CURRENT RESEARCH IN THE PLEISTOCENE

Volume 11 1994

A Peopling of the Americas Publication

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From the Editor

This is a burgeoning issue of *Current Research in the Pleistocene;* there are 65 papers. The size of this volume leads us at *CRP* to consider seriously something that I have been thinking about since I became editor. I want to begin putting out two issues a year. This would accomplish two things: first, it would allow us to accept more manuscripts, and second, the research presented in *CRP* would be even *more* current. Additionally, I think a faster turn-around time will provide more incentive for researchers to publish in this forum. If we decide to go ahead with this idea it won't be until 1996, so there is plenty of time for you to express your opinion. Would you be more likely to contribute papers, or more likely to personally subscribe, if there were two issues a year and the turn-around time for publication were four or five months?

I note with some interest that the overwhelming majority of manuscripts submitted to *CRP* continue to be from archaeologists; this in spite of the good efforts of our associate editors. I remain committed to encouraging submissions from the full spectrum of Quaternary sciences and welcome your thoughts on how to get more contributions from scholars in other disciplines.

Assistant Editor Rebecca Foster and I have a few gripes to air with some contributors. Most authors seem able to read and follow the style guidelines, but others (more than a few) are oblivious of, or choose to ignore, the information for contributors. The purpose of these guidelines is to facilitate the rapid review and publication of your research. Please make every effort to follow them.

Note: There are several changes in those guidelines beginning with this volume. If you have any questions or suggestions, or if you wish to receive special dispensation from some restriction you regard as unduly onerous, please contact me *in advance of* submitting your manuscript.

Finally, all students of the Pleistocene will mourn the passing of Hannah Marie Wormington. Her many and signal contributions to understanding the first peopling of the New World are far too numerous to catalog here. This volume of *CRP* is respectfully dedicated to her memory.

In Memoriam

MAMMOTH TRUMPET

Hannah Marie Wormington
1914–1994

Archaeology

Paleoindian and Paleoecological Evidence from Farra Canyon, Oklahoma

William E. Banks, Jack L. Hofman, and Roy Patterson

Farra Canyon, in Blaine County, Oklahoma (Figure 1), provides an opportunity to study the Pleistocene/Holocene climatic transition in this portion of the southern Great Plains. Studies have focused on deposits similar in composition and stratigraphic occurrence to the lower member of the Domebo Formation (Albritton 1966) and cultural materials associated with them. These deposits can provide information on ecological changes during the Pleistocene/Holocene transition (Hofman 1988). Paleoindian projectile points are also present in the canyon and indicate activities of human groups that inhabited the region at the time. Since erosion and redeposition of the cultural materials have made it difficult to locate sites, the canyon has been studied as a catchment basin. Studying the assemblage in this manner can inform us about past human use of the area. The cultural materials from Farra Canyon have been collected systematically after each rain since 1986 by avocational archaeologists. A preliminary analysis of projectile points from the canyon has documented patterns in canyon usage, lithic resource use, and group mobility strategy changes over time (Banks 1992). With further research, Farra Canyon can provide more clues to Paleoindian activities and how they articulate with larger regional patterns during the late Pleistocene and early Holocene.

Developing a more complete paleoenvironmental understanding of the Pleistocene/Holocene boundary as a stage for Paleoindian studies in this area of Oklahoma has led to investigations at several canyon sites (Hofman 1988). Preliminary studies of canyon deposits document the widespread occurrence of the lower member of the Domebo Formation. Several canyons have revealed Paleoindian projectile points, and dates support a time interval for the lower member of the Domebo Formation from 11,500 to 9,000 yr B.P. The Cedar Creek locality has yielded Folsom projectile points presumed to be from a stratigraphic unit comparable to that from which the Domebo mammoth was

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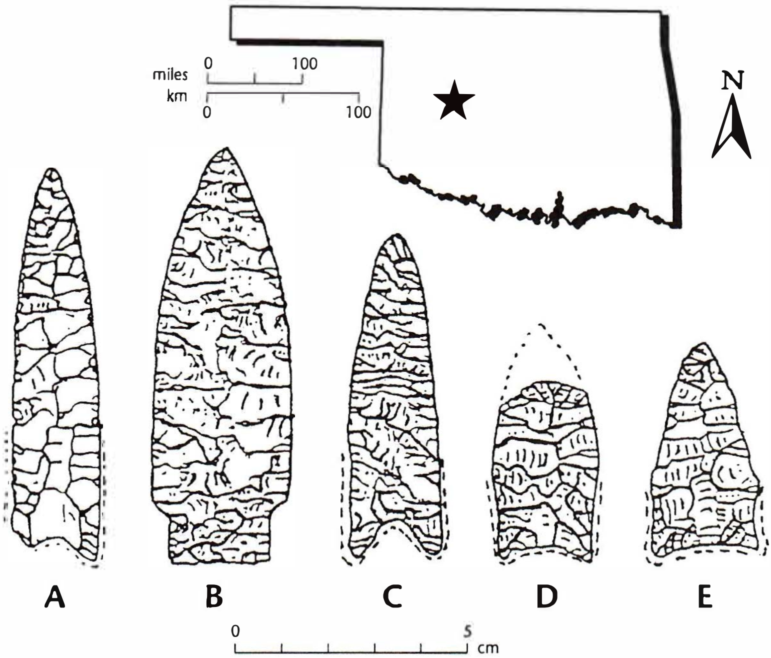

Figure 1. Location of Farra Canyon and Paleoindian artifacts from Farra Canyon. A: possible Clovis point (fluted on one side); B: Scottsbluff point; C: Allen type point; D: Plainview point reworked into scraper; E: reworked Dalton/Meserve point. Lithic material types are as follows: a = unknown chert; b, e = Edwards chert; c = unknown chert; d = non-local quartzite.

recovered. Charcoal and wood from this stratum have been dated between 9,100 and 9,700 yr B.P. (Hofman 1990). A similar stratum at Howard Gully has been dated to ca. 10,900 yr B.P. (Hofman et al. 1991). Sixteen sub-fossil tree stumps have been recovered from Farra Canyon. Most of these are from the stratigraphic unit, which is comparable to the Domebo Formation, and two have been dated: stump 4 at 8,790 ± 110 yr B.P. (Beta-25994), and stump 8 at 10,060 ± 110 yr B.P. (Beta-25995).

The stream in Farra Canyon has also yielded faunal materials including mastodon and mammoth teeth along with the remains of extinct and modern bison. The origin of the extinct remains is problematic and may be traced to Pliocene or Pleistocene gravels or the lower Domebo. The stream bed has yielded 15 Paleoindian projectile points. These account for approximately 10% of all recovered projectile points, and include Plainview, Scottsbluff, Allen and Meserve types in addition to a possible Clovis (Figure 1A). These projectile points are made from non-local raw materials including Alibates/Tecovas jasper (60%, N = 9), Edwards chert (20%, N = 3), and other exotic materials (20%, N = 3). Some of the points exhibit impact fractures, and others show signs of being reworked (Figure 1D). The predominant use of non-local lithic material types suggests that Paleoindian groups were incorporating Farra

Canyon into large mobility patterns. The canyon would have provided game, wood, water, and shelter for human groups. The breakage patterns indicate that hunting activities were taking place in the canyon's catchment area. The presence of reworked points and tools suggests the canyon was used for a variety of activities perhaps during short-term occupations.

Only with long-term and consistent avocational collecting has study of this time period in Farra Canyon been possible. Due to varying amounts of deposition and vegetation throughout the year, the gravel beds containing these materials are not always visible. A single visit or a few visits over a short time period usually yield little information. Long-term, repeated collections and investigations in cooperation with avocational archaeologists are needed if the archaeological record in such settings is to be adequately understood.

We deeply appreciate the many individuals who have contributed to the study of Farra Canyon. We especially want to thank Tim Shantz, Terrel Nowka, Ivan Stout, Michael Jaques, Lindel Thomason, Robert Kelly, and Matt Hill. The artifact drawings are by Roy Patterson, who unfortunately passed away before this study could be completed. We dedicate this paper to his efforts and memory. Roy Patterson's collections were donated to the Oklahoma Archaeological Survey at the University of Oklahoma.

References Cited

Albritton, C. C., Jr. 1966 Stratigraphy of the Domebo Site. In *Domebo: A Paleo-Indian Mammoth Kill in the PrairiePlains*, F.C. Leonhardy, ed., pp. 10–13. Contributions of the Museum of the Great Plains 1, Lawton.

Banks, W. E. 1992 Prehistoric Activities and Lithics of Farra Canyon: The Archaeology of a Small Catchment Basin. Paper presented at the 50th Plains Anthropological Conference, Lincoln, Nebraska.

Hofman, J. L. 1988 Dating the Lower Member of the Domebo Formation in Western Oklahoma. *Current Research in the Pleistocene* 5:86–88.

Hofman, J. L. 1990 Cedar Creek: A Folsom Locality in Southwestern Oklahoma. *Current Research in the Pleistocene* 7:19–23.

Hofman, J. L., L. C. Todd, R. W. Graham, and F. B. King 1991 Howard Gully: A Terminal Pleistocene Record from Southwestern Oklahoma. *Current Research in the Pleistocene*, 8:33–36.

Paleoindian Occupation in the Upper Red River Region of North-Central Tennessee and South-Central Kentucky

Gary Barker

The Red River is a primary tributary of the Cumberland River that drains portions of north-central Tennessee and south-central Kentucky. Geographically this maturely dissected upland is situated within the Highland Rim and

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Pennyroyal physiographic sections (see McFarlan 1943:183–185). The local topography is generally level to hilly, with numerous karstic features, such as active caves, springs, and sink holes, that developed from underlying Mississippian age limestones.

Controlled surface reconnaissance and test excavations along the upper forks of this tributary have identified eight Paleoindian sites that were divided into early and late phases based on the presence of fluted artifacts (Figure 1). Of the nine sites recorded, three are associated with caves (40Rb50, 40Rb82, 40Rb85), one occurs adjacent to an upland sink (40Rb96), and the remainder are located on secondary terraces.

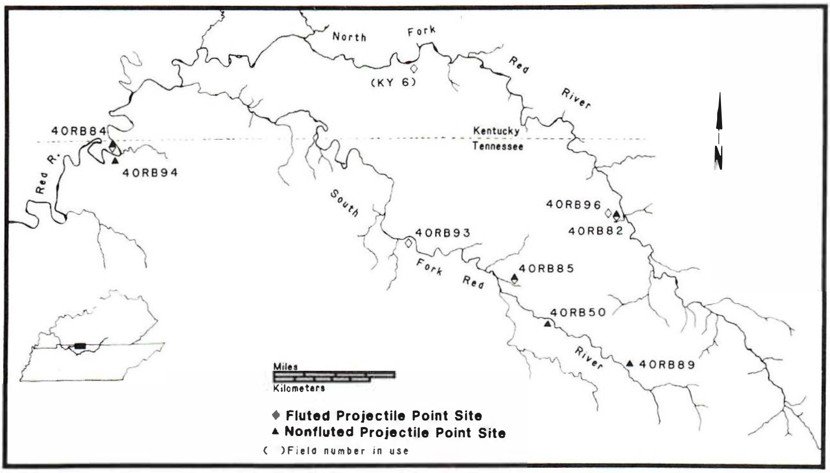

Figure 1. Reconnaissance and test excavation sites along the upper Red River.

Metrical data and county provenience information have been recorded for 141 Paleoindian projectile points from the survey area. The sample presently includes 40 Clovis, 14 Cumberland, 54 Beaver Lake, 11 Greenbriar, 7 Dalton, 10 Quad and 5 Harpeth River projectile points. These data are being used to describe intra-regional morphological characteristics and to access the variation among lithic assemblages from the early, middle, and late phases of the Paleoindian Period. An attempt is also underway to identify lithic-source areas, as 76% (n = 107) of the samples are believed to have been obtained locally.

Three Mississippian-age limestone formations (Ste. Genevieve, St. Louis and Warsaw) were exploited for lithic raw materials by the early inhabitants of the Red River locale. These sources offered Clovis immigrants a wide selection of superior-quality nodular cherts well suited for flaked-tool production. This is evidenced by the high frequency of fluted bifaces derived from local materials in the region (Gramly and Yahnig 1991; Sanders 1990; Schenian 1988; Smith and Freeman 1991). In fact, the Highland Rim is exceeded only by the Western Valley and the Central Basin of Tennessee in quantities of recorded Paleoindian projectile points (Broster: pers. comm.). In Kentucky, more fluted points have been reported from the Pennyroyal section than any other region in the state

(Tankersley 1990:103). The assumption that lithic raw material from the locale was heavily exploited is further supported by the identification of fluted points produced from Ste. Genevieve chert as far north as east-central Indiana (Tankersley 1989:160). In addition to abundant lithic raw materials the area is known to have been favorable for late-Pleistocene megafauna, which are believed to be a primary focus of Paleoindian hunting adaptation. To date, five proboscidian localities have been identified within the Western Highland Rim, and an even greater distribution is known for the adjacent Central Basin (Corgan 1976).

Excavations conducted at one identified site (40Rb82) yielded a large number of Paleoindian flaked tools (Barker and Broster 1993). However, a late-Pleistocene living surface observed at the base of the units was deflated and capped by deposits dating to the early and middle Holocene (Barker and Breitburg 1992). Future excavations are planned at several other sites along the Red River and will hopefully yield additional information concerning the strategies for lithic-tool production and resource procurement used by the early residents of the region.

The author wishes to thank Emanuel Breitburg, John Broster, Mike Moore and Kevin Smith for their assistance in the preparation of this manuscript.

References Cited

Barker, G., and E. Breitburg 1992 Archaic Occupations at the Austin Site (40Rb82). Paper presented at the 49th Annual Southeastern Archaeological Conference, Little Rock.

