activity measurements, and laboratory methods are described elsewhere (Albero and Angiolini 1985).

The fossil bones were disarticulated and scattered, but showed no sign of water transport or secondary concentration. There was also no sign of human manipulation on the bones, nor association of archaeological materials. This suggests that man may not have been involved in the extinction of the horse at this site.

The peaty stratum bearing horse remains is covered by 3 to 4 m of sandy silts and sands with few organic layers interbedded. Two C-14 dates of 9,200±140 (AC-743) and 9,050±140(AC-742) in this portion of the section suggest Holocene age. *Hippidion* remains are absent from these levels, replaced by camelid remains, represented by the genus *Lama* (llama), accompanied by some archaeological records: broken bones and one well-defined lithic artifact.

Above this older Holocene stratum lie lacustrine sediments composed of algal marls with great numbers of *Lymnaea* and *Byssanodonta.* The marl change laterally into buried soils, peat lenses, and bitumen lenses, the latter containing bird bones, insect remains, and small rodent bones (Fernandez 1985). In the younger part of the Holocene section archaeological remains increase. Radiocarbon dates bracket this interval of major human activity between 3,470±90 (AC-746) and 510±70 (AC-748) yr B.P.

Fossil remains of the American horse (*Hippidion, Parahipparion, Onohippidion*) have been documented from other regions in Argentina, such as the Pampa (Pascual 1969) and Patagonia (Bird 1937; Cardich 1984; Borrero 1984; Markgraf 1985a). This find from the Puna, a subdesertic region in the northwestern Argentina Andes, is the first well-documented find in this region. The modern horse can hardly survive on its own in this environment, where 200 mm of annual precipitation permit only scarce scrub-steppe vegetation with grasses inedible for horses due to their cellulose content.

Some of the aspects of the faunal remains in the Barro Negro section pose interesting problems. 1) The upper Pleistocene sediments provide evidence for the presence of equids (*Hippidion*) but lack evidence for camelids, even though it always had been assumed that the camelids had undergone a long and uninterrupted evolution in the Andes. 2) Evidence for camelids appear locally in great abundance only in Holocene age sediments, at a time when the horse already had become extinct. Such faunal changes near the Pleistocene/Holocene boundary have to reflect paleoenvironmental changes that could be related to paleoclimatic changes in the subtropical Andes.

The presence of *Hippidion* in the Puna environment could be related to a temperature change at the end of the last Ice Age. Unfortunately the paleoclimatic history of the high Andes at this altitude is poorly known. Glacial cirques at 4,500 m and moraines at 3,900 m elevation in the presently unglaciated Sierra de Aguilar, a mountain range about 20 km distant from the Barro Negro site, suggest that glacial conditions must have been substantially colder than today.

More recent paleoenvironmental studies in the Argentine and Bolivian Puna (Markgraf 1985b; Graf 1981) do not extend back to Pleistocene times. Records that cover the late Pleistocene and Holocene intervals are either from the lowlands 10° to 14° S. lat. south of the site, or from the Altiplano in Peru, 10° N. lat. north of the site. The pollen record from Tagua-Tagua (central Chile, 34°30′ S. lat. 200 m elevation), indicates cooler and more humid conditions during the latest Pleistocene interval, where association with mastodon and fossil horse has been dated to 11,380±320 yr B.P. (Heusser 1983). Pollen data from a cave sediment in arid western Argentina (Gruta del Indio, Mendoza Province, 34°S.lat. 600 m elevation) shows a transition from Patagonian-type grassland to Monte desert-scrub between 12,000 and 10,000 yr B.P., at a time when ground sloth dung is found in the section (D'Antoni 1980; Markgraf 1983).

Pollen data from the Peruvian Altiplano (Junin, 11° S. lat., 76° W. long. 4,100 m elevation) are interpreted as reflecting cold and dry climates prior to 10,000 yr B.P. (Hansen *et al.* 1984). None of these records show climatic reversal during the late Pleistocene such as for example, the disputed temperature reversal in the Valdivian rainforest records (Heusser 1974; Heusser and Streeter 1980; Ashworth and Hoganson 1984; Mercer 1976, 1984). Lake level studies in the Bolivian Altiplano, on the other hand, document a high stand dated between 12,500 and 11,000 yr B.P. (Servant and Fontes 1978). Thermal maximum conditions have also been predicted on the basis of Milankovitch's astronomical climate forcing for the interval between 13,000 and 11,000 yr B.P. (Kutzbach and Guetter 1984).

Thus, the presence of *Hippidion* in the Puna environment prior to 10,000 yr B.P. could be related to cooler temperatures and consequently lower evaporation. This, however, is unlikely to have been sufficient to maintain a rich, herbaceous steppe, the environmental prerequisite for presence of grazers, such as the horse. Instead, climate probably was substantially wetter than today during the last 10,000 years (Markgraf 1985b), either through increased precipitation, increased stream flow, or higher groundwater levels, leading to greater abundance of marshes. Climate probably was also somewhat warmer than today, lacking the daily freezing temperatures that characterize the high Andes at present (mean annual freezing days for the interval 1902 to 1938: 357 days). For reasons of the great continentality of the climate in northwestern Argentina it is difficult to envisage greater precipitation during the interval between 12,000 and 10,000 yr B.P. The increased relative moisture instead could be the result of the melting glaciers, leading to re-activation of spring activity, higher groundwater levels, and greater stream flow.

The disappearance of *Hippidion* in northwestern Argentina is contemporaneous with its disappearance in southern Patagonia (Bird 1937, 1951; Rubin and Berthold 1961). Extinction of the Patagonian equids and other representatives of the Pleistocene megafauna (e.g., giant ground sloths) has been ascribed primarily to climatic change, even though Early Man was present in southernmost South America at the time of extinction (Markgraf 1985a). In the case of the extinction of the horse in the Puna, contemporaneity with Early Man cannot be ascertained and environmental change appears the probable cause for extinction.

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A New Specimen of Tapir From Rancho La Brea

George T. Jefferson

Until recently, two phalanges and an ectocuneiform had comprised the entire evidence for *Tapirus* from Rancho La Brea. Although from a relatively small tapir, the specimens were insufficient for positive identification at the species level. A newly discovered, partial dentary with dentition now allows a tentative identification of the Rancho La Brea species as *T. californicus* Merriam (1913). The specimen was collected from an excavation for the foundations of the Museum Square South buildings that are located immediately southeast of the type Rancholabrean land mammal age localities in Hancock Park.

The partial left dentary with M_{1-3} was recovered from an approximately 0.5 to 1 m thick bed of asphalt-impregnated, gravelly, medium-grained sandstone, at a depth of 8.5 m below ground surface (47 m above mean sea level). The bed was channeled into underlying silty claystones, was locally crossbedded, pebbly at its base, and contained layers of transported and abraded specimens of wood that ranged in size from twigs to logs. The deposit formed a discontinuous band extending roughly north-south across the excavation and was lenticular in cross-section. These sediments are interpreted as lag deposits that formed in a stream channel depositional environment. The lithology and stratigraphic position of the bed is consistent with Woodard and Marcus' (1973) description of the basal portion of their Sub-member b of Member C of the Palos Verdes Formation, permitting the direct correlation with the fossiliferous horizons in the type Rancho La Brea deposits less than 300 m to the northwest. Identified taxa from the same deposit include *Juniperus* sp. (juniper), *Pinus* sp. (pine), Gastropoda, Bivalvia, Insecta, *Clemmys* sp. (turtle), Aves, Rodentia, *Mammuthus* sp. (mammoth), *Equus* cf. *E. occidentalis* (horse), *Camelops* cf. *C. hesternus* (camel), cf. *Hemiauchenia* (llama), and *Bison* (bison) sp.

The recovery of the new specimen has prompted the following brief review of west coast representatives of the genus. Presently, two groups of species are recognized in North America ". . . a smaller late (and probably earlier) Pleistocene form including *T. californicus, T. veroensis, T. tennesseae,* and *T. excelsus;* and a larger, early to middle (and possibly latest) Pleistocene form including *T. haysii, T. merriami* and *T. copie*" (Ray and Sanders 1984). Tapir remains from the Pacific coast generally reflect the pattern exhibited by the mid-continent and Atlantic coast forms. Two distinct forms are recognized, a large species, primarily early or middle Pleistocene in age, and a small species of primarily Rancholabrean age.

The large form, tentatively referred to *T. haysii* (following Ray and Sanders 1984), is documented by only a few specimens. Materials have been recovered from the early Pleistocene (? late Blancan) Middle Member of the Saugus Formation (Saul 1979) at Porter Ranch in Los Angeles County, from the Irvingtonian, Bautista Beds (Frick 1921; Savage 1951) in Riverside County, and from Blancan and Irvingtonian portions of the Borrego and Palm Springs

George T. Jefferson, Assistant Curator, George C. Page Museum of La Brea Discoveries, Natural History Museum of Los Angeles County, 5801 Wilshire Boulevard, Los Angeles, CA 90036.

Formations of San Diego County (Downs, pers. comm.; Miller, pers. comm.). A large tapir is also known from the El Golfo fauna of Irvingtonian age from coastal northern Sonora, Mexico (Shaw 1981). Late Pleistocene tapirs from Arizona, Ventana Cave (Colbert 1950), Lehner Ranch (Lance 1959), Murray Springs (Lindsay and Tessman 1974) and Shonto (Agenbroad and Downs 1984) are large and have been referred to both *T. haysii* (Ray and Sanders 1984) and *T. merriami* (Agenbroad and Downs 1984).

All other specimens of *Tapirus* from the western United States represent the small form and are closely comparable in size to *T. californicus* and *T. veroensis.* Most specimens have been recovered from Sangamon or Wisconsin age deposits west of the Coast Ranges of California or in inland valleys of the central part of the state. A single specimen from Irvingtonian age deposits near Elk River, Oregon have been referred to *T. californicus* Merriam 1913 (Leffler 1964).

No distinctive, consistently present morphological dental features have been successfully used to distinguish *T. californicus* from *T. veroensis* (Ray and Sanders 1984). The type specimen of *T. californicus* falls within the morphologic variation and size range of the better represented *T. veroensis* from the central and eastern United States. Although *T. californicus* takes precendence over *T. veroensis,* no attempt has been made to reconcile the taxonomic status of the two species, mainly because *T. veroensis* is well defined and has been widely applied.

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New Articulated Vertebrate Remains from Rancho La Brea

George T. Jefferson and Shelley M. Cox

Most of the vertebrate specimens from the richly fossiliferous Rancho La Brea deposit in Los Angeles (type locality of the Rancholabrean land mammal age) consist of disarticulated skeletal elements. These fossils commonly occur in large, cone-shaped deposits (5-10 m in diameter, apex downwards) within the asphaltic sediments (Woodward and Marcus 1973; Shaw and Quinn 1984). Usually, the remains of all taxa are found randomly distributed throughout these densely packed masses of disarticulated skeletal elements. The origin of these accumulations is not fully understood but each conceivably represents a significant interval of time (Marcus and Berger 1984).

The discovery in 1975 of a thin tabular asphaltic deposit containing articulated fossil material (Duque and Barnes 1975), and representing an apparently short-lived episode of accumulation, was significant in several respects, particularly for its potential for deciphering the origins of the "typical" conical bone masses. Unfortunately, other pressing fiscal and temporal priorities precluded the preparation of this exciting material until recently. We report here the results from the initial preparation phase of the first sample from the new deposit.