Barker, G., and J. B. Broster 1993 Recent Excavations at The Austin Cave Site: A Late Pleistocene through Early Holocene Occupation in North Central Tennessee. *Current Research in the Pleistocene* 10:1–3.

Corgan, J. X. 1976 Vertebrate Fossils of Tennessee. *Bulletin No. 77*, Division of Geology, Nashville.

Gramly, R. M., and C. Yahnig 1991 The Adams Site (15CH90) and the Little River, Christian County, Kentucky, Clovis Workshop Complex. *Southeastern Archaeology* 10(2):134–135.

McFarlan, A. C. 1943 *Geology of Kentucky*. University of Kentucky, Lexington.

Sanders, T. N. 1990 *Adams: The Manufacturing of Flaked Stone Tools at a Paleoindian Site in Western Kentucky*. Persimmon Press, Buffalo.

Schenian, P. A. 1988 An Overview of the Paleoindian and Archaic Period Occupations of the Savage Cave Site. In *Paleoindian and Archaic Research in Kentucky*, C. D. Hockensmith, D. Pollack, and T. N. Sanders, eds., p. 71. Kentucky Heritage Council.

Smith, E. E. Jr., and A. K. L. Freeman 1991 The Archaeological Investigation of a Series of Early Paleoindian (Clovis) Sites in the Little River Region of Christian County, Kentucky. *Current Research in the Pleistocene* 8:41–43.

Tankersley, K. B. 1989 Late Pleistocene Lithic Exploitation and Human Settlement in the Midwestern United States. Unpublished Ph.D dissertation, Department of Anthropology, Indiana University, Bloomington.

Tankersley, K. B. 1990 Paleoindian Period. In *The Archaeology of Kentucky: Past Accomplishments and Future Directions, Volume One*, D. Pollack, ed., pp. 73–142. Kentucky Heritage Council, State Historic Preservation Comprehensive Plan Report 1.

Recent Excavations at the Sunshine Locality, a Late Pleistocene/Early Holocene Site in Eastern Nevada

Charlotte Beck, George T. Jones, and Fred L. Nials

During the summer of 1993, test excavations were conducted at the Sunshine Locality, a late-Pleistocene/early-Holocene archaeological site in Long Valley of eastern Nevada. Although this site has been known for some time, little professional research has been undertaken there. A backhoe trench was excavated in 1989/90; the purpose of our test excavation was to verify the stratigraphic sequence revealed in that trench, evaluate the context of artifacts found in the sediments, and obtain datable materials. Excavation of an area measuring 5 x 6 m was completed to a depth of 3.8 m. Additional testing was carried out in a unit 1 m square to a depth of 4.8 m, and augering was completed to 4.3 m.

The stratigraphic section is consonant with a general drying trend over time. The base of the section, which is believed to rest on lacustrine deposits of Pluvial Lake Hubbs (below 4.3 m), is composed of alternating lenses of alluvial sands and gravels to a depth of 2.8 m. This gravel reflects the braided stream channel encountered in the 1989/90 backhoe trench, radiocarbon-dated to ca. 10,700 yr B.P. and from which the bones of an extinct form of camel were recovered.

A general fining upwards of gravel lenses suggests flood events of lessening energy over time. Between 2.8 m and 2.0 m, coarse to fine alluvial sands dominate, but may incorporate some aeolian sediments. A dark unit (ca. 0.30 m thick), resulting from marsh or wet meadow conditions, rests on the alluvial sequence. This unit is capped by a charcoal lens, representing two or three separate burn events. Above the organic unit, to a depth of 1.2 m, are aeolian sands, while the uppermost 1.2 m of the section is the product of sheet flood events.

Although artifacts were encountered in the upper 1.2 m of sediments as well as in the marsh unit, the primary artifactual deposits occurred in the gravel unit (n = ca. 1000). Preliminary comparisons of artifact size and gravel textural classes suggest fluvial transport and redeposition, although the artifacts exhibit no edge damage or rounding, suggesting their source is nearby.

The most notable find is a complete stemmed projectile point (Figure 1) lying directly on the charcoal lens at the top of the marsh unit. Two radiocarbon dates were obtained for the charcoal lens, 8,560 ± 100 yr B.P. (Beta 69781) and 9,820 ± 60 yr B.P. (Beta 69782, CMAS 11022). The former date should be considered as a minimum date for the unit since it was obtained on organic sediment and may be contaminated with organic residues from above; the latter date was obtained on charred material and thus is the more reliable of the two.

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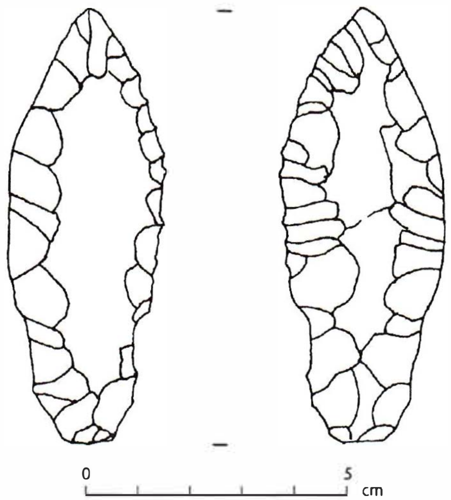

Figure 1. Large stemmed point found lying directly on the charcoal lens at the top of the marsh unit at the Sunshine Locality; manufactured from andesite.

We thank Brian C. Amme of the Ely District and Pat Barker of the Nevada State Office, Bureau of Land Management, for providing aid and equipment, which made this project possible. We also thank Donald R. Tuohy and Amy J. Dansie of the Nevada State Museum, and Phillip W. Hutchinson of Reno, Nevada, for their contributions to an earlier phase of the project and their continued support. Finally, we would like to acknowledge the work of Cynthia Irwin-Williams and Jonathan O. Davis who began the project in 1989.

The Cooper Site: A Stratified Paleoindian Bison Kill in Northwest Oklahoma

Leland C. Bement

The Cooper Site, 34HP45, consists of two vertically discrete bison-bone deposits located along the floodplain margin of the North Canadian (Beaver) River in northwestern Oklahoma. Evidence obtained by exploratory excavation undertaken in April and May 1993 indicates the Cooper site contains the remains of two bison kills. The upper kill has definite Folsom association, whereas the cultural association of the lower deposit remains to be firmly established.

The bone deposits are at the head of a steep-sided arroyo cut into bedrock. Lateral widening of the floodplain by the meandering of the river channel has removed all but the upper end of this old arroyo. The bone deposits measure approximately 6 m east-west by 5 m north-south and are separated by 20 cm of sediment. The upper bone bed contains the skeletons of at least 13 animals,

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many of which are mostly articulated. Tooth eruption patterns from these animals suggest a kill during .4–.5 years after the calving season. A limited sample from the lower bone bed sets the season of kill somewhat earlier in the year at the .3–.4 year interval. The data suggest that both kills occurred during the late summer/early fall. Preliminary analysis suggests the herd contained in the upper bone bed was composed of cows and calves.

Projectile points from the upper bone bed (Figure 1) include one made of Niobrara jasper from northwestern Kansas or southwestern Nebraska, one of

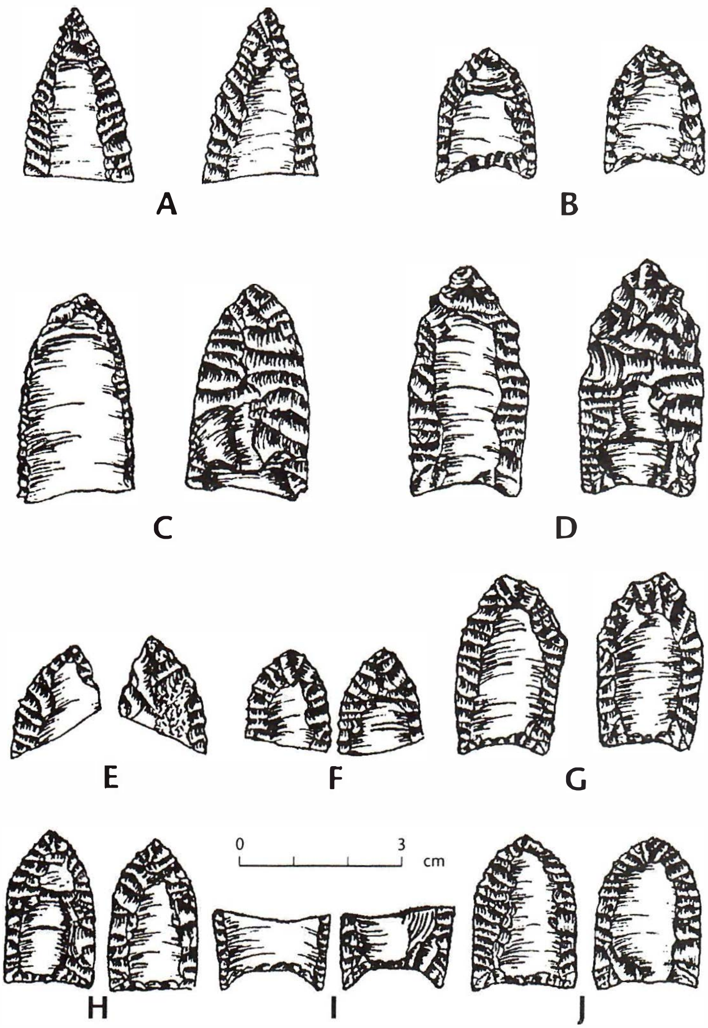

Figure 1. Projectile points from the Cooper Site. Specimens from the upper bone bed: C, D, E, F, G, and J. Specimen from the lower bone bed: I. Specimens from eroded slump: A, B, and H.

Edwards Plateau chert from central Texas, and three of Alibates agatized dolomite from the Texas panhandle. The base of a Folsom point made of Edwards Plateau chert came from the level of the lower bone bed. An additional point of Edwards Plateau chert and two of suspected Alibates have been recovered from varying contexts at the site. All the resharpening flakes are of Alibates. Three of the four flake tools are Alibates; the fourth is of quartzite. These materials suggest the hunters at Cooper had at some time been in central Texas, the Texas panhandle and northwestern Kansas. The higher percentage of points made of Alibates and the preponderance of Alibates in the non-point cultural materials suggest that the Alibates quarry was the most recent stop prior to the Cooper kill. Hofman (1991), in reviewing the distribution of Folsom points of various lithic types, suggests Folsom groups moved from south to north on the Llano Estacado and from west to east or from east to west between the Llano Estacado and the more dissected rolling plains.

If the seasonal reconstruction and mobility analysis are correct, then the Cooper site can be attributed to Folsom groups moving eastward off the Llano Estacado in late summer and early fall. The duration of stay and the direction of subsequent movements are not known.

References Cited

Hofman, Jack 1991 Folsom Land Use: Projectile Point Variability as a Key to Mobility. In *Raw Material Economies among Prehistoric Hunter-Gatherers*, A. Montet-White and S. Holen, eds. University of Kansas Publications in Anthropology, 19, Lawrence KS.

Paleoindian Site, Lithic, and Mastodon Distributions in Tennessee

Emanuel Breitburg and John Broster

The Tennessee Division of Archaeology maintains 106 Paleoindian site and 2239 point, and 62 mastodon records for eight physiographic regions defined by Miller (1974). As shown in Figure 1, while the majority of the sites (46%, 49) and points (65%, 1454) are concentrated in the Western Valley, only one mastodon record is known for the region. About an equal number of point and site, and half of the mastodon records are from the Central Basin and Western Highland Rim. While the mastodon records are not rare, site and point records are less common for the Mississippi River Valley, a pattern that is duplicated in the Valley and Ridge. Finally, site, point, and mastodon records are rare for the Eastern Highland Rim, Cumberland Plateau, and Coastal Plain, and there are no known records of any of the latter in the Unaka Mountains.

Site and point densities reveal Clovis and Cumberland populations intensely

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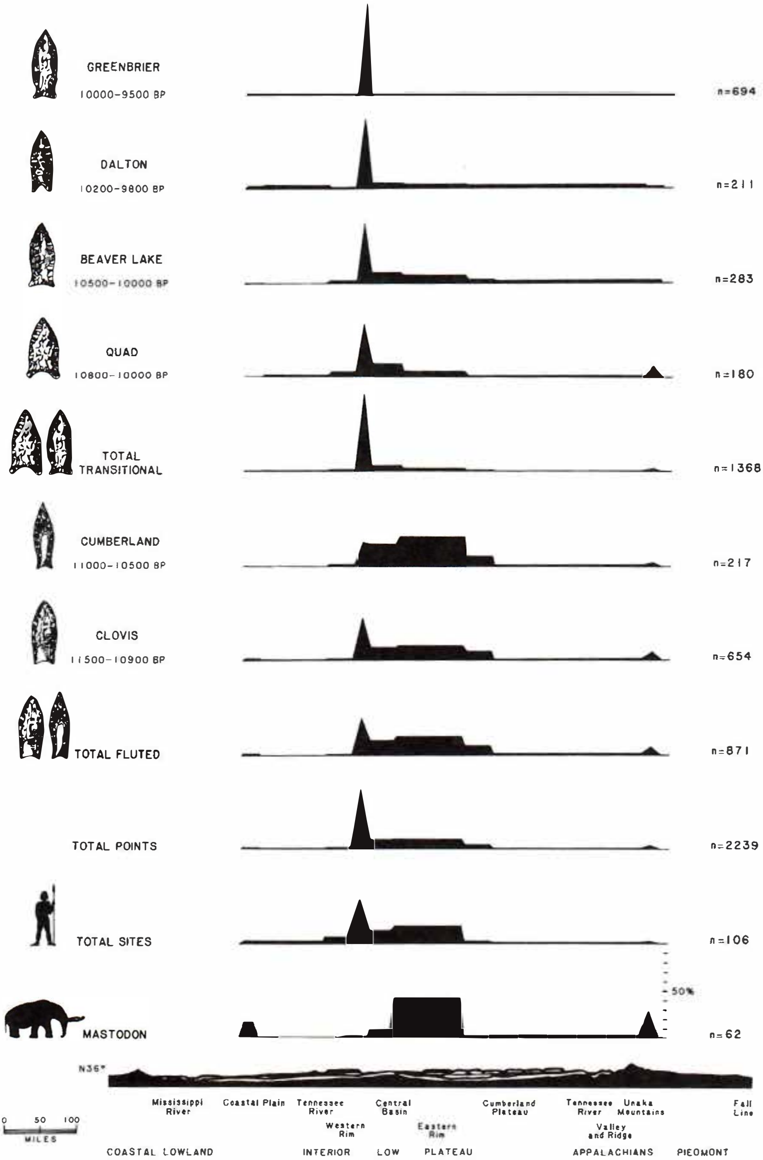

Figure 1. Percentage distributions of Paleoindian site projectile point and mastodon fossil localities.

occupied the Western Valley and Central Basin. Through late and transitional Quad, Beaver Lake, and Dalton times, the intensity of activity gradually declined in the Central Basin until Greenbriar times, when Paleoindian activity was almost completely confined to the Western Valley. The intensity and narrow nature of physical occupation are underscored by the fact that 94% of the 694 Greenbriar points occur in the Western Valley.