The layer of articulated, partially-articulated, and associated skeletal elements was discovered during excavation for the foundation of the George C. Page Museum at the east end of Hancock Park. The large, 10 x 3 m, 0.4 m thick tongue-shaped asphaltic deposit was uncovered 1.5 m below ground surface (53 m above mean sea level). Its long axis had an east-west trend. Located 2 m to the south and separated from the layer of fossils was the source vent of asphalt. The deposit was overlain with silty claystone and exhibited a sharp basal contact with a massive claystone below. As the surface of the unusual bone layer was exposed, it was mapped. Then, the deposit was carefully sectioned and removed from the excavation in 20 large, 0.6 m thick plaster-jacketed blocks.

The first of these blocks is currently being prepared in the Paleontology Laboratory at the George C. Page Museum. It measures 1 x 1.5 m in area. The sedimentary matrix consists of poorly indurated, massive mudstone and sandy siltstone. The upper portion of the deposit is impregnated with highly viscous (gummy) asphalt. The top of the asphaltic layer is solid and oxidized indicating subaerial exposure and weathering.

In the laboratory, the matrix is being removed from the top of the block in 5 cm thick, 10 x 10 cm sample units. The samples are washed, screened, and examined for small vertebrate, invertebrate, and botanical remains. Microfossil (pollen, diatoms, etc.) samples are retained for future study. Thus far, four 5 cm levels have been removed, resulting in over 450 processed samples. The precise

George T. Jefferson, Assistant Curator, and Shelley M. Cox, Curatorial Assistant, George C. Page Museum, Natural History Museum of Los Angeles County, 5801 Wilshire Boulevard, Los Angeles, CA 90036.

location and orientation of each large skeletal element is also being measured and recorded using techniques described by Shaw (1982).

Excavated from the block or exposed on its surface are the partially-articulated and associated remains of several large-size herbivores and both medium- and large-sized carnivores. Preliminary observations appear to indicate a crude stratification of the different taxa. Herbivore remains, all juvenile, have been recovered from the lower, less asphaltic part of the deposit. Articulated skeletons or parts of skeletons of the larger carnivores generally overlie the herbivores. However, there is some partial vertical overlap of parts of skeletons and associated elements from different taxa. Also, limited scattering and lateral displacement of some parts of skeletons has occurred. Parallel and sub-parallel orientation of skeleton elements apparently reflects anatomical position rather than aqueous transport. Where inclined, long bones generally dip no more than about 15 degrees.

Two juvenile (just postnatal) individuals of *Equus occidentalis* (extinct western horse) are represented by associated upper and lower dentitions, three radius-alnae, and a single, partially-articulated, complete hind limb. These specimens and several isolated skeletal elements of a juvenile *Bison* sp. (extinct bison) underlie most of the carnivore material. The remains of one juvenile and one adult *Canis latrans* (coyote) are scattered or found in loose aggregates through the lower part of the deposit. Four adult *C. dirus* (dire wolves) and an adult *Panthera atrox* (American lion), represented by articulated partial skeletons, appear to be restricted to the middle of the deposit. Articulated partial skeletons of one adult and one subadult *Smilodon californicus* (California sabercat) appear to overlie the remains of all other taxa.

Other vertebrate taxa, represented by single or unassociated skeletal elements, apparently are not stratigraphically restricted. These include Reptilia (lizards and/or snakes), *Grus americanus* (whooping crane), *Aquilla* cf. *A. chrysaetos* (golden eagle), *Glossotherium* sp. (large ground sloth), *Spermophilus* sp. (squirrel), *Thomomys* sp. (gopher), and *Dipodomys* sp. (kangaroo rat).

This unusual configuration of apparently taxonomically layered large vertebrate remains may represent a single, relatively short-lived event. Further speculation is premature. Preparation of the remaining blocks and taphonomic analyses of specimen orientation should aid in understanding the origin of the assemblage.

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New Locations of Extinct Megafauna and Plant Community Associations, Rancholabrean, Southeastern Utah

Jim I. Mead and Larry D. Agenbroad

Two alcoves in the Navajo Sandstone of the central Colorado Plateau, southeastern Utah, were found (fall 1985) to contain multiple layers of stratified canyon alluvium, dung of extinct megafauna, and many now extralocal plant species. Both alcoves are located in Glen Canyon National Recreation Area (exact location being withheld at the request of the National Park Service). BF Alcove is a north facing shelter, and only one meander bend downstream from it is Grobot Grotto, a south facing alcove. The shelters complement each other in that they record biota from the same region, yet they are distinct in their record of different immediate micro-communities and in their radiocarbon dates.

Both shelters are wide, approximately 100 to 150 m (upstream to downstream), and both are shallow in horizontal depth. BF Alcove has only about 10 m and Grobot Grotto only about 5 m within the dripline (the area of dry preservation). BF Alcove and Grobot Grotto contain multiple layers of stratified canyon alluvium (23 m thick) beginning approximately 48 m above the present stream bed level (Figure 1 illustrates a general schematic cross-section of BF Alcove). Seventy-two meters separate the top of the deposits in the shelters and the bottom of the present streams (modern base level).

Boison and Patton (1985) and Webb (1985) have stated that their data indicate that canyon sediments in the central Colorado Plateau date ≤3,000 yr B.P. (middle to late Holocene), no older. It is apparent from BF Alcove and Grobot Grotto, both not too distant from Boison and Patton's (1985) and Webb's (1985) study areas, that the alluvial sediments are of considerable antiquity, much greater than 3,000 yr B.P. Our preliminary field observations did not reveal charcoal in any of the canyon sediments in either of the two alcoves, therefore we have no direct age determinations for the canyon alluvium.

We did find that within the dry sections of the shelters and unconformably on top of the stratified alluvium were layers of apparent roof spall and eolian sediments. These sediments in BF Alcove appear to be very shallow (less than 2 m), yet they contain extralocal plant species (*Acer glabrum,* Rocky Mountain maple; *Pseudotsuga menziesii,* Douglas fir) and at least two types of large dung pellets. In a preliminary analysis of the largest pellets, they appear identical to those produced by the living Asian-African camel (*Camelus* spp.), and therefore are referred to the extinct camel (*Camelops*) that is known to have occurred in arid western North America. Smaller dung pellets are very similar to those produced by the living muskox (*Ovibos moschatus*) and are referred to its extinct

Jim I. Mead, Quaternary Studies Program, Department of Geology, Northern Arizona University and Museum of Northern Arizona, Flagstaff, AZ 86011.

Larry D. Agenbroad, Quaternary Studies, Program, Department of Geology, Northern Arizona University, Flagstaff, AZ 86011.

southern relative, shrub-ox (*Euceratherium*), also known from Bechan Cave. A radiocarbon date on the smaller pellets produced an age of 11,790±190 yr B.P. (Beta-14727).

The alluvium in Grobot Grotto appears similar to that in BF Alcove; however, the roof spall/eolian sequence unconformably on top in Grobot Grotto is much deeper (3 to 5 m). Beneath a layer of oak (*Quercus* sp.) leaves and tree stumps is a sequence of dung layers. The least common type of dung, from very low in the profile, a large dung bolus, is identifical to that found in Bechan Cave and is identified as belonging to the mammoth (*Mammuthus* sp.) (Davis *et al.* 1984; Mead *et al.* 1986). One mammoth dung bolus fragment radiocarbon dates to 28,290±2100 yr B.P. (Beta-14422). Higher in the section are dung pellets similar to the shrub-ox and these produced a radiocarbon age of 20,930±400 yr B.P. (Beta-14420). Additional extralocal plant species and great quantities of hair are in association with the dung remains.

All dung will be analyzed for overall size, shape, biochemical signatures, macro-plant contents, pollen, and content particle size. Additional radiocarbon determinations will be made and all hair and plant remains will be examined. The preliminary evidence indicates that the stratified canyon alluvium radiometrically dates no younger than at least 20,000 yr B.P. This alluvium is currently under study for sediment size, origin, and age.

Such wide and shallow sandstone shelters are rarely visited for the sake of paleontology. BF Alcove and Grobot Grotto have indicated to us that a wealth of

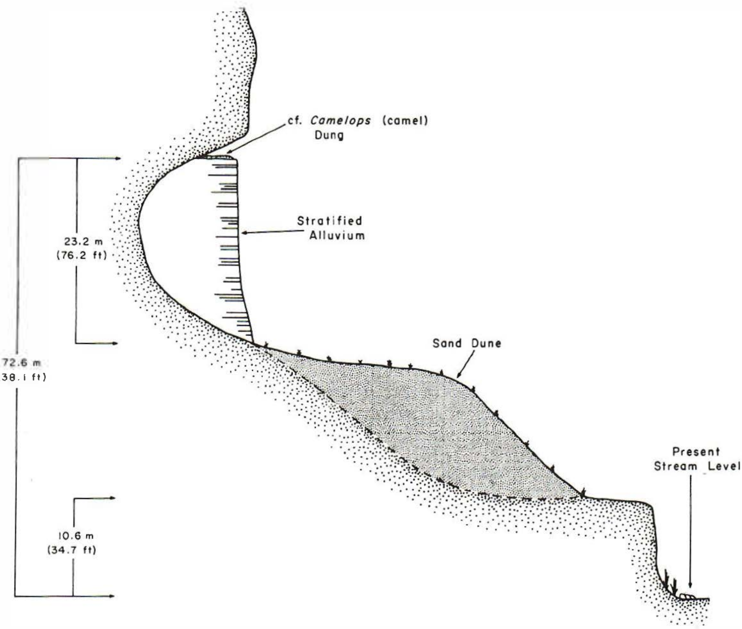

Figure 1. Schematic cross section of BF Alcove, southeastern Utah.

animal and plant remains are to be discovered in such shelters. These alcoves will prove to be very important paleoecological resources for reconstructing biotic communities of late Pleistocene age from the central Colorado Plateau.

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Biological and Archaeological Information in Coprolites from an Early Site in Patagonia

María José Figuerero Torres

Five dessicated coprolites were recovered among the organic remains at the site Cueva Las Buitreras (51°45′ S. lat., 70°15′ W. long.) in the southern tip of continental South America. They are associated with lithic artifacts and faunal remains of modern and extinct species which together form an interactive context (Caviglia *et al.* 1986). These materials are contained in the lower levels of the site which did not produce material suitable for radiocarbon dating. However, an overlying volcanic ash layer was correlated with Auer's Tephra I, thereby allowing a minimum date of 9,100 yr B.P. for the occupation (Sanguinetti and Borrero 1977).

The coprolites were rehydrated in a solution of trisodium phosphate (Na_3PO_4). External features were registered, chemical reactions during rehydration were noted, and contents separated and identified. Taking these together with known feeding habits and comparisons with a reference collection, we were able to identify the originators of the specimens. Of these only one was human and contained charcoal and as yet unidentified fragmentary plant remains (Figuerero Torres 1982a, 1982b). The other four belonged to an omnivorous carnivore and contained digested beetles, small rodent molars, and identifiable plant fragments.

Considering an arbitrary time period between 10,000 and 8,500 yr B.P., we studied the faunal contents of the coprolites to see if they reflected the available

María José Figuerero Torres, Programa de Estudios Prehistóricos (CONICET), Bartolomé Mitre 1970 5"A", 1039 Buenos Aires, Argentina

paleoenvironmental information for this portion of South America (Figuerero Torres 1982a, 1982b). This evidence is of a varied nature (pollen, glaciology, plant macrofossils, mollusks, micromammals) differentially sensitive to temperature, precipitation, and local and regional variations. However, for the time period considered, there is a general consensus that temperature was lower than now and that rainfall, while higher, was increasing. Geographically, the site was farther from the sea than now due to lowered sea levels, and nearer to the eastern limits of the subantarctic forest.

The insects identified were *Taurocerastes patagonicus* (a coprophage) and *Caenorhynus lineatus* (a herbivore). Not enough is known of their biology to say if they are particularly sensitive to temperature or rainfall, but they are to be found both in the rainforest and steppe of southern Patagonia. The two rodent molars belong to *Akodon xanthorhinus*, a field mouse common in Patagonia with two subspecies in rainforest and steppe. The molars were insufficient for taxonomic identification down to subspecies level.