While the narrow Western Valley appears to be the primary habitat of early human settlement and movement, it was poor habitat for mastodons. The Central Basin and its western rim were the principal arenas of activity for both early Amerind and mastodon populations. Low site and point densities imply that the Valley and Ridge and Mississippi River Valley were minor regions of human and mastodon activity. Even lower densities reveal the Coastal Plain, Cumberland Plateau, and the Unaka Mountains were of little or no significance to either.

The importance of the Western Valley lies in the excellence of its chert resources. The Lower Devonian bedrock of the region yields high-quality nodules of Harriman, Camden and Dover chert (Russell et al. 1975:13). The majority (93%) of the 49 early, transitional, and late base camps appear around Camden, Tennessee. These sites often have quarries and are aligned with the mouths of streams where chert nodules and soil from the surrounding landscape form alluvial fans.

To conclude, the need for and the location of superior-quality chert to make hunting armament are two of the primary factors leading to Paleoindian florescence and intense occupation of the Western Valley. Further florescence was abetted by the proximity of the mineral-rich soils, springs, and licks of the Central Basin, where migratory ungulates such as the mastodon congregated.

We wish to thank Mark R. Norton as co-director of the Tennessee Paleoindian site and projectile point survey. The memberships of the Dickson County Archaeological Society and the Middle Cumberland Archaeological Society are gratefully acknowledged for allowing the recording of their collections during our survey. Dr. Paul Parmalee, University of Tennessee, and Dr. James X. Corgan, Austin Peay State University, are thanked for additional records on mastodon locations. Gary L. Barker provided site information from the northern Central Basin, Parris Stripling drew the excellent illustration.

References Cited

Russell, E. E., L. G. Walker, and G. N. Pruitt 1975 Field Trips in West Tennessee, Field Trip 1: Fossiliferous Silurian, Devonian, and Cretaceous Formations in the Vicinity of the Tennessee River. Tennessee Division of Geology *Report of Investigations* 36:8–14.

Miller, R. A. 1974 The Geologic History of Tennessee. Tennessee Division of Geology *Bulletin* 47.

Eastern Clovis Adaptations in the Tennessee River Valley

John B. Broster, Mark R. Norton, Dennis J. Stanford, C. Vance Haynes, Jr., and Margaret A. Jodry

As part of a continuing Paleoindian site and projectile point survey, an extensive study of the Western Valley of Tennessee has been undertaken. The Western Valley forms the boundary between west and middle Tennessee. A total of 29 Paleoindian sites have been recorded for this area, and over 340 fluted projectile points have been measured and described (Broster and Norton 1990).

Four sites are an exception to the general small fluted-point sites in the valley. These four have produced several hundred uniface tools and 122 fluted points per site (Broster and Norton 1990). However, three of them are completely deflated with later materials being mixed with the fluted lithics (Sites 40Hs60, 40Hs200, and 40Bn18). The fourth site is quite different. Unlike the rest of the sites on the lake, this one (40Bn190) is a combination of a quarry/workshop locality and a series of fluted-point base camps. The site, called Carson-Conn-Short, is situated on a number of partially flooded terrace ridges located south of the old Pleistocene river channel. Some seven distinct areas of the site have been identified. Area A was selected for testing primarily because it was initially believed that only fluted materials (Eastern Clovis and Cumberland) were present at this location (Broster and Norton 1993).

The initial testing had proved very rewarding, and it was felt that a more extensive excavation was definitely needed (Broster and Norton 1992). To this end a joint project was undertaken in late 1992 and early 1993 to further define possible intact Paleoindian strata and to test the relationship between fluted artifacts and the exposed fire-cracked chert concentrations. This was made possible through the issue of an ARPA permit (No. 04-Tn-2-92). Archaeologists from the Tennessee Division of Archaeology, the Smithsonian Institution, and the University of Arizona contributed to the completion of this stage of the project.

Excavations of Test Unit 8 revealed a concentration of uniface tools and two Clovis projectile points in close proximity to one of the fire-cracked chert features. These types of feature were first recorded as possible deflated hearths, but are more likely the remains of heat treating facilities for nodules of the local chert.

A total of 1,600 tools have been either mapped, excavated, or donated during the investigation of the site. All but ten artifacts are classified as being Paleoindian. This is quite unusual for any site in the Western Valley or for the Southeast in general. The Carson-Conn-Short site (40Bn190) has great poten-

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tial for helping define and understand the full range of Paleoindian occupation in the midsouth. A clearer understanding of lithic reduction sequences is possible using the data from this very important site.

Auger tests in Area A have demonstrated a buried level of cultural debris at a depth of 1 to 1.25 m below the present surface. A small blade tool was recovered at a depth of 1 m in one of the auger holes. This may mean that a rather large section of the site is still intact and could be relatively free of disturbances from later occupations. Our future efforts will be directed toward a full investigation of this area. Buried Clovis-age features may well be located in this section. As much as 200 m^2 of the site could still be undisturbed and may provide a very interesting view of Paleoindian adaptations to the riverine environment.

The limited excavations at the Carson-Conn-Short site (40Bn190) have shown the potential for in situ eastern Clovis deposits in the Western Valley of Tennessee. In parts of the site, occupation has been recorded at depths of some 45 to 68 cm below present ground surface. The prospect of performing spatial analysis of features and associated tools is extremely important for understanding Clovis technology and cultural adaptations in the Southeast.

The senior author believes that the numerous fluted points and sites in the Western Valley, and in Tennessee in general, are a possible indicator that the Southeast may have been a major locus for initial colonization of Clovis-type peoples, and the area may represent one of the first staging areas for the peopling of the New World as defined by Anderson (1992). At present this is only speculation, as there is not even full agreement among the authors of this paper upon the subject, let alone the full professional community. However, as interesting as the argument may be, the important point may not be where fluted-point technology originated, but how these peoples organized and how the differences in settlement between regions can best be explained and understood.

We would like to thank Sarah Bridges of the U.S. Department of the Interior, Fish and Wildlife Service, for her help and understanding in processing of the A.R.P.A. permit. Thanks is also due to John Taylor, Refuge Manager, and Jerry Armstrong, Refuge Law Enforcement Officer, Tennessee National Wildlife Refuge, U.S. Department of the Interior, Fish and Wildlife Service, for their continuing commitment to the preservation of this very important site.

Harlan "Kit" Carson, Gary Conn, and Hal Short are responsible for this site being recorded and tested by professional archaeologists. Their donation of artifacts and time is greatly appreciated and their contribution to the understanding of Eastern Clovis culture cannot be minimized. This type of cooperation improves relationships between professional and amateur archaeologists.

References Cited

Anderson, D. G. 1992 Models of Paleoindian and Early Archaic Settlement in the Lower Southeast. In *Paleoindian and Early Archaic Period Research in the Lower Southeast: A South Carolina Perspective*, D. G. Anderson, K. E. Sassaman, and C. Judge, eds., pp. 28–47. Council of South Carolina Professional Archaeologists. Columbia.

Broster, J. B., and M. R. Norton 1991 Clovis and Cumberland Sites in the Kentucky Lake Region. *Current Research in the Pleistocene* 8:10–12.

Broster, J. B., and M. R. Norton 1992 Paleoindian Projectile Point and Site Survey in Tennessee:

1988–1992. In *Paleoindian and Early Archaic Period Research in the Lower Southeast: A South Carolina Perspective,* D. G. Anderson, K. E. Sassaman, and C. Judge, eds., pp. 263–268. Council of South Carolina Professional Archaeologists. Columbia.

Broster, J. B., and M. R. Norton 1993 The Carson-Conn-Short Site (40Bn190); An Extensive Clovis Habitation in Benton County, Tennessee. *Current Research in the Pleistocene* 10:3–5.

The Martins Creek Mastodon: A Paleoindian Butchery Site in Holmes County, Ohio

Nigel Brush and Forrest Smith

Association between flint tools and mastodon bones (*Mammut americanum*) has been documented for at least three sites in the U.S.: (1) the Manis site on the Olympic Peninsula in Washington (Gustafson, et al. 1979), (2) the Kimmswick site in Missouri (Graham et al. 1981), and (3) the Hiscock site in New York (Laub 1990). The recent discovery of flint flakes and tools in association with a mastodon at the Martins Creek site in Ohio adds a fourth locale to this select group.

Martins Creek is located in the glaciated portion of the Allegheny Plateau in east-central Ohio. The site is two miles north of a terminal moraine that marks the southernmost advance of the ice front into this valley during the Wisconsin Glaciation (White 1982:64). Glacial lakes periodically formed in the valley during the Pleistocene as advancing ice sheets repeatedly blocked the northward-flowing Martins Creek. The mastodon site is situated near the tip of a narrow peninsula of land that formerly extended into one of these glacial lakes.

The Martins Creek mastodon was first discovered in 1938 by a farmer who was attempting to drain a boggy area on his property. A trenching machine brought eight teeth to the surface, and subsequent excavation resulted in the recovery of a femur. Karl Ver Steeg, Professor of Geology at the College of Wooster, visited the site and identified the teeth and femur as mastodon. Ver Steeg published a brief article on the mastodon in *Science* (1938), but no further excavation was attempted at the site because of the poor preservation of the bone.

During the summer of 1993, students participating in workshops sponsored by the Departments of Geology and Anthropology at the University of Akron were able to relocate the Martins Creek mastodon by excavating a series of units 2 m square parallel to the 1938 drainage ditch. On the east side of the drainage ditch the pelvis and part of the lower spinal column were discovered at a depth of 56 cm. On the west side of the ditch various leg and rib bones were encountered at a depth of 46 cm. Horizontally, the bones were scattered over an area of roughly 8 x 8 m.

The mastodon bones were lying on top of a stratum of light-gray clay marl.

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The bones in the eastern portion of the site were covered by 11–26 cm of dark-brown organic clay. Above the dark clay was a layer 9–17 cm thick of black flaky soil. Capping the sequence was a layer 29–35 cm thick of medium-brown muck soil. In the western portion of the site the clay marl rose toward the surface, and the black, flaky layer had been obliterated by plowing. Here the bones were covered by 11–24.5 cm of dark brown, organic clay and capped with 24–31 cm of medium brown, muck soil.

Mingled among the mastodon bones on the southern and eastern margins of the site were deer bones and teeth. The deer bones increased in frequency to the south and east as the mastodon bones decreased in number. The highly disarticulated state of both the mastodon and deer skeletons suggested the possibility that these animals had both been butchered. The narrow peninsula near which these skeletons were located would have served as a perfect kill site. Animals trapped on this tongue of land by the approach of hunters from the northwest would have had no choice except to plunge into the water and sticky clay that surrounded this narrow peninsula. The discovery of flint flakes among the bones gave substance to this hypothesis.

A total of five medium-sized (> 2.5 x 2.5 cm) flint flakes and one flint side-scraper were found in direct association with undisturbed mastodon and deer bones. Two medium-sized flint flakes were recovered from the disturbed zone created by the trenching machine. Although the flint flakes had not been retouched, they were clearly waste flakes derived from flintknapping activities and were made of material from outcrops about 20 miles to the southwest. Nicholas Toth (1987) has demonstrated that unmodified waste flakes could have served as very effective butchering tools.

The side-scraper and four of the flint flakes from Martins Creek were submitted to Margaret Newman at the University of Calgary for immunological analysis of possible protein residues. Two of the flint flakes gave positive results: one for elephant and one for deer. Both of these flakes had been found in association with undisturbed mastodon bones.

Therefore, based on (1) the location of the site, (2) the disarticulated condition of the skeletons, (3) the discovery of seven medium-sized flint flakes and a side-scraper among the bones, and (4) the presence of elephant and deer blood on two of the flakes, we conclude that both the mastodon and deer at the Martins Creek site were likely butchered by Paleoindians.

References Cited

Graham, R. W., C. V. Haynes, D. L. Johnson, and M. Kay 1981 Kimmswick: A Clovis-Mastodon Association in Eastern Missouri. *Science* 213:1115–1117.

Gustafson, C. E., D. Gilbow, and R. D. Daugherty 1979 The Manis Mastodon Site: Early Man on the Olympic Peninsula. *Canadian Journal of Archaeology* 3:157–164.

Laub, R. S. 1990 The Hiscock Site (Western New York): Recent Developments of Pleistocene and Early Holocene Interest. *Current Research in the Pleistocene* 7:116–118.

Toth, N. 1987 The First Technology. *Scientific American* 256:112–121.

Ver Steeg, K. 1938 Mastodon Discovered in Ohio. *Science* 88:498.

White, G. W. 1982 *Glacial Geology of Northeastern Ohio*. Ohio Division of Geological Survey, Bulletin 68.

Immunological Analysis of Flint Flakes from the Martins Creek Mastodon Site

Nigel Brush, Margaret Newman, and Forrest Smith

The discovery of flint artifacts among mastodon and deer bones at the Martins Creek site in Holmes County, Ohio, was exciting but initially inconclusive. The vertical and horizontal association between the artifacts and bones was excellent—both were mingled together near the bottom of a dark clay stratum that rested on a thick deposit of clay marl. In the eastern portion of the site, the dark clay stratum was 11–26 cm thick. Above the dark clay stratum was a layer 9–17 cm thick of black flaky soil, capped with a layer 29–35 cm thick of muck soil. Unfortunately, these deposits only had an average combined depth of 56 cm below the surface (46 cm in the western portion of the site). Therefore, we could not exclude the possibility that flint artifacts from a later period had been introduced into the strata containing the mastodon bones. Although the plastic clay in which the bones and flint flakes were imbedded would have provided a relatively impermeable barrier, bioturbation and desiccation cracks recorded at the site could have provided possible routes of entry for surface materials.

Lacking diagnostic Paleoindian tools, the status of the flint artifacts at Martins Creek might have remained permanently indeterminate. However, the recent application of molecular biological techniques for analyzing ancient proteins made it possible to determine whether or not the flint artifacts had initially been associated with the mastodon and deer bones. Studies utilizing these techniques (Hyland et al. 1990; Kooyman et al. 1992; Newman and Julig 1989; Yohe et al. 1991) have demonstrated that animal and plant proteins on artifacts can be identified to at least the family level (e.g., *Bovidae, Cervidae, Elephantidae*). Although various methods have been used in this analysis, the basis for all these techniques is the antigen-antibody reaction first observed in the precipitin test in the late 1800s by individuals such as Richet, Behring, and Ehrlich.

Following its discovery, the precipitin test quickly achieved integrity in clinical medicine as well as in criminal jurisprudence (Gaensslen 1983). One of the techniques used in the medical/legal field is cross-over electrophoresis, which has served as a routine test for over 30 years to determine whether "stains of unknown origin" are human or animal blood. The test is based on the antigen-antibody reaction, but uses an electric current to speed the reaction. The test is very sensitive to levels of 10^{-8} g (10 nanograms) of protein, does not require expensive equipment, is reasonably rapid, and lends itself to the processing of multiple samples (Culliford 1963). The test has long been used in medical/legal arenas, thereby making the technique especially relevant for ancient and severely denatured proteins.

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A side-scraper and four flint flakes from the Martins Creek site were sent to Margaret Newman at the University of Calgary for immunological analysis. Five soil samples from the immediate vicinity of the artifacts were also submitted. Because naturally occurring compounds such as bacteria, tannins, and iron chlorates can cause nonspecific precipitation of the antisera, it is important that control soil samples be included in all analyses (Gaensslen 1983).

Residues on the artifacts were removed by using a 5% ammonium hydroxide solution. This has been found to be extremely effective when dealing with old or severely denatured bloodstains (Dorrill and Whitehead 1979; Kind and Cleevely 1969). The flint flakes and scraper were each placed in shallow plastic dishes, and 0.5 mL of ammonium solution was directly applied to the artifact. Disaggregation was accomplished by first floating the dish and contents in an ultrasonic cleaning bath for two to three minutes and then placing the dish and contents in a rotating mixer for 30 minutes. At the end of this extraction process, one milliliter (1 mL) of Tris buffer (pH 8.0) was added to 1-g amounts of each sample, mixed well and allowed to extract for 24 hours at 4° C to inhibit bacterial contamination.

The resulting supernatant fluids derived from the artifacts were subsequently removed and initially tested against pre-immune serum to determine if non-specific proteins were present, which could result in false positive results. No positive results were obtained, and testing was continued against a range of mammalian antisera, including bear, bovine, camel, cat, chicken, deer, dog, horse, human, pig, rabbit, and sheep. These antisera were developed for use in forensic medicine by a commercial source (Organon Teknika), while two additional antisera, elephant and elk, were developed at the University of Calgary. The commercial antisera are polyclonal and will recognize epitopes (attachment sites for certain antibodies) that are shared by closely related species. For example, anti-deer will give positive results with other members of the *Cervidae* (e.g., deer, moose, elk, and caribou) as well as with pronghorn (*Antilocapridae*). The anti-elephant antisera will give positive results for extant or extinct members of the order *Proboscidea.*

Two of the four flint flakes from the Martins Creek site gave positive results—one for deer antisera and one for elephant antisera. These results strongly suggest that at least some of the flint flakes found among the mastodon and deer bones at the Martins Creek site were used to butcher these animals. If this site had been excavated before the introduction of immunological analysis, the association between the flint artifacts and bones might have gone the way of so many similar mastodon sites in eastern North America—tantalizing but tenuous.

References Cited

Culliford, B. J. 1963 Precipitin Reactions in Forensic Problems. *Nature* 201:1092–1094.

Dorrill, M., and P. H. Whitehead 1979 The Species Identification of Very Old Human Bloodstains. *Forensic Science International* 13:111–116.

Gaensslen, R. E. 1983 *Sourcebook in Forensic Serology, Immunology, and Biochemistry.* U.S. Department of Justice, Washington, D.C.

Hyland, D. C., J. M. Tersak, J. M. Adovasio, and M. I. Siegel 1990 Identification of the Species of Origin of Residual Blood on Lithic Material. *American Antiquity* 55:104–112.

Kind, S. S., and R. M. Cleevely 1969 The Use of Ammoniacal Bloodstain Extracts in ABO Groupings. *Journal of Forensic Sciences* 15:131–134.

Kooyman, B., M. E. Newman, and H. Ceri 1992 Verifying the Reliability of Blood Residue Analysis on Archaeological Tools. *Journal of Archaeological Science* 19(3):265–269.

Newman, M. E., and P. Julig 1989 The Identification of Protein Residues on Lithic Artifacts from a Stratified Boreal Forest Site. *Canadian Journal of Archaeology* 13:119–132.

Yohe, R., M. E. Newman, and J. S. Schneider 1991 Immunological Identification of Small-Mammal Proteins on Aboriginal Milling Equipment. *American Antiquity* 56:659–666.

Results of Blood Residue Analysis of a Late Paleoindian Projectile Point from Yellowstone National Park, Wyoming

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Recent studies have demonstrated that biochemical and immunological methods have the potential to identify species of origin of animal residues on stone tools (Hyland et al. 1990; Kooyman et al. 1992; Newman 1990) and in soils (Newman et al. 1993; Nolin et al. n.d.), which has direct implications for reconstruction of prehistoric subsistence patterns, tool use, and paleoenvironmental studies. While many of the reports have focused on middle- and late-Holocene assemblages, late-Pleistocene and early-Holocene results have been extremely limited. The results reported below provide exciting implications for late-Paleoindian studies in the Middle Rocky Mountains, an area of generally poor organic preservation.

A modified version of cross-over immunoelectrophoresis (CIEP) analysis, used by the Royal Canadian Mounted Police Serology Laboratory (Ottawa) and the Centre of Forensic Sciences (Toronto) for identification of residues in criminal investigations (Culliford 1963; Gaensslen 1983; Royal Canadian Mounted Police 1983), was used by MEN in the analysis of flaked lithic artifacts from the Fishing Bridge site (48YE1), Yellowstone National Park, Wyoming. A full discussion of the procedure is presented in Newman and Julig (1989). While 8 of the 33 artifacts submitted produced positive results, this article discusses the results from only one of these, a late-Paleoindian projectile point.

The Fishing Bridge site is situated at the outlet of Yellowstone Lake and is bounded on the east by Pelican Creek, on the west by the Yellowstone River, and on the south by Yellowstone Lake. Intermittent work over the last 40 years (Taylor et al. 1964; Reeve 1989), the most extensive under the direction of KPC as part of the compliance process for highway reconstruction, has defined the

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site as an extensive (1,350,000 m²) open-habitation site with cultural deposits dating back nearly 10,000 years.

During 1992 and 1993, investigations were conducted within the "Fishing Bridge Peninsula," which consists of constructional landforms identified as Pleistocene deltaic sediments, storm bars of Holocene-aged open-worked gravels, and Holocene eolian sands (Cannon et al. 1992). A complex geomorphic history is apparent due to dynamics of the resurgent dome of the Yellowstone caldera, which has caused uplift and subsidence along the north shore of the lake on the order of tens of meters, significantly influencing landforms (Pierce et al. 1993; Pierce et al. this volume).

The projectile point discussed in this report has been tentatively placed within the Cody Complex, a northwest plains late-Paleoindian archeological tradition dating to around 9,000 years ago (Frison 1991). Results of investigation of the Cody Complex have generally shown the economy focused upon bison procurement (Wheat 1972; Frison and Todd 1987); however, research in the foothills and mountains of northwest Wyoming and southern Montana indicates a possible broader economy (Husted 1969; Frison 1992).

This point (FS4495) was recovered from unit N316/W450 at 70 cm below datum in medium sands. No evidence of water redeposition is present on the artifact, and preliminary geomorphic investigations suggest the point is near its original context. The point (Figure 1) was manufactured from a translucent

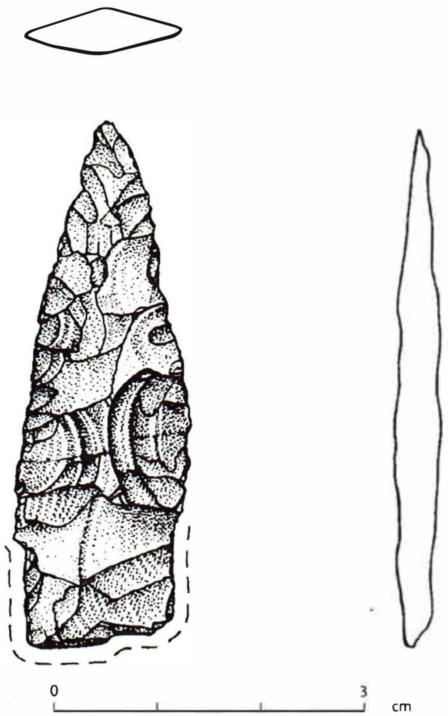

Figure 1. Late Paleoindian projectile point, tentatively placed within the Cody Complex, which produced positive immunological results of rabbit antiserum. The point has been reworked along the right lateral margin and damage is evident along the base.

light-gray (7.5YR 7/1) chalcedony. Its total length is 50.18 mm, maximum blade width is 16.32 mm, the stem is 14.31 mm in width, and it is 5.25 mm thick. Evidence of damage to the base, extensive retouch along the blade, and grinding along the base is present.

Immunological analysis produced a positive reaction to rabbit antiserum. Positive results to this antiserum are obtained with all members of the order Lagomorpha (rabbits, hares, and pikas), but cross-reactions with other orders do not generally occur. Of interest is the reaction to rabbit antiserum; this may suggest that the tool was used in butchering rabbit, an economic pursuit not usually associated with Cody Complex, or perhaps that rabbit sinew was used on the haft. While this uncertainty is currently unresolved, the results significantly add to our understanding of tool use and subsistence patterns in areas where faunal preservation is lacking.

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References Cited

Gannon, K. P., K. L. Pierce, and G. M. Crothers 1992 The Ups and Downs of the Yellowstone Caldera: Archeological Investigations at Arnica Creek and Fishing Bridge, Yellowstone National Park, Wyoming. Paper presented at the 50th Plains Anthropological Conference, Lincoln, Nebraska.

Culliford, B. J. 1963 Precipitin Reactions in Forensic Problems. *Nature* 201:1092–1094.

Frison, G. C. 1991 *Prehistoric Hunters of the High Plains.* Second Edition. Academic Press, New York.

Frison, G. C. 1992 The Foothills-Mountains and the Open Plains: The Dichotomy in Paleoindian Subsistence Strategies Between Two Ecosystems. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 323–342. Denver Museum of Natural History.

Frison, G. C., and L. C. Todd (editors) 1987 *The Horner Site: The Type Site of the Cody Cultural Complex.* Academic Press, New York.

Gaensslen, R. E. 1983 *Sourcebook in Forensic Serology, Immunology and Biochemistry.* U.S Department of Justice, Washington D.C.

Husted, W. M. 1969 Bighorn Canyon Archeology. River Basin Surveys, Museum of Natural History, Smithsonian Institution, *Publications in Salvage Archeology, No. 12.* Lincoln, Nebraska.

Hyland, D. C., J. M. Tersak, J. M. Adovasio, and M. I. Siegel 1990 Identification of the Species of Origin of Residual Blood on Lithic Material. *American Antiquity* 55(1):104–112.

Kooyman, B., M. E. Newman, and H. Ceri 1992 Verifying the Reliability of Blood Residue Analysis on Archeological Tools. *Journal of Archeological Science* 19(3):265–269.

Newman, M. E. 1990 The Hidden Evidence from Hidden Cave, Nevada. Unpublished Ph.D. Dissertation, University of Toronto, Canada.

Newman, M. E., and P. Julig 1989 The Identification of Protein Residues on Lithic Artifacts from a Stratified Boreal Forest Site. *Canadian Journal of Archeology* 13:119–132.

Newman, M. E., R. M. Yohe, H. Ceri, and M. Q. Sutton 1993 Immunological Protein Residue Analysis of Nonlithic Archeological Materials. *Journal of Archeological Science* 20(1):93–100.

Nolin, L., J. K. G. Kramer, and M. E. Newman n.d. Detection of Animal Residues in Humus Samples from a Prehistoric Site in the Lower Mackenzie River Valley, Northwest Territories. *Journal of Archeological Science,* in press.