The extinct fauna at the site includes two juvenile ground sloths (*Mylodon listai*), fox (*Dusicyon avus*), and horse (*Hippidion-Onohippidion*). Their habits are for the most part unknown (although see Moore 1978 on ground sloth), and cannot profitably be used in the present study. The association of coprolites pointing to an omnivorous-carnivore diet together with fox remains could be indicative of the latter's ecological niche. *D. avus* survived into late Holocene times in the Pampa region (Tonni and Politis 1981), and the causes for its extinction could be sought in competition with other successful present day foxes with similar diets.

The modern fauna consists of gaunaco (*Lama guanicoe*), small rodents (*Reithrodon* and *Ctenomys*), and dolphin (Delphinidae). All these species are within their normal distribution, past and present.

As can be seen, the coprolite and faunal remains from Cueva Las Buitreras do not confirm nor contradict the broad environmental evidence for southern Patagonia 10,000 to 8,500 yr B.P. More information on the biology and habits of some of the species could aid in defining the local conditions surrounding the site.

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Ochotona in the Late Pleistocene of the Niobrara Valley, Nebraska: Paleoenvironmental Significance

M.R. Voorhies

North American pikas (genus *Ochotona*) are small, gregarious diurnal mammals that today live primarily in alpine areas in the western half of the continent (Hall 1981). Most populations occur at high altitudes (≥3,000 m) in the Rocky Mountains but some reach elevations as low as 600 m in Alaska (Guthrie 1973). Fossil ochotonids (usually *O. princeps*) have been reported from more than 20 localities in western North America (Harris 1985), all in deposits of late Pleistocene (Rancholabrean) age. The only known occurrences in eastern North America were reported by Guilday (1979) who described ochotonid remains from four Irvingtonian-aged cave deposits in the central Appalachians.

The absence of *Ochotona* from the rich fossil record of the Great Plains as then known led Guilday (1979:441) to suggest that the region "served as an ecological barrier to *Ochotona* throughout the Pleistocene as it does today." This conclusion now requires modification as a result of the discovery of ochotonid remains in north-central Nebraska. Fragmentary jaws and teeth readily identifiable as *Ochotona* (Figure 1A) were recovered from four of the 11 sites that have yielded the Smith Falls Local Fauna (Voorhies and Corner 1985). The fossils were sieved from lenses of coarse sand and gravel which also produced a diverse assemblage of other small mammals of boreal and/or montane affinities including *Dicrostonyx, Phenacomys, Microtus xanthognathus,* and *M. montanus.* No datable organic materials have yet been recovered from any of the sites but the fauna strongly indicates a Rancholabrean, probably Wisconsin, age.

The geomorphological setting of the Smith Falls site (Figure 1B) may account for some of the faunal peculiarities including the presence of pikas (and porcupines, see Voorhies 1981) which are otherwise unknown from Great Plains fossil localities. The coarse fluvial sediments that yielded the fossils constitute a terrace fill occurring high on the valley walls of the Niobrara River. Incorporated into the terrace deposits, as well as overlying them, are numerous boulders of well-indurated sandstone clearly derived from the Cap Rock Member of the Ash Hollow Formation (Miocene) that locally forms the rim of the trench-like river valley. Rounded clasts up to 0.4 m in diameter are common and angular blocks up to 2.5 m across are present where the terraces impinge on the valley walls. I propose that talus piles at the edges of the high terrace provided a suitable microhabitat for pikas during the late Pleistocene. The lack of extensive scree slopes may have prevented ochotonids from establishing themselves in other parts of the Great Plains during colder climatic episodes. Harris's (1985:155) conclusion that *Ochotona* "descends to lowland areas where talus habitat is available in conjunction with cool and moist conditions" is reinforced by the present study. The Nebraska fossils document an ochotonid population that must have been approaching its ecological limits.

M.R. Voorhies, Division of Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, NE 68588-0514.

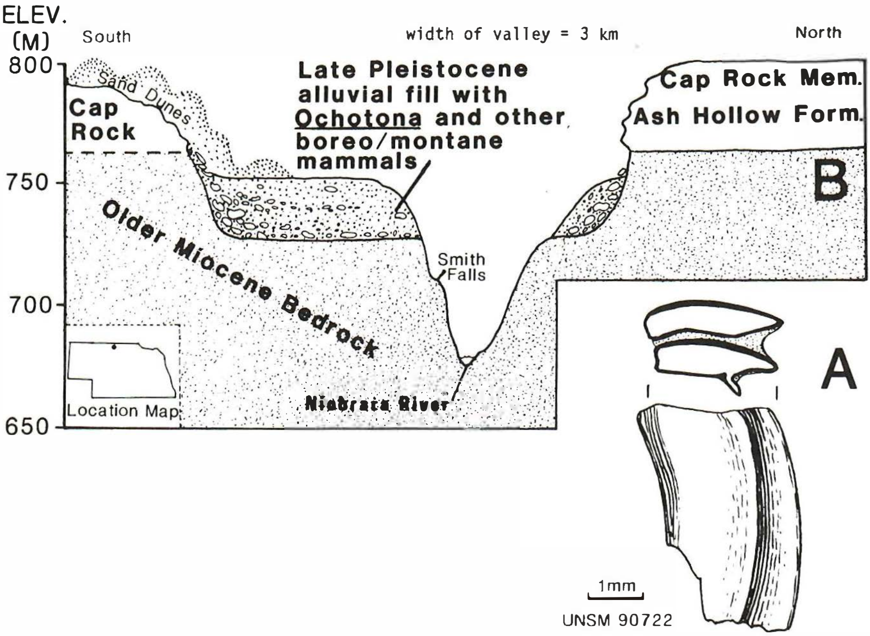

Figure 1. A. Upper molar tooth (RM^2) of *Ochotona* (cf. *O. princeps*) from UNSM locality Bw 109, Peter Bear Quarry, Smith Falls Local Fauna, late Pleistocene, north-central Nebraska. B. Diagramatic cross section of Niobrara River valley near Smith Falls (42°53′ N. lat., 100°19′ W. long., Cherry County, Nebraska) showing relationship of fossiliferous late Pleistocene terrace deposits to Miocene bedrock. Talus from the Cap Rock unit may have provided habitat for *Ochotona,* today an almost exclusively montane mammal, during late glacial time. Ochotonid remains have been recovered at four sites in the high terrace alluvium (locality Bw 109=Peter Bear Quarry, Cr 106=Head of Big Cedar, Cr 108=Smith Falls, Cr 110=Smith Spring). Locations of these sites, and others which have produced the Smith Falls Local Fauna, are shown in Voorhies and Corner 1985, fig. 2.

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Paleoenvironments: Geosciences

Geoarchaeological Investigations at the Cummins Paleoindian Site, Thunder Bay, Ontario

P.J. Julig, J. McAndrews, and W.C. Mahaney

In 1983 a 'three-year' excavation program was started at Cummins, a large Plano period quarry/workshop and habitation site situated on raised beaches of proglacial Lake Minong. Minong levels were present in the Superior Basin during two periods, from ca. 10,500 to 10,100 yr B.P., and ca. 9,500 to 9,300 yr B.P., separated by a higher Lake Duluth stand (Clayton 1983). Cummins, Brohm, Simmonds, and other Lakehead Complex Plano sites located on Minong beaches at elevations of 230 to 240 m had previously been assigned maximum geological dates of ca. 9,000 to 9,500 yr B.P. (Fox 1975; Dawson 1983). The earliest C-14 date for Cummins is an accelerator date of 8,480±390 yr B.P. (NMC-1216), on the fragmentary remains of a cremation burial recovered in 1963 by J.V. Wright (Dawson 1983). Excavations in 1983 revealed water-tumbled artifacts in poorly sorted (lag?) cobbles and gravels beneath Minong beach sands, underlying dune deposits, and in bog sediments of adjacent Cummins Pond indicating diverse geomorphic site environments and a substantial period of occupation (Julig 1984). The water-worn taconite artifacts in the lower gravels indicate occupation prior to the last Minong level at ca. 9,500 yr B.P. Various sediment analyses are used to refine site geochronology, and to assist in interpretation of site formation processes, artifact context, and paleoenvironment.

In the western portions of Cummins, at the WTT section, a podzolic soil has formed in 2 m of medium fine sand, overlying 0.5 m of lag gravel with cobbles, a thin deposit of sandy silt, and taconite bedrock. The upper sands are very well sorted with a mean Ø of 2.0, and are positively skewed. Observations with SEM (scanning electron microscope) indicate quartz grains are generally well-rounded and frosted, supporting an aeolian origin. Taconite artifacts present in the upper soil horizons are lightly polished. The underlying coarse gravel with cobbles is interpreted as a lag gravel, as pebble orientations indicate no fabric.

P.J. Julig, Department of Anthropology, University of Toronto, Ontario, M5S 1A1, Canada.
J. McAndrews, Department of Botany, Royal Ontario Museum, Toronto, M5S 2G6, Canada.
W.C. Mahaney, Department of Geography, Atkinson College, York University, Downsview, Ontario, M3J 2R7, Canada.

Taconite artifacts, only slightly worn, were recovered in the upper parts of this very coarse and poorly sorted archaeological-geological facies.

At the DT section, adjacent to Cummins Pond, heavily worn artifacts occurred in coarse sand and gravel (mean Ø of -2.2), at depths of 1.5 m below the surface. Three cultural strata are present in the overlying sandy soil; a thin Archaic horizon below the humus, and two Plano occupations with Agate Basin and Plainview type lanceolate points (Julig 1984). There is some aeolian sand in the upper soil horizons of most locations sampled on these main Minong beaches.

A small tributary of the Neebing River cuts the Minong beach on site, associated with a bog (Cummins Pond), interpreted by B. Phillips (pers. comm.) as being a former lagoon of Lake Minong. The oldest fossil pollen assemblage for Cummins Pond and Oliver Pond (2 km to the northeast) are similar, with spruce (*Picea*) (30%) and pine (*Pinus*) (40%) dominating lower (zone 2) sediments; however, poplar (*Populus*) pollen is abundant in the clay-rich sediments at the base of Oliver Pond core. A birch (*Betula*) and alder (*Alnus*) rise signals the beginning of zone 3, C-14 dated to 7,730±95 (DIC-2504) at Cummins Pond. Spruce wood from the 454-457 cm level of the Cummins Pond core is dated at 8,110±110 (Beta-4486), with a 15 cm sandy strata present immediately above. This 15 cm fine sand horizon is partly aeolian in origin, indicating a dune-forming episode at ca. 8,000 yr B.P.

Excavations at the edge of Cummins Pond yielded artifacts and a cultural feature (post molds) below 30 cm of peat. Associated pollen was zone 3B (abundant alder and birch), indicating a relative date of ca. 7,500 yr B.P. for this cultural component. Smectite (montmorrillinite) is present in the Cummins Pond core below 8,100 yr B.P., and in lower grey clays of the DT section, which suggests a source in a dry environment. Lake Agassiz discharges into the Minong basin at ca. 9,500 to 8,500 yr B.P. (Clayton 1983), are likely responsible.

Analysis of sediments indicate a variety of geomorphic processes affected the Cummins site. Glacial activity in the basin during initial occupations may be responsible for the coarse, poorly sorted, lower facies. Contrary to previous research, Cummins is deeply stratified, with continued human use through much of the preceramic period, despite changing environmental conditions.

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Stratigraphic and Pedologic Evidence for a Relatively Moist Early Holocene on Black Mesa, Northeastern Arizona

Eric T. Karlstrom

Soils, stratigraphic, biotic and radiocarbon data from northern Black Mesa, northeastern Arizona, support Antev's (1955) concept of a relatively moist "Anathermal" period between ca. 10,000 and 8,000 yr B.P. Reconstruction of early Holocene environments here take on increased significance due to recently recovered evidence of early Archaic cultural occupation in this area dating back to ca. 8,000 yr B.P.

Valley fills dissected by post-1880s arroyos on northern Black Mesa include varying numbers and heights of alluvial terraces underlain by alluvium ranging in age from late Pleistocene to latest Holocene. In general, alluvial and pedalogical research on Black Mesa (Euler *et al.* 1979; Karlstrom 1983) supports and expands Hack's (1942) three-fold subdivision of alluvial deposits, including late Pleistocene Jeddito alluvium (subsequently dated pre-Illinoian to late Wisconsin by Shoemaker *et al.* 1962), Tsegi alluvium (dated ca. 5,000 to 550 yr B.P.), and post-550 yr B.P. Naha alluvium. Tree-ring, C-14, and archaeological dating of point boundaries (geosols or uncomformities which separate alluvial units) has permitted informal subdivision of Tsegi and Naha alluvium into 10 major units thought to represent generally synchronous and climatically-induced cycles of deposition and erosion in the region (Karlstrom 1985).

Chronostratigraphic data suggest that aggradation generally occurred by vertical accretion of overbank deposits during relatively moist periods of rising water tables while soils (geosols) which cap and separate alluvial deposits represent periods of entrenched arroyos, mostly channel-confined floods and inferred lowered water tables and drier conditions. Relative drought conditions prevail in the region today; arroyos are entrenched some 1 to 16 m below levels of abandoned terraces and permanently flowing stream segments occur only in the few locales where water table intersects the surface. Alluvial piezometers in arroyo floors indicate that average depth to water table is 3 m while depth of alluvium over irregular bedrock (Cretaceous Wepo Formation) floors averages $\geq$7.6 m.

Recent investigations on northern Black Mesa suggest that Anathermal-aged alluvium be distinguished from Jeddito, Tsegi, and Naha deposits. Where Jeddito alluvium is locally preserved and exposed in valley fills, it is generally capped by a moderately- to strongly-developed Haplargid soil which includes 16 to 58 cm cambic and/or 37 to 95 cm argillic horizons and 40 to 190 cm calcic horizons with Stage II to III carbonate development (Gile *et al.* 1966). In at least two valleys, alluvial deposits dating between 10,510±510 and 8,150±810 yr B.P. overlie and/or are inset beneath the level of this soil. These deposits generally

Eric T. Karlstrom, Department of Geography, Box 15016, Northern Arizona University, Flagstaff, AZ 86011.

consist of banded gray clays and buff sands which locally include cienega (organic rich, marsh-type) deposits, marls, aquatic snail shells, and C-14 datable wood and charcoal.

An arroyo cut in Red Peak Valley at about 36°26′ N. lat. and 110°19′ W. long. (N403216, E56094) exposes some 420 cm of clay-rich, mottled, rhythmitic sediments which date 9,660±150 yr B.P. (Beta-8807) near the arroyo floor and 9,110±130 yr B.P. (Beta-8806) some 180 cm higher in the section (Figure 1). Abundant aquatic snail and clam shells, including *Gyraulus parvus, Lymnea* sp., *Planorabella* sp., and *Pisidium* sp. (R. Hevly, pers. comm. 1985) indicate sedimentation in a shallow standing water body. This unit can be traced some 3.6 m down valley where ca. 7 to 8 m of similar sediments overlie and/or are inset below the level of the "post-Jeddito" soil. Sticks collected from this unit ca. 1 m above the arroyo floor date 10,510±510 yr B.P. (Beta-7235), indicating that this unit probably represents the same interval of rising water tables, lengthened permanent flow segments, and standing water. Height of such slack-water deposits in terraces some 5 to 14 m above present arroyo floor in this valley suggests a rise in local water tables of at least that magnitude during the Anathermal.

A tributary arroyo some 100 m south of the axial valley at Figure 1 exposes a buried Cumulic Haplustoll soil developed in Jeddito-aged alluvium/colluvium. This soil includes a 60 to 140 cm dark brown (10 YR 3/2 m) cumulic A horizon, a 40 cm strong brown (7.5 YR 4/6 d) cambic horizon, and an 81 cm light brown

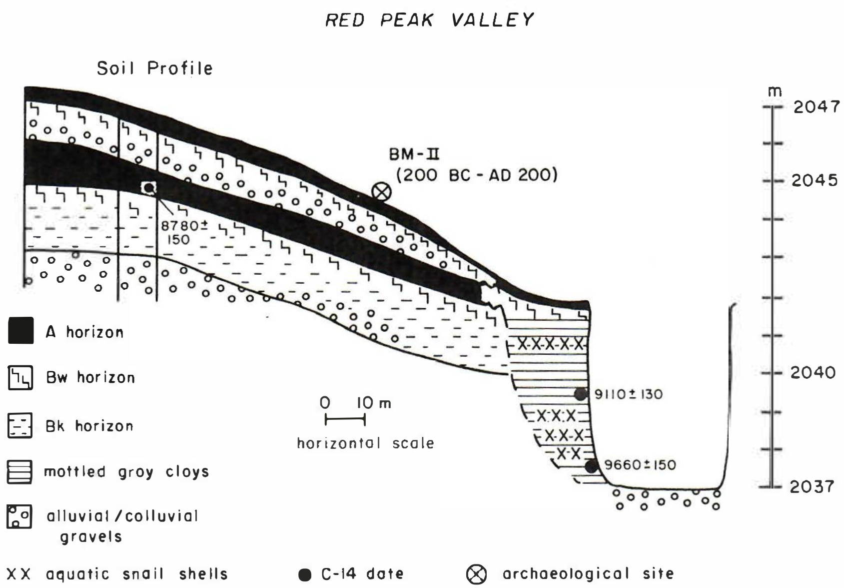

Figure 1. C-14 dated alluvial deposits and soils at Red Peak Valley, Black Mesa, Arizona.

(7.5 YR 6/4 d) calcic horizon with up to 6.5% $CaCO_3$ and Stage II carbonate development. The A horizon includes roots and earthworm tracks and probably formed under a relatively luxuriant tall grass vegetation. Mean residence time for organic carbon collected from the base of the A horizon dates 8,780±150 yr B.P. (Beta-8805), suggesting that the soil formed contemporaneously with ponding in the axial valley. Similar cumulic A horizons are not generally forming today on Black Mesa but are widespread in the Lukaçhukai Mountains some 610 m higher and 120 km east of this area and commonly cap "post-Jeddito" soils on Black Mesa. The A horizon of a buried "post-Jeddito" soil in Yellow Water Canyon (36°34′ N. lat., 110°24′ W. long.) dates 8,970±230 yr B.P. (Beta-8804). The buried soil in Figure 1 underlies a Typic Haplustoll soil, including a 40 cm dark brown (7.5 YR 3/4 m) A horizon and a 15 cm dark brown (7.5 YR 4/4 m) Bw horizon developed in colluvial and eolian material. This soil underlies a Basketmaker II site dating ca. 2,150 to 1,750 yr B.P.

Anathermal alluvium, including banded gray clays, reddish sands, and cienega deposits, is also preserved in Coal Mine Wash (36°38′ N. lat., 110°22′ W. long., N404445, E55595). Stick fragments some 1 m above stream level date 8,880±170 yr B.P. (Beta-8809). About 800 m upstream, similar alluvium overlies a truncated "post-Jeddito" soil some 4.5 m above stream level and dates 8,150±810 yr B.P. (Beta-7236; Karlstrom and Karlstrom 1986). This alluvial unit may represent the latter stages of the Anathermal ponding event recorded in Red Peak Valley or a distinct, later Anathermal depositional event.

While discretely Anathermal-aged deposits have not been identified in other drainages mapped on Black Mesa, it seems likely that, 1) such deposits exist but have not been dated, or 2) such deposits accumulated during regionwide, mesic Anathermal conditions but have been removed from most locations by subsequent erosion.

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Geoarchaeological Investigations in the Lower Kansas River Basin

Brad Logan and William C. Johnson

Current geoarchaeological research in the lower Kansas River basin demonstrates the differential effects of fluvial processes in preserving or eroding late Pleistocene-early Holocene deposits and any archaeological evidence they may have contained. Four terraces have been delineated in the lower Kansas River valley: in order of decreasing elevation they are the Menoken, Buck Creek, Newman, and Holliday Terrace Complex. The Menoken and Buck Creek Terraces are presently believed to date to pre-Wisconsin time. The ages of the Newman and Holliday Terraces and the deposits beneath them are currently being determined, where possible, with radiocarbon assays or by their association with temporally diagnostic archaeological materials.

Paleosols burned beneath the Newman Terrace at two localities have been dated at 7,250±115 yr B.P. (DIC-2946) and 10,430±130 yr B.P. (Beta-2931), indicating the fill was being deposited during late Pleistocene and early Holocene time. The presence of at least one bured soil that dates to a time when Paleoindian groups occupied the central Great Plains indicates some potential for discovering evidence of their activities. An important characteristic of the distribution of the Newman Terrace, however, is of concern to archaeologists seeking such evidence in the lower Kansas River drainage. This terrace constitutes 50% of the valley floor from the city of Topeka downstream to the village of Eudora and 90% of that in tributary valleys. Below Eudora, this terrace has been largely removed by lateral planation. Along the latter reach, perhaps not entirely by coincidence, sand and gravel bars contain skeletal remains of Rancholabrean fauna, including mammoth, mastodon, musk ox, sloth, peccary, and stag moose (Martin *et al.* 1979) and the few finds of fluted projectile points that form our only evidence to date of the presence of Paleoindians in the Kansas River valley (Rogers and Martin 1982, 1983). Although not yet demonstrated conclusively, such finds may reflect, in part, the erosion and redeposition of Newman Terrace deposits.

The distribution of the Newman Terrace and the ages of its underlying deposits provide a predictive guide for archaeological survey. Since Newman Terrace fill constitutes most of the valley floor along tributary streams, subsurface surveys in those areas where it is preserved have a greater potential for discovery of buried, in situ deposits of Paleoindian materials. An exception to the preservation of the Newman Terrace in tributary valleys is Stranger Creek basin. This system is analogous to the lower Kansas River drainage in that the trunk stream has meandered extensively throughout the lower part of its valley and removed the Newman Terrace fill. This terrace, however, still remains largely intact along streams tributary to Stranger Creek. Recent archaeological surveys and geoarchaeological investigations have determined that the Newman

Brad Logan, Museum of Anthropology, University of Kansas, Lawrence, KS 66045.
William C. Johnson, Department of Geography, University of Kansas, Lawrence, KS 66045.

Terrace has been stable along tributary streams since at least 2,000 yr B.P., based on the presence of numerous surface sites of the Plains Woodland and Plains Village periods, the low incidence of late Archaic sites, and the absence of Paleoindian, early Archaic, and middle Archaic sites (Logan 1985).

The Holliday Terrace Complex has developed to only a modest extent along the lower reach of tributary streams in Stranger Creek basin. However, it forms the valley floor throughout the lower portion of Stranger Creek valley, and extensive surveys in that area have not found Paleoindian or Archaic sites. The fill below the Holliday Terrace Complex has been dated at one locality in Stranger Creek valley to 4,260±55 yr B.P. (DIC-3148; Logan 1985) and at another locality in the lower Kansas River valley to 4,290±310 yr B.P. (Beta-2159; Holien 1982). These dates demonstrate that the Newman Terrace and any archaeological deposits it contained were being removed from the lower Kansas River basin by at least 4,200 years ago.