Pierce, K. L., K. P. Cannon, G. M. Crothers, G. Meyer, and M. Rubin 1993 Backflooding

Upstream from the Resurgent Dome of the 0.6 Ma Yellowstone Caldera—Two Backflooding Cycles in the Last 8,000 Years (abs). *Eos* 74(43):592.

Reeve, S. A. 1989 Prehistoric Settlement at the Yellowstone Lake Outlet, Yellowstone National Park, Wyoming. Manuscript on file at the Midwest Archeological Center, Lincoln, Nebraska.

Royal Canadian Mounted Police 1983 *Methods Manual, Serology Section*. Ottawa, Canada.

Taylor, D. C., K. Wood, and J. J. Hoffman 1964 Preliminary Archeological Investigations in Yellowstone National Park. Manuscript on file at the Midwest Archeological Center, Lincoln, Nebraska.

Wheat, J. B. 1972 The Olsen-Chubbuck Site: A Paleo-Indian Bison Kill. *Memoirs of the Society for American Archeology*, No. 26.

A Paleo-American (Pre-Clovis) Settlement in Alberta

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Geoarchaeological investigations initiated in 1990 in the Bow River valley, southwestern Alberta, provide evidence for an earlier prehistoric occupation predating the earliest Paleoindian ("projectile point") record known from western Canada. Two formally identical assemblages of pebble cores and flakestone tools have been found deeply buried in late-Pleistocene deposits exposed in two large-scale sections in the western part of the city of Calgary. A mid to early late-Wisconsinan age of the lithic artifacts is suggested by their stratigraphic position within a series of (glacio)fluvial, glacial and glaciolacustrine deposits.

The study area is located at the southwestern margin of the Western Alberta Plains near the Porcupine Hills about 100 km east of the Front Range of the Canadian Rocky Mountains. The locations referred to as Site 1 (Varsity Estates) and Site 2 (Silver Springs), are situated on the northern side of the Bow River valley in the middle part of cliff-forming slopes 30–50 m high (1070–1085 m asl). At Site 1, recognized in October 1990, lithic artifacts were found in the eroded exposures in the steep middle part of the bluffs at the contact of the Cordilleran Bow Valley till and the overlying Glacial Lake Calgary deposits. Twenty-two artifacts, including three finished tools and two cores, were recorded in a small 2-m^2 section excavated in 1992 on top of the till stratigraphically 24 m below the present surface. The artifacts were embedded within a cohesive clayey matrix among unmodified, unbroken and perfectly rounded cobbles and pebbles. The lithic sample includes *débitage* flakes, six of which were refitted to a biface made on a flat quartzite cobble (Figure 1). From the 17 flakes removed during modification of the biface, 5 were found within a small gully, 50 x 50 cm, eroded at the till surface; 12 others were recorded in situ in the excavated section. Some other culturally flaked and partly rolled lithics were found redeposited in the till.

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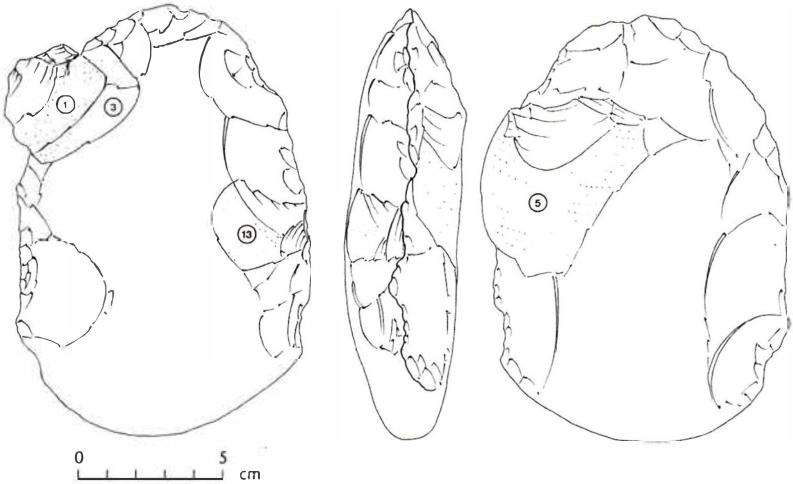

Figure 1. Calgary Site 1 (1992 excavation). A part of the *débitage* refitted to the biface found beneath 24 m of Glacial Lake Calgary deposits.

At Site 2, recognized in February of 1991, similar percussion-flaked artifacts are distributed in the upper part of fluvial gravels and the basal part of the Bow Valley till. The culturally modified cobbles and flakes were originally distributed on top of the uppermost massive gravelly alluvium, and became partly redeposited into the till during the valley ice advance. This is well documented by glacial striations superimposed on artifactually flaked faces of a number of lithic specimens. The evidence for the cultural authenticity of the recorded lithic assemblages consists of the occurrence of diagnostic patterned flaking and edge-retouching attributes, which are encountered in the Old World Pleistocene as well as in local Holocene stone industries made on similar clastic raw materials (mainly quartzite). These patterned flaking attributes, however, are absent on transported rocks with identical lithological composition from local high-energy fluvial and glacial environments.

Cobbles from the fluvial and glacial deposits were used for the manufacture of tools at both sites. Lithic technology is rather simple, but repeated in patterned occurrences of specific artifact types. Direct, hard percussion was the dominant flaking technique. Soft-hammer percussion blade technology is documented on one core with a single flaking platform. The formal typology of both assemblages consists largely of a variety of crudely modified "pebble tools," including choppers, bifaces, and massive scrapers on cobbles. Small flake tools also occur in the form of steeply retouched side scrapers, less often as end scrapers and simple dihedral and other burins. Utilized flakes and unmodified lithic waste are also present. In general, the lithic industry displays analogous technological and typological traits of the late Pleistocene Paleolithic of northeastern Eurasia.

The suggested age of the cultural assemblages is based on the stratigraphic position of the artifact-incorporating deposits correlated in the Quaternary framework of the larger study area. The *upper series* lithic industry excavated at Site 1 from the gravelly surface of the till predates formation of the ice-marginal glaciolacustrine basin (Glacial Lake Calgary) that was ponded by a late Wisconsinan Laurentide ice advance into the Calgary area (Moran 1986). The implied early late-Wisconsinan age (*ca.* >21,000 yr B.P.) is supported by the palynological evidence from the archaeological horizon, including sedges (Cyperaceae) and some arboreal taxa *(Pinus, Picea)*, indicating a cool semiarid interstadial climate during the occupation episode. Coniferous forests were widely distributed throughout Alberta during the mid-Wisconsinan Non-Glacial Interval (65,000–23,000 yr B.P.) and likely survived for some time in the Rocky Mountain Foothills prior to the Laurentide ice advance over the prairies. Pine and spruce, however, were absent in the Calgary area until about 10,000 yr B.P. The *lower series* lithic industry from the fluvial gravels and the till at Site 2 predates the Bow Valley Advance (Rutter 1972), being the first late-Wisconsinan glaciation that reached the study area (Jackson 1987). Therefore, a (late) mid to early late-Wisconsinan age for the earlier Bow Valley occupation can be assumed (*ca.* 25,000–21,000 yr B.P.). As there are no formal differences between the stone tools from both sites, they can be assigned to one Paleo-American (pre-Paleoindian) tradition.

The geoarchaeological data from the Bow Valley sites suggest that the opening of the "ice-free corridor" along the eastern flanks of the Rocky Mountains during the final late Wisconsinan (Liverman, Catto and Rutter 1989) should no longer be regarded as a major precondition for the initial peopling of North America south of the continental ice, as people evidently occupied this area before the time of glacial coalescence in northwestern Alberta.

References Cited

Jackson, L. E. Jr. 1987 The Quaternary history of the Calgary area. In *Geology of the Calgary Area,* edited by L. E. Jackson, Jr. and M.C. Wilson, pp 97–107. Canadian Society of Petroleum Geologists, Calgary.

Moran, S. R. 1986 *Surficial Geology of the Calgary Urban Area.* Bulletin No. 53. Alberta Research Council, Edmonton.

Liverman, D. G. E., N. R. Catto, and N. W. Rutter. 1989 Laurentide glaciation in west-central Alberta: a single (Late Wisconsinan) event. *Canadian Journal of Earth Sciences* 26, 266–274.

Rutter, N. W. 1972 *Geomorphology and Multiple Glaciation in the Area of Banff, Alberta.* Geological Survey of Canada Bulletin no. 206. Ottawa.

The River Spur Site: Paleoindian Occupation in the Texas Coastal Prairie

William A. Cloud, Robert J. Mallouf, Edward A. Vogt Jr., W. W. Birmingham, and E. H. Schmiedlin

At the urging of local avocational archaeologists, test excavations were conducted by the Office of the State Archaeologist (OSA), Texas Historical Commission, in September 1993 at the River Spur Site (41VT112) in Victoria County, Texas. This is one of several deeply buried sites in the central coastal prairie region known to have early cultural components (e.g., Brown 1987). Located in an occasionally flooded fossil floodplain terrace system of Meguin silty clay (Miller 1982) along the lower Guadalupe River, the River Spur Site is endangered by lateral and downward cutting of a short, intermittent tributary of the river. In monitoring the area for years, avocational archaeologists have recovered over 700 artifacts eroding from the terrace slope and bed of the intermittent tributary at the site. A large percentage of the artifacts surface-collected from the site have affinities with Paleoindian and transitional early-Archaic lithic assemblages of the Texas central coastal prairies. Included in the collection are Plainview, Scottsbluff, Angostura, Golondrina, and Victoria projectile points; Clear Fork gouges and Guadalupe adzes; an early style of net sinker; large drills; a wide variety of bifacial preforms; cutting and scraping implements; and utilized flakes. Most of the tools are fashioned from chert nodules that are readily available in upstream gravel bars of the Guadalupe River. Of particular importance is the past discovery by avocationals of an intact hearth and in-situ human burials eroding out of the floor of the intermittent tributary some 4 m below the modern terrace surface. This significant collection (Ed Vogt Collection), including human skeletal material, has recently been donated to the Texas Archeological Research Laboratory of the University of Texas at Austin.

OSA investigations at River Spur included the cutting of a 9.5-m-long backhoe trench extending from the top edge of the terrace to the floor of the tributary, and four small hand-excavated units strategically placed to more fully explore lower stratigraphy and early cultural deposits at the site. Seven alluvial soil zones of recent to early-Holocene age (Zone 1–Zone 7), including at least two buried paleosols and several distinct lenses, are defined on the basis of the backhoe cut (Figure 1). The lowest of the defined strata (Zone 7) forms the current bed of the stream and consists of a thick, mottled, yellow silty clay with high iron/manganese content, pea gravels, redoximorphic features, and krotovena. Hand excavations in Zone 7 yielded strong evidence of Paleoindian

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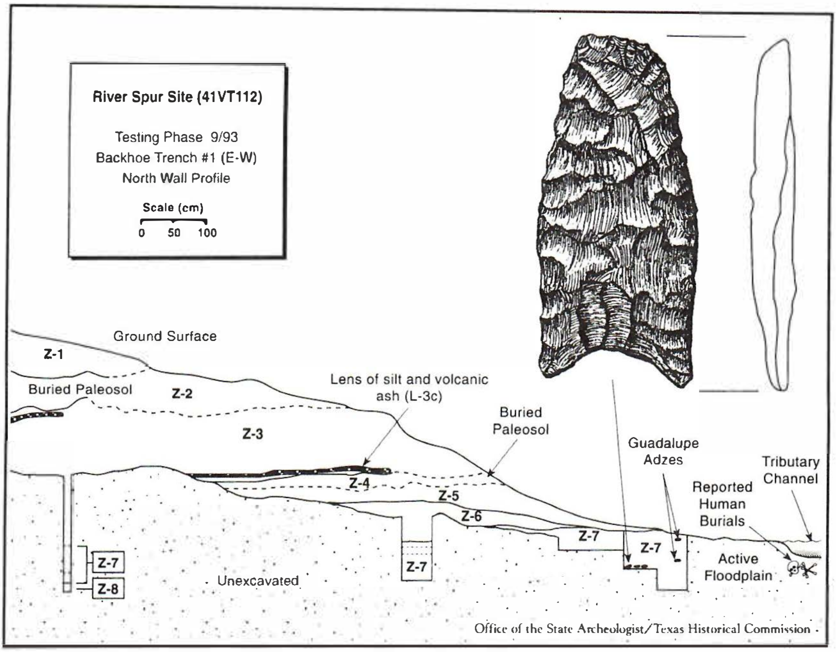

Figure 1. North wall profile of Backhoe Trench #1 at the River Spur Site (41VT112).

and/or transitional early-Archaic components in the form of in-situ Guadalupe adzes, a bifacial dart-point preform, core fragments, a bifacial knife, and, somewhat lower, a Dalton point. Notable clusters of debitage encountered during the testing suggest the possibility that some living surfaces might be discernible in the zone. Previously discovered human burials and hearths at River Spur are also known to be associated with Zone 7. A soil core carried down through the floor of the backhoe trench confirms that the substantial Zone 7 stratum extends beneath the terrace for a distance of at least 10 m (Figure 1). Current evidence suggests that early human occupations of the River Spur Site were in a relatively wet environment—possibly at the edge of a marsh, or low above a pond or backwater slough. Significantly, any remaining human burials or other features found in Zone 7 are expected to be of transitional early-Archaic, or potentially late-Paleoindian, age.

Buried paleosols located higher in the stratigraphic sequence above Zone 7 also contain cultural material, but little can be said about these components at this time. Zones 1–6 are composed chiefly of dense, dark to medium brown, calcareous floodplain clays with varying silt content. Of special note is a 2-m-long lens, 5–7 cm thick, of grayish-white volcanic ash and silt located 1.2 m above the top of Zone 7 (Figure 1). The origin and age of this unusual non-cultural deposit are currently unknown, but it presents future investigators with a number of interesting interpretive possibilities.