Ongoing archaeological investigations, including the continuing acquisition of C-14 dates, in the lower Kansas River basin are demonstrating that surveys in that area for evidence of human occupation during the late Pleistocene and early Holocene can be guided by an understanding of the age of terraces and their underlying deposits. Higher terraces, Menoken and Buck Creek, have been sufficiently stable since at least late Wisconsin time and may therefore contain surface sites of the Paleoindian period. Fill below the Newman Terrace typically exhibits several buried surfaces and may contain evidence of the Paleoindian and early Archaic periods. However, this terrace has been systematically eroded from the lower parts of Kansas River and Stranger Creek valleys. In these it has been replaced by the more recent deposits of the Holliday Terrace Complex, and any search for in situ evidence of late Pleistocene peoples therein will be in vain.

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Missouri River Trench and Terrace Sequence, North-Central South Dakota

Michael McFaul

Presented here are the results of a 1985 field geoarchaeologic investigation covering approximately 65 km^2 along the right bank of the dammed Missouri River from the North Dakota-South Dakota state line southward to the Grand River in South Dakota. The study attempts to develop a geomorphic history of the Missouri River trench and its terrace topography as it relates to previous investigations (McFaul 1985). For this work, landforms are grouped by similarities in their elevations above sea level, pedogenic development, depositional environments, spatial distribution, and topographic expression.

The five major landform associations are illustrated in Figure 1. They include a deflation plain, an erosional terrace, and three accumulation (Zonneveld 1975) or fill terraces. The highest landform association at 634 m is an erratic-littered deflation plain. The plain divides two east-trending pre-Missouri drainages (Flint 1955). Below the deflation plain at 549 m is the gravel-armored and silt-capped T4 accumulation terrace. The gravels consist of an unknown thickness of nonweathered alluvial gravels overlain by 2 m of slightly oxidized gravels. Color suggests two periods of silt deposition consisting of a darker fluvial deposit capped by lighter-colored loess. Although some $CaCO_3$ accumulation is present at the gravel-silt boundary, the soil is weakly developed.

At 513 m, the T3 erosional terrace lacks gravels. Laminated silt/clay sediments mantle the Cretaceous Pierre Shale and are occasionally covered by 0.5 to 1.25 m of loess. The loess soil is also weakly developed with minimal $CaCO_3$ accumulation.

Below the T3 terrace at 499 m is the T2 accumulation terrace. T2 sediments consist of approximately 5 m of alluvial gravels overlying the Pierre Shale in addition to two distinct loess sequences. Gravels are similar to the slightly oxidized gravels of the T4 terrace. Soil of the basal loess sequence is moderately developed, containing a Bt horizon and a Stage II/III $CaCO_3$ accumulation superposed into its A horizon. Two soils are present in the upper loess, a weakly developed modern soil and a buried moderately-developed structural soil with a Stage II/III $CaCO_3$ horizon.

The T1 accumulation terrace rests upon 35 m of glaciofluvial gravels and redeposited shales (Flint 1955). Above the gravels, the sediments become texturally finer toward the terrace tread at 491 m. These sediments contain a buried A horizon and $CaCO_3$ accumulation similar to the lower three members of the Oahe formation (Moran *et al.* 1976).

Even though thermoluminescence and radiocarbon dates are not yet available, the following preliminary geomorphic history is presented: An early Wisconsin or Napoleon (Moran *et al.* 1976) till plain was deflated in Iowan (Ruhe 1969) or middle Wisconsin time. During the late Wisconsin (early Tazewell), the east-trending drainages were dammed and runoff was diverted

Michael McFaul, LaRamie Soils Service, P.O. Box 255, Laramie, WY 82070.

southward when ponding topped the "Iowan" drainage divide. Downcutting through the Pierre Shale continued until the newly created Missouri stabilized at a paleo-Grand River floodplain (T4). Rejuvenation followed and the river cut to the T3 level. Laminated sediments mantling the Pierre Shale at the T3 level suggest ponding occurred before renewed cutting took place to the T2 bedrock level.

Following downcutting, a gravel fill event and subsequent loess deposition mantled the T2 strath. Pedogenic development in the loess sequence suggests a period of stability preceded a renewed downcutting and fill cycle (Cary). The Cary cycle was succeeded by a sequence of events described for the lower three Oahe formation members at the T1 terrace and by loess deposition and pedogenesis on the upper terraces.

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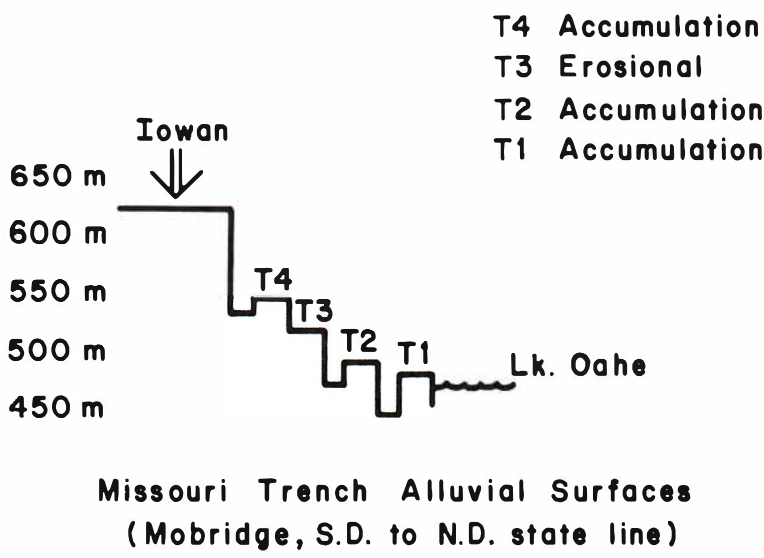

Figure 1. Major landforms along the Missouri river, north-central South Dakota.

Paleoenvironmental Studies in the Guayana Region Southeast Venezuela

Carlos Schubert

Evidence of late Pleistocene aridity in northern South America includes: fossil dunes, arkosic sand on the Brazilian continental platform, palynological analyses, alluvial fans and terraces, relict savannas, and duricrusts (Shubert and Fritz 1985); biological refugia were proposed to occur in Amazonia and the Guayana Highlands (Prance 1982; Steyermark 1979). In 1984, a survey was begun to search for paleoenvironmental evidence in Guayana. Two types of Quaternary sediments have been studied to date (Figure 1): peat deposits on the summits of sandstone table mountains (up to 2,900 m elevation) and alluvial deposits in the lowlands (600-1,000 m).

The herbaceous peat deposits occur as a discontinuous 1-2 m thick layer covering the highly irregular and dissected summits. Samples for palynological and radiocarbon analyses were collected from outcrops and Hiller-type cores. Radiocarbon dating at two sites (Chimantá and Guaiquinima massifs) showed that the maximum age of the peat layer ranged from 5,100±90 to 6,000±80 yr B.P. (Schubert and Fritz 1985).

Alluvial deposits form terraces along the Kukenán, Arapán, and Aponguao rivers (Figure 1, black dots from east to west, respectively). At Kukenán, there is a 3-5 m thick, unbedded boulder and cobble conglomerate in a sandy, ferruginous matrix. The clasts are subrounded to subangular sandstone, jasper, and diabase fragments derived from the Roraima table mountains. The conglomerate is a chaotic mixture, with no sedimentary structures, resting on Precambrian rock. At one outcrop, the conglomerate contained a sandy peat lense with charcoal fragments, and it is overlain by a discontinuous 1 m brown sand layer with frequent charcoal fragments. At Arapán, there is a 1-2.5 m layer of unbedded conglomeratic sand in a highly ferruginous matrix. The sandstone and jasper pebbles are rounded to subrounded and there are no visible sedimentary structures. At Aponguao, there is a 2 m terrace consisting of brown, poorly-bedded sand with discontinuous basal and top intervals containing charcoal fragments. From all of these localities, samples of charcoal and peat were collected for radiocarbon dating (in process by P. Fritz, University of Waterloo).

The radiocarbon ages of the peat suggest that climate before the early Holocene did not permit the formation of peat; as it does today (2,000-4,000 mm annual rainfall; Grupo Científico Chimanta, in press). The alluvial deposits suggest a rapid, short-distance, intermittent, and torrential sedimentation. At present, rivers carry little sediment above silt- or fine sand-size, and weathering and erosion is mainly chemical. All of these preliminary data suggest that the late Pleistocene climate in the Guayana region was more arid than today. Further radiocarbon and, particularly, palynological analyses will refine this tentative interpretation.

Carlos Schubert, Centro de Ecología, I.V.I.C., Apartado 1827, Caracas 1010A, Venezuela.

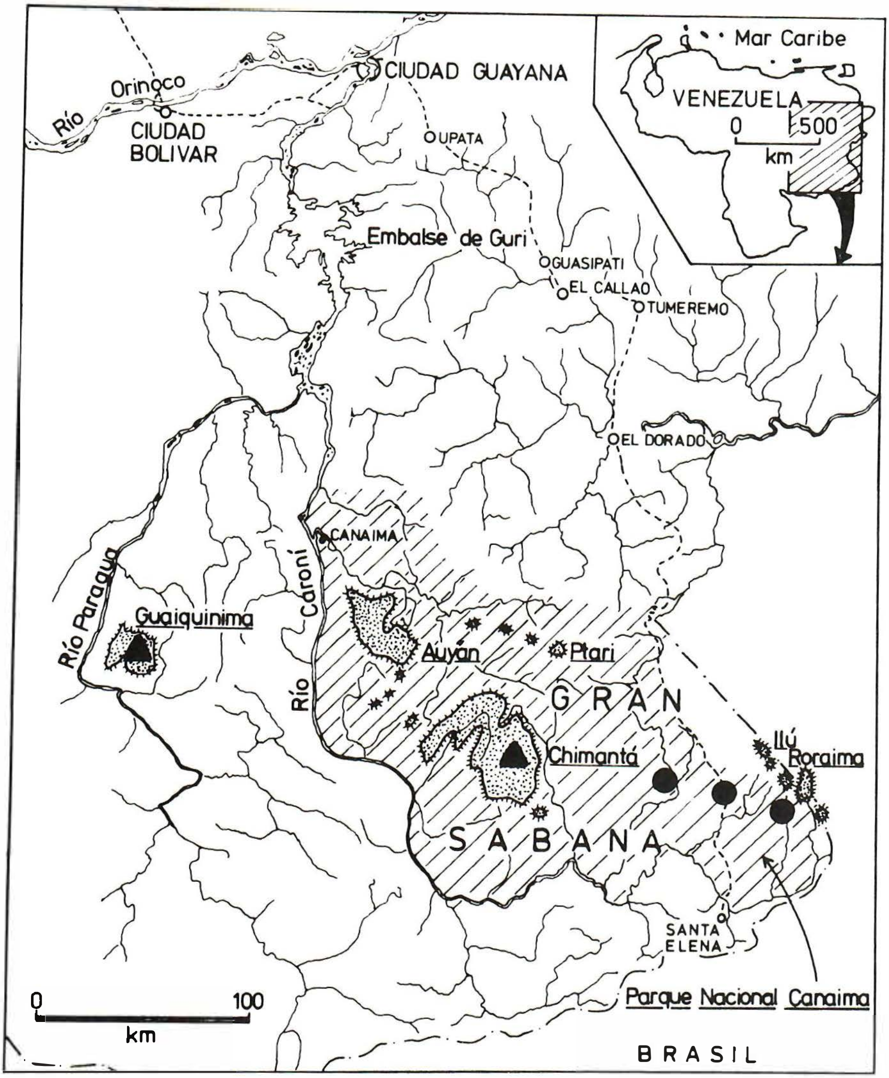

Figure 1. Location of study area. Stippled areas are table mountains cut into Precambrian sandstone (Reid and Bisque 1975). Hatched area is a 600-1,000 m plain which surrounds the mountains. The black dots represent the sites of alluvial deposits and the black triangles the sites of peat deposits studied.

This study is being done in the collaboration with C.V.G.—EDELCA, the Department of Earth Sciences of the University of Waterloo,.and with partial support of CONICIT, Grant s l-1343 to O. Huber.

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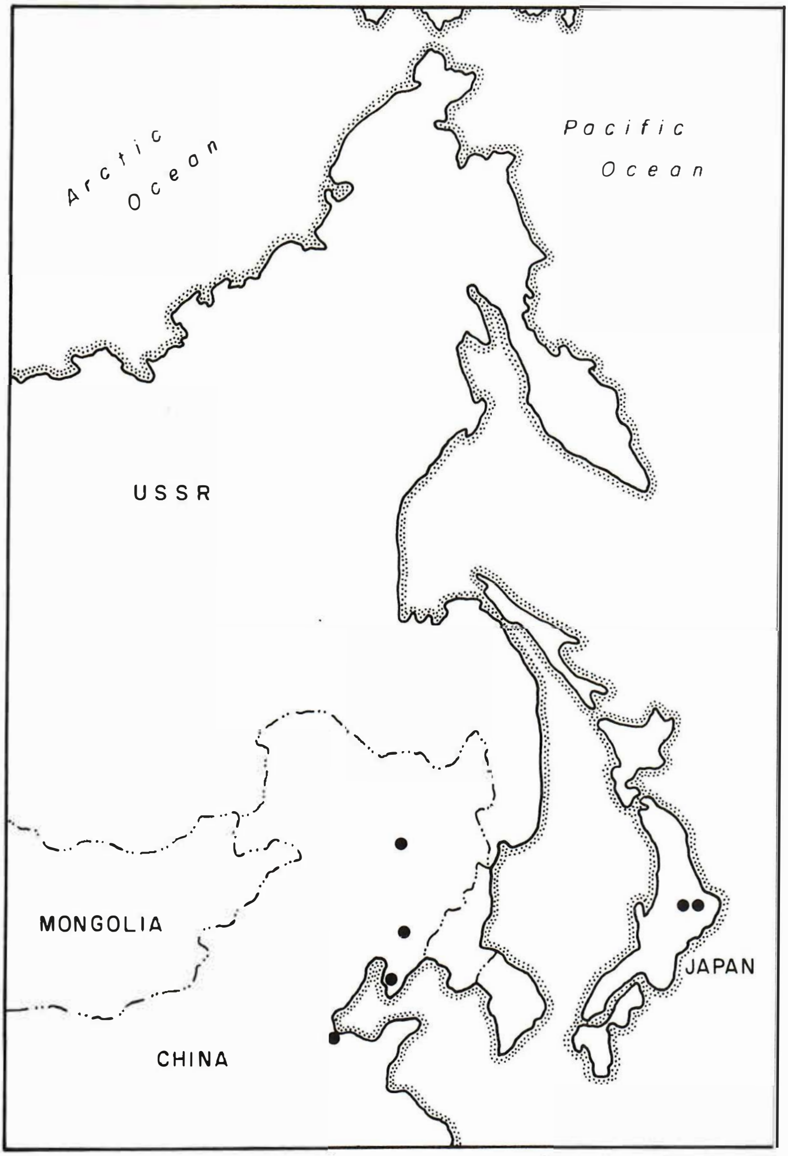
Regional Focus—Northeast Asia



Map of greater Asia locating sites and features discussed in this section.

Hunting Strategies of Late Paleolithic Man in Northeast China

Jiang Peng and Ho Chuan Kun

Introduction

The geographic area that will be covered in this paper is roughly 118° E. long., 38° N. lat. in the northeastern part of China. The purpose of this paper is to discuss the hunting strategies of late Paleolithic man by using the most recently found archaeological material from this area. Twelve late Paleolithic sites have been found in this portion of China: four cave sites and eight other sites, most of which are located in the central and southern part of northeastern China.

The modern climate in this area is continental. Regional annual temperature differentials are pronounced. Both faunal and pollen data indicate a tundra and periglacial environment during the late Paleolithic. It is estimated that the temperature was 6°C colder than it is today. *Homo sapiens* could only gather during the short summer; the rest of the year they devoted to hunting. This is in contrast to the hunting behavior of *Homo sapiens* in temperate, warm temperate, and subtropical zones. It is possible that there was seasonal food storage (e.g., of meat) in northeastern China during the late Paleolithic.

Lithic Technology and Hunting Strategies

Most lithic assemblages are predominantly flake tools; core tools are seldom found. For instance, of more than 10,000 lithic artifacts found at Xianjendong, 90% are flake tools. The tool types are mainly scrapers, choppers, pointed tools, burins, and bola stones. The most common tools are scrapers, the least common are choppers and burins. Overall, these 10,000 lithic artifacts are relatively small.

The most common manufacturing technique entailed the use of the hammerstone. Most of the tools have prepared platforms, but some tools have cortical platforms. The anvil technique was also used. Both unifacial and bifacial retouch are apparent. The manufacturing techniques of the late Paleolithic are much improved when compared with the middle Paleolithic. Pressure-flaking and small tool size are the main characteristics of the late Paleolithic industry.

The hunting gear consists of bolas, choppers, and possibly wooden clubs. Bola stones are widespread in the northern Chinese sites along the Yellow River. They first appeared in China during the early Paleolithic and were widely used during the middle Paleolithic site of Xujiayao, which may indicate the role that bolas played in the hunting mode of subsistence. Thus far, in northeastern Chinese sites from the late Paleolithic, bola stones have been found only at Xianjendong in Haicheng Province. The stones are vein quartz (largest diameter, 10-12 cm; smallest diameter, 3-5 cm).

Jiang Peng, Jilin Institute of Archaeology, Changchun City, Jilin Province, China.
Ho Chuan Kun, 2018 Shangrila Circle, Ridgecrest, CA 93555.

As mentioned, bola stones do not appear in northeastern China until the late Paleolithic. These artifacts are found mainly in the southern portion of northeastern China, and are found in large quantities. These facts suggest several possibilities. First, the hunting lifeway in northeastern China during the Paleolithic was different from that of northern China in terms of hunting kits and strategies. Second, the late appearance of bola stones in northeastern China is related to the hunting mode of subsistence of the late Paleolithic of northern China. Third, once the bola stones were adopted they were widely used. For example, bolas are still used by groups in southwest China, such as the Tibetan, Naxi, Pumi and I people.

Choppers were used to cut down trees to make wooden clubs. Of course, they can also be used for fighting. No wooden clubs have been found in any of the Paleolithic sites in northeastern China, but such tools would have been good for hunting. The lack of wooden objects may be due to poor preservation. It is possible that wooden points were the progenitors of stone points. Finally, a tool reminiscent of an arrowhead was found at Xibajianfang. This artifact may have been the prototype of projectile points. The small size of some of the fauna found in late Paleolithic sites supports the inference of the use of bows.

Mammalian faunal remains are deposited primarily due to one of three factors: catastrophic events, carnivore accumulation, or human activities. Most mammalian faunal assemblages in northeastern China have been discovered with human and cultural remains. More importantly, most fossil remains are highly concentrated, and no carnivore gnaw marks have been found. Thus, we may conclude that most of the fossils, especially the remains of hunted game, were accumulated by *H. sapiens*. The large numbers of fossil bones recovered from Paleolithic sites and the evidence of hunting behavior both indicate that some of the houses and windbreaks could have been built with animal remains as well.

Although some small- and medium-sized mammalian species are represented in faunal assemblages, most fossil bones are from big game: *Mammuthus primigenius* (mammoth), *Coelodonta antiquitatis* (rhinoceros), *Equus przewalsky* (horse), *Bos primigenius* (cattle), and *Cervus canadensis* (deer). These animals are large and fierce and thus hard to approach. It is only by developing group strategies that such game can be hunted. This in turn implies organized and planned behavior. It is also possible that game was driven with fire. Bolas and traps may also have been important hunting strategies. Most faunal assemblages consist of large, grassland mammals, followed by rodents and, much less frequently, carnivores. Hunting apparently could have caused the partial extinction of big game in northeastern China.

Most of the bones were used as food resources by late Paleolithic man, but some of them were used for decorative purposes and for bone tools. The hunted game may have been transported back to campsites or residential areas for further processing. Butchering tools include scrapers, pointed tools, and flakes. These artifacts constitute more than 35% of the lithic assemblages. Burned bones and ash layers found at many late Paleolithic sites are positive evidence of the use of fire. Fire is used not only to increase the number of edible resources but also to keep houses warm. Large numbers of discarded bones have been found in late Paleolithic sites; some exhibit hack marks and others have been modified into bone tools and decorative items. Most bone objects are made from limb bones. Skulls and ribs are seldom used for bone tools. Thus, most of the bone tools found in the late Paleolithic sites in northeastern China are scrapers, pointed tools, needles, awls, points, and harpoons.

Some Key Characteristics of Japanese Pleistocene Archaeology

Charles T. Keally

Paleolithic, or Pleistocene, archaeology in Japan is a large enterprise. There are several thousand sites, of which at least 500 can be ranked as important. The total number of archaeological sites in Japan exceeds 200,000 in a territory of only 377,000 km^2. Perhaps as many as half, or more, of these Paleolithic sites have been excavated. Up to 150 of the over 10,000 excavations of all periods conducted each year involve major Paleolithic work. The funding for this Paleolithic work must be a similar 2% of the more than $150,000,000 spent annually for all types of excavations. Fifteen to 20 of the roughly 1,000 excavation reports published yearly focus on the Paleolithic. At least 50 to 100 of the thousands of articles also deal solely or mainly with the Paleolithic. Untold numbers of additional monographs and articles contain considerable information useful to Paleolithic research.

Individual Paleolithic excavations are usually quite well funded, sometimes almost limitlessly so. A significant proportion of them strip in excess of 1,000 m^2 and some exceed 10,000 m^2. However, there is a definite imbalance in the number, size, and funding of the work; the vast majority of Paleolithic excavations, especially large ones, are in eastern Japan and relatively few are in western Japan. But the work everywhere is generally careful and detailed. Most Paleolithic excavations record the precise three-dimensional locations of every object, including all debitage and burned pebbles. Complete maps of the distribution of all these objects are published. All tools are drawn to show the mechanics of their production as well as their shape. These drawings also are published completely.

Many of the sites have superb stratigraphy, especially in the South Kanto Plain around Tokyo. Sites with 10 to 15 occupation floors intercalated in 2-5 m of loam are not at all uncommon. Further, the deposits in that region are uniform and easily compared from site to site over an area of more than 3,000 km^2. Pleistocene volcanic activity has resulted in many other smaller regions with reasonably good stratigraphy. One enormous eruption in southern Japan 21,000 to 22,000 yr B.P. spread a unique and easily-distinguished layer of glass

Charles T. Keally, Sophia University, 4 Yonban-cho, Chiyoda-ku, Tokyo 102, Japan.

over most of the country, providing a marker horizon for aligning the majority of the important upper Paleolithic sites.

The hundreds of well-stratified occupations from extensively excavated sites near Tokyo provide the basis for a solid sequence of Paleolithic development from around 35,000 to 10,000 yr B.P. in that region. The geologic and cultural layers are firmly dated by radiocarbon, fission-track, and fission-track-based obsidian hydration measurements. Typological, geological, palynological, and chronometric comparison of this regional sequence with sequences from other regions of Japan has allowed construction of a rather firm chronology for the entire country (Oda and Keally 1979). However, despite nearly 40 years of Paleolithic archaeology, there is still no consensus on the cultural divisions of this sequence and several different chronologies are in use at the same time.