In sum, archaeological testing has demonstrated the presence of transitional early-Archaic and late-Paleoindian components in a relatively hydric paleoenvironmental setting at the River Spur Site. The potential for encountering early in-situ cultural features, including human burials, is considered to be high. Deeply buried cultural deposits at this significant early site are, however, eminently endangered by erosion, and large-scale controlled excavations must be initiated in the very near future if potentials are to be realized.

The authors extend their appreciation to Paul Locher and other staff of the City of Victoria, to Wes Miller of the SCS, to volunteers Don Will, Esther Sloan-Cavanaugh, Chris Howell, Bob Baker, Danny Cantu, Steve Harris, Patsy Goebel, Lee Tucker, Sonny Timme, and Charlie Gosset, and finally to Michael Collins, Gene Mears, and their associates from UT-Austin.

References Cited

Brown, K. M. 1987 Early Occupations at Berger Bluff, Goliad County, Texas. *Current Research in the Pleistocene* 4:3–5.

Miller, W. L. 1982 *Soil Survey of Victoria County, Texas.* Soil Conservation Service, United States Department of Agriculture.

Cueva Quebrada Shelter, Texas

Michael B. Collins

Cueva Quebrada (41VV162A) and Conejo (41VV162) are two contiguous rockshelters in a short canyon tributary to the Rio Grande in the Lower Pecos region of Texas. Being in the impact area of then-planned Diablo Reservoir (later completed and renamed Amistad Reservoir), the two were first recorded in 1958 (Graham and Davis 1958) and then tested in 1967 for archaeological significance (Collins 1969). Both were deemed significant and were extensively excavated in 1968–69 by crews directed by Robert K. Alexander under auspices of the Texas Archeological Salvage Project of the University of Texas at Austin. Conejo, the larger of the two, yielded extensive archaeological remains primarily of Archaic affiliation (Alexander 1974).

No comprehensive formal report has ever been prepared for the smaller shelter, Cueva Quebrada, and for a number of years the complete original field documentation was inaccessible. Cueva Quebrada yielded an important late-Pleistocene fauna in "Layer IV," with uncorrected and uncalibrated radiocarbon ages on wood charcoal of 12,280 ± 170 (TX879), 13,920 ± 210 (TX 880), and 14,300 ± 220 (TX881) (Valastro et al. 1977, 1979; Lundelius 1984:456–481; Johnson 1989:439–443).

There were also a small number of stone artifacts recovered from the site, mostly from the surface and high in the deposits, above the layers containing the Pleistocene fauna (Collins 1976). Owing to an unfortunate error, six artifacts actually recovered from Conejo Shelter (41VV162) were incorrectly

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labeled "41VV162A," the designation of Cueva Quebrada, but they were given specimen numbers denoting their correct provenience in Conejo Shelter. By chance, the corresponding provenience numbers in Cueva Quebrada denote Layer IV in the site where Pleistocene faunal remains dated 12,000–14,000 B.P. rested. Unaware of that error, I reported earlier the presence of those six artifacts in association with the fauna and inferred a possible cultural presence with an age greater than 12,000 radiocarbon years (Collins 1976). It is clear from the field records, which are now housed at the Texas Archeological Research Laboratory, that no stone artifacts were found in association with the Pleistocene-age bones, a fact that Johnson (1989) has already noted. Johnson (1989) also notes that no bone tools can be identified in the assemblage and that the bone breakage seems natural.

The faunal assemblage from Cueva Quebrada is diverse (23 taxa, of which 7 are extinct and 1 is extirpated) and most of the bones are burned (Lundelius 1984; Johnson 1989); notable taxa are short-faced bear (*Arctodus simus*); an unidentified canid; two horses (*Equus* cf. *scotti*, *E. francisci*); bison (*Bison antiquus* or *occidentalis*); camel (*Camelops* sp.); American mountain deer (*Navajoceros ficki*); antelope (*Stockoceros*); and wood rat (*Neotoma*). Carnivore gnawing is present on some bones, and most are broken. Among the fauna are taxa such as the short-faced bear and the canid, which could account for the presence of these bones in this small shelter as well as for the damage they exhibit.

Wood charcoal is present in patches in the shelter, and the three radiocarbon dates are based on this material (Valastro et al. 1977 and 1979). Because Cueva Quebrada opens on the face of a steep canyon, it is most likely that wood entered by the actions of either animals or humans. The wood rats may have introduced the wood as well as some of the bone into a nest in the cave.

Misfortune in the history of this collection is not limited to the cataloguing error just discussed. When I studied the collection (which lacked field notes) in 1976, I noted that the calcaneum of a small extinct artiodactyl (then tentatively identified as the extinct antelope, *Capromeryx*) had a series of small V-shaped incisions on one side (Collins 1976:112–113 and Figure 6). These were lightly encrusted with endurated cave dust, eliminating excavation tools as causing them. They were not rounded, U-shaped, or square-bottomed in the usual manner of carnivore or rodent tooth-marks, and they appeared to me to have been produced by a very sharp-edged object, most likely a stone flake (Collins 1976:112–113). That calcaneum was recovered from the layer of Pleistocene bones and clearly derives from that fauna; unfortunately, it is now missing from the collections in the Vertebrate Paleontology Laboratory at the University of Texas at Austin.

Those who have examined the faunal assemblage from Cueva Quebrada have noted the possibility that humans were partly responsible for its presence and its condition, especially the burning (Collins 1976; Lundelius 1984; Johnson 1989), and that question remains open. My error of reporting stone artifacts in association with the fauna is hereby corrected. There remains the urgent need for the missing calcaneum to be located and for it to be examined by experts in bone modification. The entire data set from this site needs to be completely analyzed and reported in an effort to clarify as fully as possible the taphonomy of the faunal remains.

References Cited

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

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

Collins, M. B. 1976 Terminal Pleistocene Cultural Adaptations in Southern Texas. Pretirage, Colloque XVII, *Habitats Humains Antérieurs à l'Holocene en Amérique.* Union Internationale des Sciences Préhistorique et Protohistorique, IX$_e$ Congrès, Nice, France.

Graham, J. A., and W. A. Davis 1958 Appraisal of the Archeological Resources of Diablo Reservoir, Val Verde County, Texas. Report prepared by the Archeological Salvage Program Field Office, Austin, Texas. U. S. National Park Service.

Johnson, E. 1989 Human Modified Bones from Early Southern Plains Sites. In *Bone Modification*, R. Bonnichsen and M. H. Sorg, eds., pp. 431–471. Center for the Study of the First Americans, Institute for Quaternary Studies, University of Maine, Orono.

Lundelius, E. L., Jr. 1984 A Late Pleistocene Mammalian Fauna from Cueva Quebrada, Val Verde County, Texas. In *Contributions in Quaternary Vertebrate Paleontology: A Volume in Memorial to John E. Guilday*, H. H. Genoways and M. R. Dawson, eds. pp. 456–481. Special Publication Carnegie Museum of Natural History, No. 8, Pittsburgh.

Valastro, S. Jr., E. M. Davis, and A. G. Varela 1977 University of Texas at Austin, Radiocarbon Dates XI. *Radiocarbon* 19:280–325.

Valastro, S. Jr., E. M. Davis, and A. G. Varela 1979 University of Texas at Austin, Radiocarbon Dates XIII. *Radiocarbon* 21:257–273.

Recent Excavations at the Paw Paw Cove Paleoindian Site, Talbot County, Maryland

Jay F. Custer and Darrin Lowery

The Paw Paw Cove Paleoindian site is located in the coastal plain of the central eastern shore of Maryland on the Delmarva Peninsula. The site's physiographic setting is the flat margin of a small tidal wetland adjacent to the Chesapeake Bay. During late-Pleistocene times the site was located in an interior setting and was associated with a freshwater wetland, based on local sea-level rise and pollen data (Custer 1989).

Prior to test excavations at the site, more than 300 Paleoindian artifacts, including 25 fluted projectile points and 11 preforms, had been found in eroded and redeposited contexts on the modern Chesapeake Bay shoreline (Lowery 1989). Excavations were undertaken to determine the source of the eroding artifacts and to recover Paleoindian artifacts from undisturbed contexts. Three 1-m test units were excavated on three small fingers of land that extended into adjacent wetlands, and each test unit produced a fluted point (Figure 1). In all three units the fluted points were recovered from a clayey

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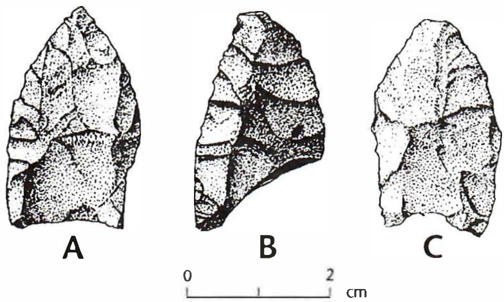

Figure 1. Fluted projectile points from test excavations.

fragipan soil that was located approximately 30–40 cm beneath the modern land surface. The artifact-bearing soils were located beneath wind-blown loess-like soils and above a grey marine clay dated to c. 17,000 yr B.P. (Lowery 1990). Paleoindian artifacts have been recovered from similar fragipan soils at other sites in the immediate area (Lowery and Custer 1990), and the fragipan soils may represent a late-Pleistocene chronostratigraphic unit for the central section of the eastern shore of Maryland.

Eight additional contiguous test units were excavated on the finger of land closest to the Chesapeake Bay because this locale was threatened with destruction by erosion. The excavation units exposed a small activity area and recovered 25 additional lithic artifacts. The artifact assemblage included the previously noted fluted point (Figure 1A), a biface, a hammerstone, a scraper, and 21 pieces of debitage, one of which might be a portion of a channel-fluting flake. All the chipped-stone artifacts are manufactured from cryptocrystalline materials, with jasper being the most common. Cortex is present on more than half of the artifacts, indicating that pebbles and cobbles were being used as a source of lithic raw materials. Similar raw-material utilization was noted for the beach collections (Lowery 1989).

The excavated area represents a small tool-refurbishing locale that was probably associated with hunting and gathering activities focused on the freshwater wetlands. The presence of the two other fluted-point loci suggests that the wetlands were used on numerous occasions during the late Pleistocene. Paleoindian artifacts found eroding on the beach were probably derived from additional and similar Paleoindian occupations of the local area. If the single fluted point and approximately 20 flakes are typical of all the Paleoindian occupations of the site, then the 300 artifacts found on the beaches represent approximately 15 additional Paleoindian occupations of the Paw Paw Cove wetland area.

In sum, the results of the test excavation reinforce the notion that Paleoindian groups of the middle Atlantic coastal plain intensively utilized freshwater wetland environments (Custer 1989; Custer and Mellin 1991; Lowery 1989; Lowery and Custer 1990).

References Cited

Custer, J. F. 1989 *Prehistoric Cultures of the Delmarva Peninsula: An Archaeological Study*. University of Delaware Press, Newark.

Custer, J. F. 1991 Paleoindian Component at the Linn Woods Site, Sussex County, Delaware. *Current Research in the Pleistocene* 8:15–16.

Lowery, D. 1989 The Paw Paw Cove Paleoindian Site Complex, Talbot County, Maryland. *Archaeology of Eastern North America* 17:143–164.

Lowery, D. 1990 Recent Excavation at the Paw Paw Cove Site: A Maryland Coastal Plain Paleoindian Habitation Locality. *Current Research in the Pleistocene* 7:29–30.

Lowery, D., and J. F. Custer 1990 Crane Point: An Early Archaic Site in Maryland. *Journal of Middle Atlantic Archaeology* 6:75–120.

Paleoindian Evidence in the Upper Barton Creek Watershed, Travis County, Texas

Susan W. Dial, Pamela J. Headrick and Thomas R. Hester

Intermittently from 1989 to 1992, students and staff of the University of Texas at Austin conducted a reconnaissance survey of a 7,000-acre ranch in the upper Barton Creek watershed in western Travis County, Texas. Eight sites with evidence of use during Paleoindian times were recorded. Of particular interest in survey data was the near uniformity in Paleoindian site distribution and the apparent correlation between early sites and soil types.

Sites with Paleoindian diagnostics were detected almost exclusively in bottomland settings, typically on eroded surfaces and broad, filled-in stream meanders. At six of the sites, cultural materials were found in association with distinctive, reddish-colored soils containing pea-sized calcium-carbonate nodules; such characteristics can be attributed chiefly to long periods of weathering and great age (Michael Blum, personal communication 1992). Once this pattern was observed, intensified survey efforts were directed toward areas identified in county site maps as containing these soils. Although not a completely accurate indicator, such maps served to locate general areas where the early soils tended to be exposed at the surface.

A total of 21 Paleoindian projectile points of six different types was recovered from surface contexts; together, they represent a temporal frame estimated at 11,200–8000 yr B.P. Points with Plainview attributes were most prevalent, followed by Angostura, Golondrina, Clovis-like, Scottsbluff, and San Patrice (Figure 1). Two of the specimens are basal fragments identified to the Clovis type. Although neither specimen was sufficiently complete for certain classification, the overall constellation of large size, thickness, and fluting attributes conforms more to Clovis than to any other point type.