Paleolithic sites are typically open sites, and only one or two have yielded faunal remains. Consequently, data for Paleolithic research consists of stone tools, flaking debris, large pebbles and cobbles, fire-reddened and cracked pebbles, and the spatial relationships of these in their distribution over the occupation surface. Refitting of tools and flakes and cracked pebbles, obsidian source analysis, and palynological and geological studies have added a lot of important information to this knowledge.

Agreement on the classification of the stone tools seems to be a way off yet, but sharp regional differences in types are obvious, particularly in the later half of the upper Paleolithic (Akazawa *et al.* 1980). The kind and degree of continental contact is also unclear. The existence of artifacts of human manufacture older than 30,000 or 35,000 yr B.P. is perhaps the most disputed issue in Japanese Paleolithic archaeology. The process of transition from the Paleolithic to the following Jomon culture is becoming better understood, but a lot of research remains to be done to fully illuminate that process. And to date little more than talk has been given to the subject of how the Paleolithic people actually lived; the research is habitually directed at lithic technology and typology.

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A Terminal Pleistocene Salmon-Fishing and Lithic Worksite at Maeda Kochi, Tokyo, Japan

Charles T. Keally and Hiroshi Miyazaki

Maeda Kochi is a terminal Pleistocene riverside workcamp that has yielded over 2,000 spear points in various stages of production, over 7,000 dog salmon (*Oncorhynchus keta* Walbaum) teeth, the remains of two shelters, and fragments of two clay pots. The site is located on the middle Tama River near the edge of the mountains, about 45 km west of downtown Tokyo and the modern Tokyo Bay. When it was occupied 13,000 yr B.P., the site was 80 km upstream from the Pacific Ocean, based on reconstruction of the coastline at that time.

A team of researchers and excavators has been working on the site year-round since the summer of 1976. Shimpei Kato of Tsukuba University, Ibaragi prefecture, is the director. The on-site supervisor was Sadashi Hashiguchi until March 1979, and has been Hiroshi Miyazaki, a Tokyo metropolitan archaeologist, since then. Excavation ended in December 1984. The final reports will be published by December 1987. To date, three excavation reports and three articles on aspects of the research have been published; all are in Japanese without English abstracts.

The spear points and flaking debitage were scattered over a large part of the 30,000 m^2 of the site exposed by excavation, but they concentrated in six locations on both sides of the channel of an ancient spring-fed stream in the old floodplain at the confluence of the Tama and Aki rivers. Nearly all of the spear points are unfinished objects, many broken in the final stages of manufacture. The predominant form is long and slender, with a hint of a stem at the base. Refitting of the points and approximately 500,000 larger flakes recovered by hand-troweling is providing virtually complete details on the manufacturing process. The raw materials are mostly chert and sandstone obtained from the local river gravels, with some rare pieces coming from Hakone and Niigata, 50 and 200 km away.

In addition to the spear points, there are a few notched pieces and scrapers, and two axes in the lithic collection. There are also a fair number of fire-reddened and cracked pebbles. Two features thought to be the remains of small shelters were found on the north bank of the stream channel. Both had slightly sunken floors. A lens of charcoal and burned pebbles discarded in one of them contained about 10,000 minute fragments of bones and teeth. The potsherds were associated with this refuse; all of them are plain and they are among the oldest yet found in Japan. But the materials do not suggest a dwelling site. Almost certainly, Maeda Kochi was a worksite detached from a base camp on the nearby bluff.

Dog salmon teeth account for 7,300 of the bone and teeth fragments found in the one shelter. It is estimated that these teeth represent 60 to 80 individual fish

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Charles T. Keally, Sophia University, 4 Yonban-cho, Chiyoda-ku, Tokyo 102, Japan.
Hiroshi Miyazaki, Office for Buried Cultural Resources, Department of Culture, Education Agency of Tokyo, 3-8-1 Marunouchi, Chiyoda-ku, Tokyo 100, Japan.

averaging about 1 m in length. The rocky bottom of the stream running through the site probably was a salmon spawning ground. Among the remaining 2,400 fragments, a few were identified as those of a bear species, most likely the Japanese black bear (*Selenarctos tibetanus japonicus*), and a small land mammal.

Geological, palynological, chemical, and radiometric dating results are not yet complete. Technological study of the spear points and flaking debris is still in progress. But when all of this information is in and compared, a relatively complete picture of activities at the site should emerge.

Seasonality and Site Structure of Late Paleolithic Sites from Northeast China

You Yu-Zhu, Xu Qi-Qin, Li Yi, and Ho Chuan-Kun

At least 12 localities with fossil hominids, 17 lithic assemblages, and 140 Quaternary deposits with mammalian fossils were found during the 1970s in Manchuria. The geologic age of these localities is primarily mid-Pleistocene to early Holocene, but most are from the late Pleistocene. The earliest site has been dated to 330,000 yr B.P. by uranium series dating, the most recent one has been dated to 7,000 yr B.P. Cultural remains that indicate a cultural evolutionary sequence have also been found at these sites, and environmental reconstruction from the mammalian faunal assemblages indicate four evolutionary stages. These new finds from northeastern China will undoubtedly provide us with basic data for the research of hominid migration and cultural diffusion between East Asia and North America.

This paper will discuss in a preliminary fashion the seasonal occupation and site structure of two newly excavated late Paleolithic sites from northeastern China.

Gulongshan Cave site

The Gulongshan cave site is located near Dalien, a city in northern Fuxian Province (39°40′ N. lat., 122°01′ E. long.). The cave has formed within Cambrian limestone. Due to recent quarrying activities, the main cave has been destroyed. The portion of the cave that remains is estimated to be 60 m long and has an inverted trapezoidal cross-section. The deposits within the cave consist of a 4 m thick grayish white clay near the bottom level that darkens near the surface and becomes grayish yellow. The uppermost level is a dark red clay. The bottom level has been dated to 40,000 yr B.P. and the middle level to 20,000 yr B.P. by uranium series dating; the upper level has been radiocarbon dated to 17,160±240 yr B.P.

You Yu-Zhu, Xu Qi-Qin, and Li Yi, Institute of Palaeontology and Palaeoanthropology, Academia Sinica, Beijing, China.

Ho Chuan-Kun, 2018 Shangrila Circle, Ridgecrest, CA 93555.

The cultural remains consist of six lithic artifacts, fire-cracked rocks and burned bones, bone flakes that have been chipped by hominids, and other fossils. The six lithic artifacts, one core and five flakes, are definitely human-made. The flakes are small (<60 mm) and made of quartzite. Based on the presence of cortex, we believe that most of the raw materials were collected from the banks of the Huitou River. There are more than 100 chipped animal bones that were evidently made by humans. Most of them are 15 cm long. These chipped bones have a pointed end; the opposite end may be obtuse or truncated, but most have points on both ends. There is evidence of trimming at one end.

Other bone artifacts have been found at late Paleolithic sites in China recently (e.g., Shiyu site, Shanxi; Jinnuishan site in Liaoning; Yusu site in Jilin; and Yenjiagang site, Harbin). Most of the broken bones are regarded as non-worked, but some of them are recognized as bone tools. In fact, at those places where lithic raw materials are in short supply, Paleolithic man may possibly have used bone tools. When we performed a paleoecological analysis of those sites at which bone tools have been found, we found a clear correlation between sites with bone tools and grassland or steppe-grassland environments.

Reconstruction of the environmental setting at Gulongshan indicates that it is evidently profitable to study seasonal occupation. There are 62 species of fauna represented in the Gulongshan assemblage: 7 species of birds, 2 species of fish, 1 reptile species, and 52 species of mammals (Table 1). Five community types can be identified within the mammalian fauna: open steppe types (17 species), forest-grassland or shrub types (20 species), cool temperate/tundra types (3 species), mixed environment types (8 species), and 2 species from special environmental settings. These 5 different community types indicate the mosaic of the natural environment, but the temperate, steppe, and forest-grasslands are predominant (71% of the species). Minimum number of individuals (MNI) counts of the steppe species represent 80% of the total.

The natural landscape is roughly similar to the modern boundary between the Songliao Plain and Daxinganling. We estimate that the mean annual temperature was 3-6°C, which is 3-4°C lower than it is at present. Annual precipitation was 400 mm, 200 mm less than it is today. Annual temperature differences were widely variable; thus, unfavorable for less cold- and warm-adapted species, presumably affecting MNI results.

The people that lived in the Gulongshan area were hunters; the animals that they hunted were mainly ungulates, especially horses. According to our estimation, the more than 6,000 isolated horse teeth represent at least 250 individuals. The age profile of the horses is estimated in Table 2 based on a total of 151 right maxillary first molars. The age profile reflects the predominantly subadult character of this prey species. Deer, antelope, hyena, and mastodon remains are also predominantly from subadult individuals. Finally, tooth-section studies show that the outermost annual growth ring is whitish and semitransluscent; thus, we may suggest that the animals were killed during the summer.

As indicated on Table 3, 7 species of birds are represented in the faunal assemblage. Ducks and pheasants are widely distributed in China, while *Perdix* sp. (partridge) are found only in northeastern China and the mountainous areas of northern China. *Charadrius* sp. (*Pelbates;* plover) are adapted to relatively cold climates and presently can be found in the mountainous areas of Hailongjian and Changbaishan in Jilin Province. They can be found in the Dalien area of Fuxian Province year-round, but they are difficult to find during the winter. Plover (*Charadrius* sp.) and sandpiper (*Tringa* sp.) are migratory. They stay in the Dalien area only during the late spring and early autumn and migrate to East Africa and other tropical regions for the winter.

The bird remains indicate that the Gulongshan site was occupied by *Homo sapiens* during the late spring and early winter. In addition, the fact that remains of cold-weather-adapted mammals, such as mastodon, occur at the site suggests spring and autumn occupation as well.

In summary, the Gulongshan cave site was occupied by hunters from northern China during the spring. These hunters subsisted mainly on animals that lived in the open grassland, and then moved back to North China during winter.

Yenjiagang Site

Yenjiagang is located 25 km southwest of Harbin. The site was found in 1982. In three years of excavation, the following archaeological remains have been found: one broken skull (*Homo sapiens*), six lithic artifacts, and the remains of 24 species of mammals. The skull fragment is a posterior portion of the right parietal. The lithic artifacts are choppers, scrapers, and cores made of flint, quartzite, or basalt. Only one chopper is longer than 70 mm. One flint scraper is well-made and exhibits secondary retouch. The faunal assemblage is described in Table 4.

Most of the lithic and faunal materials were found in the grayish white, fine sand that occurs 3.5 m below the surface. This cultural layer is 0.8 m thick and overlain by loess, black soil, and cultivated soil. The site is 15 m above the nearby river (Yunlian He) and located near the upper part of the second terrace. The cultural remains and fauna are especially concentrated at the protruding portion of the terrace.

The excavated portions of the site have been designated Tests A, B, and C (TA, TB, and TC). The eastern section of TB contains fewer, scattered materials while the central portion of TA and the western portion of TC have heavy concentrations of cultural materials.

An additional 200 bones have been found in TA3. The horizontal distribution of these fossils is elliptical; the east-west extent of the concentration is 4 m and the north-south axis is 3 m. Identifiable individuals include 6 wild horses, 5 bison, 2 rhinoceros, 1 deer, and 1 wolf.

Three hundred bones are scattered in a semicircle in TC4, 40 m northwest of TA3. Five individual rhinoceros, five wild horses, three bison, four deer, one hyena, one wolf, and two antelope are represented. Interestingly, most of the bones in both TC4 and TA3 are subadult. The only exception is a rather mature mammoth. In addition, most of the large or broken bones have hack marks.