The recovery of the San Patrice point is of particular note. These points previously have been identified chiefly in eastern parts of the state and adjacent

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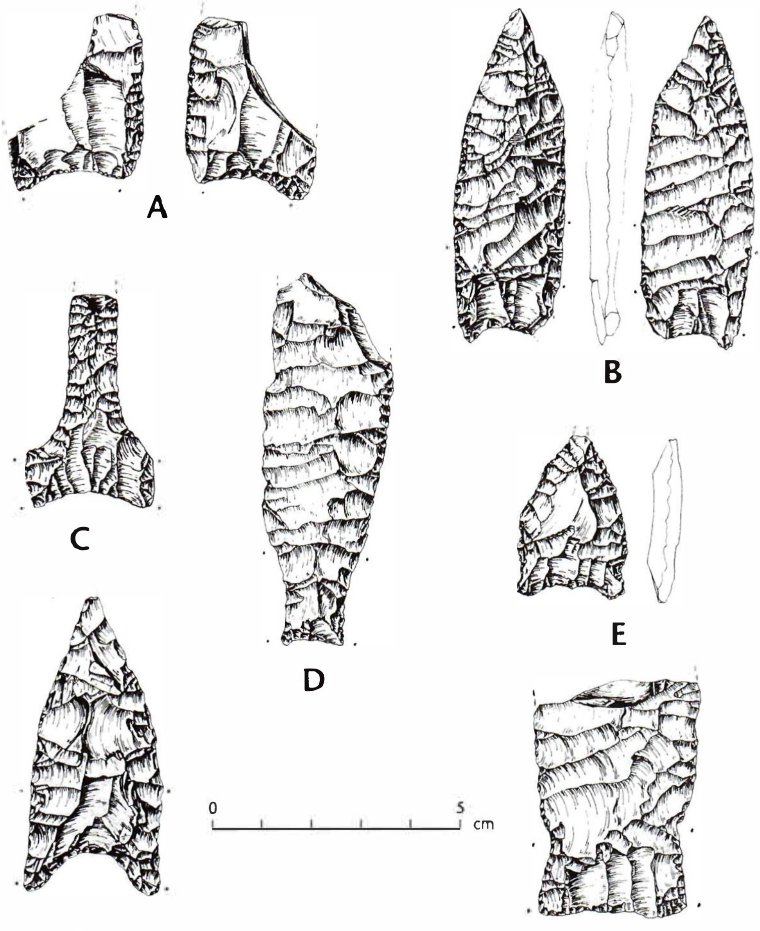

Figure 1. Selected Paleoindian projectile points from the upper Barton Creek watershed. **A,** Clovis-like; **B,** Plainview; **C,** perforator on Plainview-like base; **D,** Angostura; **E,** San Patrice; **F,** Golondrina; **G,** Scottsbluff.

Woodland areas; however, San Patrice variants reported in central and Panhandle sections of the state have stimulated a reconsideration of the type and its distribution (Ensor 1987).

With the exception of the two Clovis-like specimens and an apparent perforator made on a reworked Plainview-like base, all the Paleoindian diagnostics were heavily patinated. Preliminary examination of selected specimens under ultraviolet light (cf. Collins 1969; Hoffman et al. 1991) suggested that the majority were made on local Edwards chert, likely that recorded at two nearby hilltop chert-procurement sites.

References Cited

Collins, M. B. 1968 The Andrews Lake Locality: New Archeological Data from the Southern Llano Estacado, Texas. Masters thesis, The University of Texas at Austin, August 1968.

Ensor, H. B. 1987 San Patrice and Dalton Affinities on the Central and West Gulf Coastal Plain. *Bulletin of the Texas Archeological Society* 57:69–81.

Hoffman, J. L., L. C. Todd, and M. B. Collins 1991 Identification of Central Texas Edwards Chert at the Folsom and Lindenmeier Sites. *Plains Anthropologist* 36 (137):297–308.

North American Paleoindian Database—An Update

Michael K. Faught, David G. Anderson, and Anne Gisiger

An earlier paper in *CRP* presented information on the distribution of diagnostic Paleoindian projectile points in the eastern United States (Anderson, 1990a). Since that time, additional data have been compiled, including information from the central and western states assembled by Faught.

We present this information in two formats. Figure 1 represents the distribution of points tallied in each of the 3,075 counties in the coterminous United

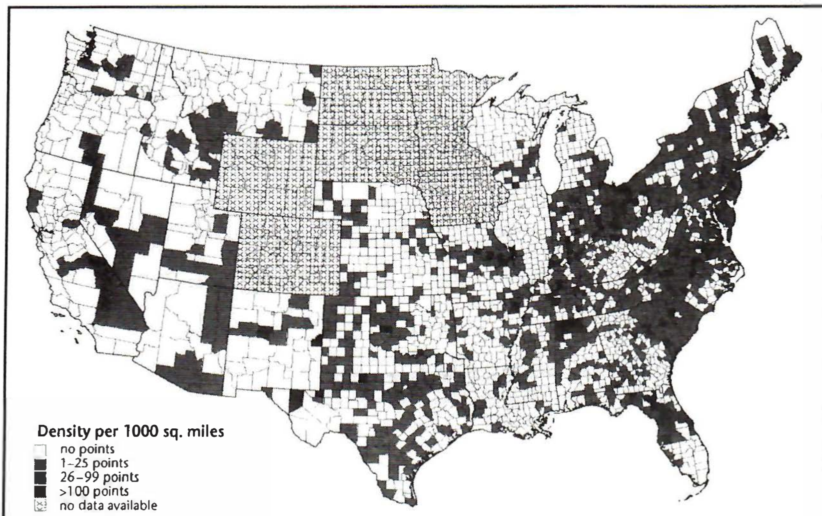

Figure 1. Fluted-point frequency per 1000 square miles, by county.

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States, standardized to points per 1000 mi². This map was prepared by Gisiger at CAST using data provided by Anderson and Faught. The mapping was accomplished by GRASS GIS software. Values were estimated by dividing county area by the number of fluted points recorded for that county from both published and unpublished sources. Figure 2 is a contour map showing the same data. This map was contoured with SURFER software, using the centroids of each county as data points, with zeroing of areas outside the continental shelves and/or the glacial boundaries of 11,000 years ago (Dyke and Prest, 1987).

These maps are based on a sample of 10,198 points. In the 1990 *CRP* article the sample included just over 9,000 fluted and nonfluted early- and middle-Paleoindian diagnostics. The sample reported here is restricted to fluted points, including Clovis, Folsom, Debert, Gainey, and other variants. Daltons, Suwannees, Simpsons, and Quads, which have both fluted (or basally thinned) and unfluted variants, were not included. The inclusion of other than classic Clovis fluted points is intended to render the samples more comparable from east to west, and to extend the possible temporal base.

While this is a better controlled sample and the data set continues to grow, problems remain. Although information exists from some Canadian provinces, we have not incorporated it into the mapping routines. Also, some states have spotty reporting (i.e., Illinois, Louisiana, Oregon, and New Mexico), while for others either no systematic reporting exists or the data were unavailable for this version (i.e., Colorado, Wyoming, North and South Dakota, Minnesota, Iowa).

These data have a number of important implications for the study of early

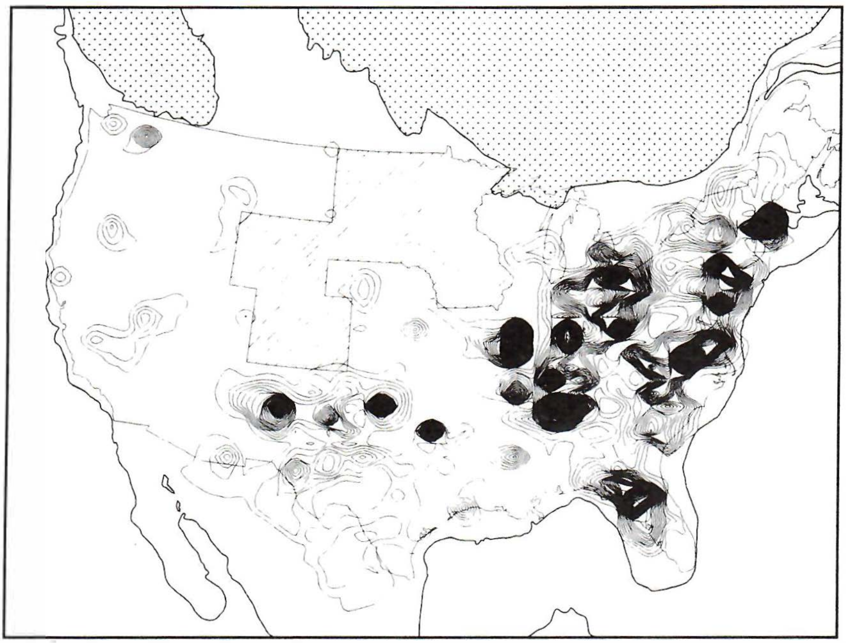

Figure 2. Fluted-point frequency per 1000 square miles: contour interval = 1.

human occupation in North America. Immediately evident is the apparently much higher density of fluted points in the East than in the West. If this pattern continues to hold when factors such as missing data from the Plains, geomorphological visibility, agricultural practices, and collector population density are considered, then a number of additional observations follow.

First, fluted points are distributed unevenly across the landscape, with pronounced concentrations in some areas. This suggests that human populations were unevenly distributed and that, if fluted points are indeed evidence for initial human settlement, that the colonization of the region more closely resembles a leapfrog than a wave-of-advance pattern (cf Anthony, 1990; Martin, 1973).

Second, these concentrations may hold clues to the subsequent emergence of discrete cultural traditions (e.g., Anderson 1990b; Willig and Aikens, 1988). Third, several concentrations are located near the continental shelf, suggesting possible locations of inundated sites (Dunbar et al, 1992; Faught, 1988). Fourth, if movement during initial colonization proceeded down the ice-free corridor or along the Pacific Rim, this movement did not leave a strong signal. Of course, additional data from these areas could change this picture.

We are continuing to assemble and compile data on Paleoindian artifacts and assemblages, and welcome information of this kind. To date, attribute data on some 6,000 diagnostics have been collected and compiled by Anderson, primarily from the East. Comparable data from the West are needed. The kinds of data that are particularly useful include state or province compilations (compiled to the county level or equivalent) (e.g., Brown and Logan, 1987; and Largent et al, 1991). Send information to either Anderson or Faught (in hard, reprint, and/or electronic format) and we will incorporate it into the database. The database is available upon request in either Macintosh or DOS format on 3.5″ diskettes.

The authors wish to thank all those people who have contributed so far in the construction of this database, and encourage others to join in.

References Cited

Anderson, D. G. 1990a A North American Paleoindian Projectile Point Database. *Current Research In the Pleistocene,* 7:67–69.

Anderson, D. G. 1990b The Paleoindian Colonization of Eastern North America: A View From the Southeastern United States. In *Research in Economic Anthropology, Supplement 5,* edited by K. B. Tankersly and B. Issac, pp. 163–216. JAI Press Inc.

Anthony, D. W. 1990 Migration in Archeology: The Baby and the Bathwater. *American Anthropologist* 92:895–914.

Brown, K. L., and B. Logan 1987 The Distribution of Paleoindian Sites in Kansas. In *Quaternary Environments of Kansas,* edited by W. C. Johnson, pp. 189–195. Kansas Geological Survey Guidebooks, Series 5.

Dunbar, J. S., S. D. Webb, and M. K. Faught 1992 Inundated Prehistoric Sites in Apalachee Bay, Florida, and the Search for the Clovis Shoreline. *Paleoshorelines and Prehistory: An Investigation of Method* , edited by L. L. Johnson and M. Stright, pp. 117–146. CRC Press, Boca Raton.

Dyke, A. S., and V. K. Prest 1987 Paleogeography of Northern North America, 11000–8400 Years Ago. *Geological Survey of Canada, Map 1703A.*

Faught, M. K. 1988 Inundated Sites in the Apalachee Bay Area of the Eastern Gulf of Mexico. *Florida Anthropologist* 41(1):185–190.

Largent, F. B., M. R. Waters, and D. L. Carlson 1991 The Spatiotemporal Distribution and Characteristics of Folsom Projectile Points in Texas. *Plains Anthropologist* 36(137):323–341.

Martin, P. S. 1973 The Discovery of America. *Science* 179:969–974.

Willig, J. A., and C. M. Aikens 1988 The Clovis—Archaic Interface in Far Western North America. In *Early Human Occupation in Far Western North America: The Clovis—Archaic Interface,* edited by J. A. Willig and C. M. Aikens, pp. 1–40. Anthropological Papers of the Nevada State Museum, Number 21, Carson City.

Reinvestigations at the San Jon Site, New Mexico

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The San Jon site (LA 6437) is a little-known multicomponent archaeological locality situated on the northern rim of the Llano Estacado in Quay County, New Mexico. The site is in a small (1 km wide) dry lake basin or "playa." Archaeological materials were buried by basin fill consisting of lacustrine, slopewash, and aeolian sediments. The human-occupation debris is now being exposed along deep arroyo tributaries of a canyon that cut into the High Plains escarpment. Excavations directed by Frank Hibben in 1940 and Frank H. H. Roberts in 1941 provided evidence that Paleoindian and Archaic hunters repeatedly used the site to procure and process bison (Judson 1953; Roberts 1942). However, recent fieldwork and reanalysis of the extant San Jon collection curated at the Smithsonian Institution shed new light on this important locality. Preliminary research suggests at least one Cody Complex component exists at San Jon as well as two Archaic occupations. A late-Prehistoric occupation is also known.

Roberts's excavations focused on three areas (I–III) of the site (Roberts 1942, Fig. 1), and four stratigraphically distinct prehistoric occupations were identified (Judson 1953; Roberts 1941, 1942). Three of the components are thought to represent bison kill-butchery episodes. Two quartzite flakes and several pieces of fragmentary bone were recovered at the Area I excavations (Roberts 1941). In Area II, an Alibates dolomite Cody Complex projectile point (Roberts 1942, Fig. 2a; Wormington 1957) was found in association with bison identified as *Bison taylori = antiquus.* This is the earliest documented occupation of the site, although in 1941 an Alibates dolomite Folsom point was collected approximately 150 m north of Area II eroding out of a similar stratigraphic unit. A second Cody Complex projectile point manufactured from Edward's chert (Roberts 1942, Fig. 2c) was collected at the "Hibben" bison bonebed (Roberts 1941). Two Clear Fork points manufactured from Dakota (Roberts 1942, Fig. 2b) and Morrison Formation quartzites were excavated in situ with the bison

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(*B. bison*) remains at Area III. The fourth horizon identified by Roberts (1942) and Judson (1953) contains ceramics and notched projectile points situated directly beneath the modern ground surface (Roberts 1942).