The modern Yunlian River flows southeast to northwest. The direction of the flow may have been the same in the past as indicated by the stratigraphy and geomorphology of the site location. The distributional patterns of the bone scatters at TC4 and TA3 and the direction of flow of the river do not correlate, because most bones lack evidence of rolling and the microstructure of the sandy layers is diagonal to the distribution of the bones. Based on the modern fluvial system in northeastern China, we suggest that these two site locations were buried by low-energy regimes during the early summer. The main feature of this type of sedimentation process is that during high water level most of the fine sands begin to settle, a process that will not disturb the distribution of the fossils. The distribution of the bones and the flow of water at TA3 are in the same direction, while the distribution pattern and the flow of water at TC4 are in opposite directions. Thus, we suggest that the distributional patterns of bones in both test pits are not coincidental; they are related to human activity.

Other evidence also supports this interpretation. For instance, charcoal has been found inside the ellipse of TA3 and the semicircle of TC4, and the two bone piles create a berm. Below this short wall a rich organic paleosol has been found. The water could not possibly have brought all of the subadult individual carcasses together and accumulated at 0.8 m high and 1.0 m wide berm.

Thus, we conclude that TC4 and TA3 are two ancient campfires. Because there is no evidence of central hearths and postholes, the site was probably occupied temporarily. The faunal assemblage indicates a cold climate, which is consistent with the results of the pollen analysis (90% nonarboreal pollen). It is difficult to imagine how the occupants of this site could have solved the over-wintering problem at such simple campsite structures in this cold environment.

Table 1. Faunal assemblage at the Gulongshan cave site

1. **Open steppe (17 species)**
   - *Ochotona kolowi* (pika)
   - *O. daurica* (pika)
   - *Myospalax armand* (mole-rat)
   - *M. psilurus* (mole-rat)
   - *M. fontanieri* (mole-rat)
   - *Citellus* sp. (squirrel)
   - *Mustela* sp. (ferret-mink)
   - *Equus hemionus* (horse)
   - *E. przewalskyi* (horse)
   - *Megaloceros ordosianus* (elk)
   - *Spirocerus kjachtensis* (kijachta antelope)
   - *Gazella przewalskyi* (gazelle)
2. **Forest-grassland or shrub (20 species)**
   - *Mus musculus* (mouse)
   - *Rattus rattus* (rat)
   - *Microtus* sp. (vole)
   - *Erinaceus europaeus* (hedgehog)
   - *Cuon* cf. *alpinus* (dhole)
   - *Meles* cf. *meles* (badger)
   - *Cervus canadensis* (deer)
   - *C. xanthopygus* (deer)
   - *Capreolus manchuricus* (roe deer)
   - *Bubalus wangi* (buffalo)
   - *Bos primigenius* (cattle)
   - *B. tanis* (cattle)
   - *Felis microtus* (cat)

3. Cold temperate–tundra (3 species)

Mammuthus primigenius (woolly mammoth)
Coelodonta antiquitatis (rhinoceros)
Lynx sp. (lynx)

4. Mixed (8 species)

Ursus arctos (brown bear)
Canis lupus (wolf)
Panthera tigris (tiger)
Sus scrofa (pig)
Lepus sp. (rabbit)
Panthera pardus (leopard)
Vulpes sp. (fox)

5. Special (2 species)

Lutra sp. (river otter)
Camelus sp. (camel)
Acinonyx sp. (cheetah)
Hipposideros sp. (bat)

Table 2. Age profile of horses in the faunal assemblage from the Gulongshan cave site, estimated using 151 right upper molars

MNI	Age (years)	Percent
91	<4	60.4
31	4-12	20.4
29	13-22	19.2

Table 3. Bird species in the faunal assemblage from the Gulongshan cave site

Anas sp. (duck)
Falco sp. (falcon)
Perdix sp. (partridge)
Phasianus sp. (pheasant)
Charadrius sp. (plover)
Tringa sp. (sandpiper)

Table 4. Faunal assemblage at the Yenjiagang site

Cricetellus sp. (squirrel)
Erinaceus europaeus (hedgehog)
Microtus sp. (vole)
Myospalax psilurus (mole-rat)
Martes sp. (marten)
Marmota sp. (marmot)
Mustela putorius (polecat)
M. sibirica (Siberian weasel)
Ochotona sp. (pika)
Lepus sp. (rabbit)
Canis lupus (wolf)
Nyctereutes sp. (racoon-dog)

Vulpes sp. (fox)
Crocuta ultima (hyaena)
Equus hemionus (horse)
Coelodonta antiquitatis (rhinoceros)
Mammuthus sp. (mammoth)
Bison exiquus (bison)
Bubalus sp. (buffalo)
Cervus elaphus (deer)
Megaloceros ordosianus (elk)
Sus scrofa (pig)
Gazella przewalskyi (gazelle)

Two Earliest Paleolithic Sites in Northeast China

Zhang Zhen-Hong and Chen Chun

The extensive area of northeast China is an important region, which bridges central China and northeast Asia. Yet as late as 1973, few cultural remains belonging to the lower Paleolithic period were found. Of the Middle and the Upper Paleolithic periods, the findings were confined to a humerus of Jianping man of Liaoning Province, and a human skull fossil at Zhoujiayufang, Yushu county, Jiling Province. Controversy over the actual value of these remains still exists, because the strata upon which excavations were made had been disturbed, and were therefore unclear.

In recent years, many archaeological sites of the Middle and the Upper Paleolithic periods have been found. The most significant discoveries were two Lower Paleolithic sites—Miaohoushan and Jingniushan. They are all cave sites, representing the earliest human remains so far discovered in northeast China (Zhang 1981).

The Miaohoushan site is located in the middle part of Benxi county, Liaoning Province, 41°14′49″ N. lat., 124°7′50″ E. long. It is the northernmost site of the Lower Paleolithic period so far discovered in China. The cave deposit, more than 10 m thick, was divided into eight layers. The layers 4, 5, 6, and 7 contained human remains, including 3 human teeth, 74 stone artifacts, a few bone tools, and a large number of mammalian fossils, in addition to ash and charred bones. The stone artifacts are cores, flakes, and tools, which can be divided into scrapers, chopper-chopping tools, points and stone balls. The scrapers are of various types with different edges and forms.

The characteristics of most stone tools of the Miaohoushan industry are: A) They were made of quartz sandstone, aplite and a few of veined quartz. B) They were chiefly made of flakes, limited in form. Main types are scrapers and

Zhang Zhen-hong, Department of Anthropology, Zhongshan University, Guangzhou, China.
Chen Chun, Department of History, College of Liberal Arts, Shanghai University, Xi-Jiang-Wan-Lu 574, Shanghai, China.

chopper-chopping tools. C) They lack regular type. All of them were crudely retouched.

The mammalian fossils included remnant species of the Tertiary period, such as *Sinocastor anderssoni* and *S. zdanskyi* (beavers); the species of the early Pleistocene period, such as *Homotherium* cf. *crenatidens* (scimitar cat); the typical species of the middle Pleistocene, such as *Megaloceros pachosteus* (giant deer), *Equus sanmeniensis* (horse), *Dicerorhinus merki* (rhinoceros), *Canis lupus variabilis* (grey wolf), *Panthera youngi* (panther), *Bubalus teilhardi* (buffalo), and *Coelodonta antiquitatis* (woolly rhinoceros). Judging from the fossils we can see that the duration of the site was long, probably from the middle and late period of the middle Pleistocene to the late Pleistocene (Yang 1982).

According to the absolute dating tests of paleomagnetic, uranium-series and radiocarbon methods, it might be determined that the age of layers 1-3 is old, dating back to 690,000 yr B.P. A hiatus is recognized between layers 3 and 4. Layer 4 is 400,000 yr B.P., layer 5 is 240,000 yr B.P., layer 6 is 140,000 yr B.P., and layer 7 is 96,000-17000 yr B.P.

The deposit of the Miaohoushan site has great significance in setting up a standard section in the strata division of the Pleistocene in northeast China.

The Jingniushan site is about 200 km to the south of Miaohoushan, 40°34′ N. lat., 122°30′ E. long. Only 7 stone tools have been found. The most exciting discovery is the skeleton fragments of a *Homo erectus,* including a rather complete skull, the fragments of ulna, hipbone and bones of hands and feet, in the summer of 1984 (Huang 1985).

According to the uranium-series dating test, the age of the stratum is between 200,000 to 300,000 yr B.P. The discovery of the Jingniushan Man is a great breakthrough in the research on Early Man in northeast China. All materials are still being studied.

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中国東北两处最早的旧石器遗址

張鎮洪 陳 淳

中国東北地区地处中国中原地区通往東北亚的桥梁地带，1973年以前，一直没有发現属于旧石器时代早期的文化遗存。中、晚期的文化遗址和人类化石也仅限于辽宁建平人上臂骨、吉林榆树周家油房的头骨和哈尔滨顾乡屯旧石器文化遗址。对于这些发現还存在着不同程度上的争论，因为有些遗物是没有地层的。

在最近几年里，发現了许多旧石器时代中期和晚期的考古遗址，其中最有意义的发現是两处旧石器时代早期遗址——本溪庙后山遗址和营口大石桥金牛山遗址。这两个遗址均为洞穴遗址，是中国東北地区迄今发現的最古老的文化遗址（張鎮洪，1981）。

庙后山遗址是迄今中国境内已发現的旧石

張鎮洪 中山大学人类学系 中国广州
陳 淳 上海大学文学院历史系 中国上海

器时代早期文化遗址中分布最北的一个。它位于辽宁省本溪县中部地区，经纬度是北纬41°14′49″，东经124°07′50″，海拔高度为325米。

该遗址第四纪堆积厚达10米，共分8层，文化遗物集中在第4、5、6和7层中。自1978年3月发现以来，经过四次发掘，找到了74件石制品和3颗人牙，大批哺乳动物化石、人类用火痕迹——炭屑和灰烬层及烧骨。此外，还发现有少量骨器。

石制品包括石核、石片和石器。石器类型可分为刮削器、砍斫器、尖状器和石球等，其中刮削器种类最丰富。

庙后山石器工业的特点是：A．石料单一，主要以灰绿色石英砂岩为主，其次是细晶岩，个别的为脉石英；B．石器主要以石片石器为主，类型单调，以刮削器和砍斫器为主；C．石制品中缺乏规整类型，加工简单。

庙后山遗址的时代，根据出土的动物群分析，它既有第三纪的残余种如安氏和斯氏中华河狸及早更新世的种类如似锯齿虎，又有不少中更新世的典型属种如肿骨鹿、三门马，梅氏犀、变种狼、贾氏獾、杨氏虎、德氏水牛等、

同时又有一些東北地区晚更新世披毛犀—猛犸象动物群的屬种。所以，该遗址的时代延续较长，从中更新世的中晚期一直延续到晚更新世（杨文才等，1982）。根据古地磁、铀系法和碳十四绝对年代测定，遗址的第1－3层，年代较早，距今69万年以上。第3层和第4层之间有一段沉积间断。从第4层开始，在距今40万年以内。第5层距今24万年以内。第6层距今14万年。第7层堆积较厚，延续时间也长，从距今9.6万年一直延续到距今1.7万年。庙后山遗址作为東北地区第四纪地层年代划分的一个标准剖面是很理想的。

金牛山遗址在庙后山遗址以南约20公里，北纬40°34′，東径122°30′。其时代经铀系法测定与庙后山遗址接近，大约距今20—30万年。在文化内涵上，石器发现很少，只有7件，但在人类化石方面十分丰富。尤其是在1984年夏天，发现了一个相当完整的直立人头骨化石，同时还发现了上肢的尺骨和手骨，下肢的髋骨和足骨。金牛山人的发现是中国東北地区早期人类研究的一个重大突破，所有的材料目前正在研究之中（黄蕴平，1985）。

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Dissertations

The following subject headings were reviewed to produce the following list: anatomy, anthropology, botany, geochemistry, geology, paleoecology, paleontology, paleozoology, palynology, physical geography, and zoology.

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