In June 1993 a surface survey and geological drilling were conducted to assess the potential for future research at San Jon. Geological cores were drilled in all of Roberts's excavation areas. Since only the general vicinity of the "Hibben" locale (Robert 1942:7) could be established, it was not cored. The cores are intended to address questions related to the site's formational history and to clarify aspects of Judson's (1953) geologic research (cf. Wormington 1957:122–123). Several sediment samples were removed from these cores for radiocarbon dating, but the analyses are not yet completed. During 1993 fieldwork, two side-notched Archaic projectile points made from Alibates dolomite and Dakota quartzite were collected approximately 25 m west of Area II among considerable quantities of lithic debitage and bone fragments.

Examination of the faunal remains collected during the 1941 field work provides additional data on bison hunting at the site. At least five bison, based on complete mandibles, are represented in the Area III Archaic bonebed, while a minimum of five, based on astragali, were recovered in the Area II Cody bonebed. However, bonebed maps, photographs, and field notes clearly indicate that a larger variety of skeletal elements, and perhaps more animals, were once present in the San Jon bonebeds than are in the Smithsonian collections. Apparently only larger articulated limb units or complete bones were saved during the original excavations. No faunal material or bonebed maps exist from the "Hibben" locality or Area I excavations. This selective documentation has made questions related to human and nonhuman modification to the faunal remains difficult to address with the available assemblage.

Preliminary conclusions, supported by recent fieldwork and reanalysis of the extant San Jon collection, document important Paleoindian and Archaic components at the site. Future research is critical before more substantial observations related to human behavior and site formation processes at San Jon can be made. The site may provide additional data on late-Paleoindian artifact types. We refer to the two lanceolate points as "Cody Complex" but also recognize that typological and technological relationships between northern and southern Plains unfluted lanceolate points is far from clear (e.g., Wheat 1972; Knudson 1983). Excavation at the "Hibben" locality is necessary to determine if the bonebed and Cody Complex point are redeposited, as Wormington (1957:122–123) suggested. Excavation of the Archaic components in Area II and Area III will offer valuable insights about Archaic bison hunting on the Southern High Plains. Additionally, investigations where the Folsom point was recovered are necessary to determine if the specimen is simply an isolated find or indicative of a much larger Folsom component. Contemporary methods of bonebed excavation and analysis should permit such questions to be addressed.

Field work at San Jon was supported by funding (to VTH) from the National Science Foundation. Study of the San Jon collection was made possible by a Smithsonian Institution Ten-Week Graduate Fellowship (to MGH). Special thanks is extended to the Callison family of Tucumcari, New Mexico, for their cooperation and for allowing access to the San Jon site. Joanne and Jim Dickenson (Blackwater

Draw Archaeological Site) organized much of the 1993 field work and helped with the survey at San Jon. Garry Running helped with the coring. The efforts of these people are greatly appreciated. However, the authors remain responsible for the interpretations presented in this paper.

References Cited

Judson, S. 1953 Geology of the San Jon Site, Eastern New Mexico. *Smithsonian Miscellaneous Collections* 121(1).

Knudson, R. 1983 Organizational Variability in Late Paleo-Indian Assemblages. Washington State University, Laboratory of Anthropology, *Reports of Investigations* No. 60.

Roberts, F. H. H., Jr. 1941 Unpublished Field Notes on File. In, Frank H. H. Roberts, Jr., Papers. Smithsonian Institution, National Anthropological Archives, Washington, D.C.

Roberts, F. H. H., Jr. 1942 Archeological and Geological Investigations in the San Jon District, Eastern New Mexico. *Smithsonian Miscellaneous Collections* 103(4).

Wheat, J. B. 1972 The Olsen-Chubbuck Site: a Paleo-Indian Bison Kill. *Society for American Archaeology Memoir* No. 26.

Wormington, H. M. 1957 *Ancient Man in North America.* Denver Museum of Natural History, Popular Series No. 4 (4th ed.), Denver.

The Occurrence of Folsom Points in Kansas

Jack L. Hofman

The 12 Mile Creek site may represent a Folsom- or Clovis-age bison bonebed (Hill 1994; Rogers and Martin 1984), but otherwise Folsom evidence from Kansas is limited to surface finds of projectile points. The 32 specimens included here are widely distributed across the state (Figure 1). Howard (1935: 115,119; 1939:278) was first to report a Kansas Folsom point (Seward County). Wedel (1959:536–37,685, Plate 15 h, i) described six Folsom points, three each from Doniphan and Seward counties. In addition, Folsom points have been documented from Barton, Pottawatomie, Jefferson, Mitchell, and Marshall counties (Lippincott 1976:91–93; Schmits 1980:84–85, Fig. 42a; Shippee 1953: Fig. 3; Yaple 1968, n.d.).

Several previously reported Folsom points (Brown and Logan 1987; Glover 1978) are not included here, either because they may be modern replicas (Hofman 1994) or because information is inadequate to verify the finds. Identification of modern replicas presents a significant analytical concern for regional studies of Folsom archaeology.

Brown and Logan (1987), like Yaple (1968), attribute the uneven distribution of Kansas Folsom artifacts (Figure 1) in part to the limited study of private collections. It can be noted, however, that collections from the lower Kansas River Basin have not produced Folsom evidence, even though Clovis and Dalton artifacts are well represented there (Rogers and Martin 1983; Wetherill

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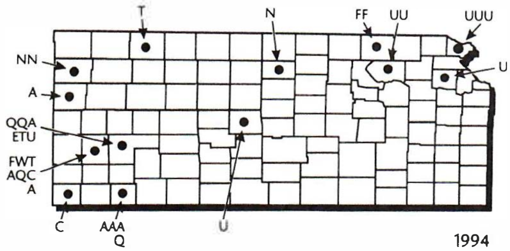

Figure 1. Documented Folsom point finds in Kansas by county and lithic material (n = 32).

1994). This suggests that Folsom activity was not of equal intensity across the state. A similar pattern exists in Nebraska (Myers 1987) and Oklahoma (Hofman 1987).

Study of collections in western Kansas yielded information on 17 previously undocumented Folsom points (Hofman 1994). These are from Decatur (1), Finney (6), Kearny(?) (7), Sherman (2), and Wallace (1) counties. Site-specific provenience is lacking for the Kearny County pieces, which could come from locations further east or west in the sand hills south of the Arkansas River. This incomplete information is unfortunate, but at the scale of regional comparisons the problem is of less significance.

The Kansas Folsom sample includes a variety of lithic material. Seven Folsoms (21.9%) are made from Alibates (Texas panhandle), four (12.5%) are fine quartzites (Dakota or Morrison formations or gravel sources), three (9.4%) are Permian cherts (northern Flint Hills), three (9.4%) are Flattop chalcedony (northeastern Colorado), three (9.4%) are Niobrara jasper (northwest Kansas and southwest Nebraska), two (6.2%) are chalcedony (eastern Colorado or gravel), one (3.1%) is fossilized wood (eastern Colorado or gravel), and one is Edwards chert (central Texas). Eight points (25%) are of unidentified or unknown cherts. Three Midland points from southwestern Kansas include two of Alibates and one of chalcedony.

The limited occurrence of Niobrara Jasper may reflect the small sample, especially from central and northwestern Kansas. Niobrara is a common material for Folsom and Clovis points from Nebraska, and from Oklahoma (Hofman 1990; Myers 1987).

Kansas Folsom points include complete specimens (n = 11, 34.4%), tips (n = 9, 28.1%), blade sections (n = 4, 12.5%), and basal fragments (n = 8, 25%). A Sherman County Folsom base was found on a ridge on the east margin of a large playa and may represent a temporary camp, retooling site, or hunting overlook where equipment was repaired and projectile tips were resharpened or replaced. Folsom preforms or production debris have yet to be reported from Kansas. The circumstances of most Kansas Folsom finds are undocumented, so potential associations with bone beds or tool and debitage assemblages remain open to investigation.

For assistance in a variety of ways I thank Mary Warren, Charlie Norton, Dan Busse, Patricia Heath, Charlie Drew, Lowell Brooks, Harlan House, Mark Brown, Bill Urie, Al Johnson, Martin Stein, Brad Logan, Tom Witty, Randy Thies, Larry Schmits, Matt Hill, Dean Sather, and Karolyn Kinsey. This research was supported in part by the University of Kansas General Research Fund.

References Cited

Brown, K., and B. Logan 1987 The Distribution of Paleoindian Sites in Kansas. In *Quaternary Environments of Kansas,* edited by W. C. Johnson. Kansas Geological Survey Guidebook 5. Lawrence.

Glover, G. F. 1987 An Analysis of early Paleo-Indian Projectile Points with New Data from Southwestern Kansas. M. A. Thesis, Department of Anthropology, Wichita State University.

Hill, M. E., Jr. 1994 Paleoindian Archaeology and Taphonomy of the 12 Mile Creek Site in western Kansas. M.A. Thesis, Department of Anthropology, University of Kansas, Lawrence.

Hofman, J. L. 1987 The Occurrence of Folsom points in Oklahoma. *Current Research in the Pleistocene* 4:57–59.

Hofman, J. L. 1990 Paleoindian Mobility and Utilization of Niobrara or Smoky Hill Jasper on the Southern Plains. *Kansas Anthropologist* 11(2):1–13.

Hofman, J. L. 1994 Kansas Folsom Evidence. *Kansas Anthropologist* in press.

Howard, E. B. 1935 Evidence of Early Man in North America. *The Museum Journal* 24(2–3). University of Pennsylvania, Philadelphia.

Howard, E. B. 1939 Folsom and Yuma Points from Saskatchewan. *American Antiquity* 4(3):277–279.

Myers, T. P. 1987 Preliminary Study of the Distribution of Fluted Points in Nebraska. *Current Research in the Pleistocene* 4:67–68.

Rogers, R. A., and L. D. Martin 1983 American Indian Artifacts from the Kansas River. *Transactions of the Nebraska Academy of Sciences* 11:13–18.

Rogers, R. A., and L. D. Martin 1984 The 12 Mile Creek Site: A Reinvestigation. *American Antiquity* 49:757–764.

Schmits, L. 1980 Holocene Fluvial History and Depositional Environments at the Coffey Site, Kansas. In *Archaic Prehistory on the Prairie-Plains Border,* edited by A. E. Johnson, pp. 79–105. University of Kansas Publications in Anthropology 12. Lawrence.

Shippee, J. M. 1953 A Folsom Point from Marshall County, Kansas. *Plains Archeological Conference Newsletter* 5(4):48–49.

Wedel, W. R. 1959 *An Introduction to Kansas Archaeology.* Bureau of American Ethnology Bulletin 174. Washington, D.C.

Wetherill, B. 1994 A Comparative Study of Paleoindian Evidence at the Bonner Springs Locality, Lower Kansas River Basin, Kansas. M.A. Thesis, Department of Anthropology, University of Kansas. Lawrence.

Yaple, D. D. 1968 Preliminary Research on the Paleo-Indian Occupation of Kansas. *Kansas Anthropological Association Newsletter* 13(7):1–9.

Yaple, D. D. n.d. Notes on file, University of Kansas, Museum of Anthropology. Lawrence.

Gainey Phase Site Differentiation: Lithic Evidence

Lawrence J. Jackson

Recently completed research at two small Gainey phase sites in the Rice Lake region of southern Ontario has revealed the existence of subtle site functional differences. The Sandy Ridge and Halstead sites, on the north and south shores, respectively, of Rice Lake (see Figure 1), each show dominance of unifacial activity and paired-hearth features associated with concentrations of scraper-retouch debris. The dominance of Collingwood chert at each site permits their close comparison without the complication of raw-material variability.

Detailed comparison of trianguloid end scraper assemblages from both sites showed remarkable similarity in style, metric attributes, and wear patterns. The only significant differences were greater thickness and shortness of the Sandy Ridge end scrapers. This observation becomes more significant when analysis of uniface/scraper retouch flakes is considered.

Consistent use of 1/8-inch-mesh excavation screen for the Sandy Ridge and Halstead sites provided a uniquely comparable sample of uniface retouch flakes. Since scrapers are the dominant tool class at both sites, the majority of these flakes are believed to derive from end scraper rejuvenation.

Close examination of flake scars on scraper bits indicates about 15 to 20 medium- to large-size retouch flakes for a rejuvenation episode. With 20 end scrapers present at Sandy Ridge, one rejuvenation episode per scraper might result in 300 to 400 recoverable retouch flakes. The actual site count of 1,371 retouch flakes from near-complete activity area excavation suggests three to five rejuvenation episodes, on average, per end scraper. This would fit well with the shortness (heavily rejuvenated) of end scrapers and greater thickness might relate to either pre-selection of thicker end scrapers for use at the site or, less likely, to rejuvenation only to the point of maximum scraper body thickness.

By contrast with Sandy Ridge, the Halstead site shows an incidence of only 305 scraper retouch flakes for the 14 end scrapers in the assemblage. Estimates of recoverable end bit rejuvenation flakes are between 210 and 280 for a single episode for each scraper. It appears quite likely, therefore, that the Halstead scraper assemblage saw, on average, only one rejuvenation episode. This possibility is more strongly emphasized by the higher incidence of other types of unifacial tools at Halstead than at Sandy Ridge.

Together with other evidence of lithic assemblage diversity at the two sites, the data on scraper-retouch flakes strongly suggest that Sandy Ridge represents a short-term Gainey phase logistical camp and that Halstead represents a longer-term residential camp. Both sites appear to have had similar-sized occupying groups and likely relate to caribou exploitation along the shores of late-Pleistocene Rice Lake.

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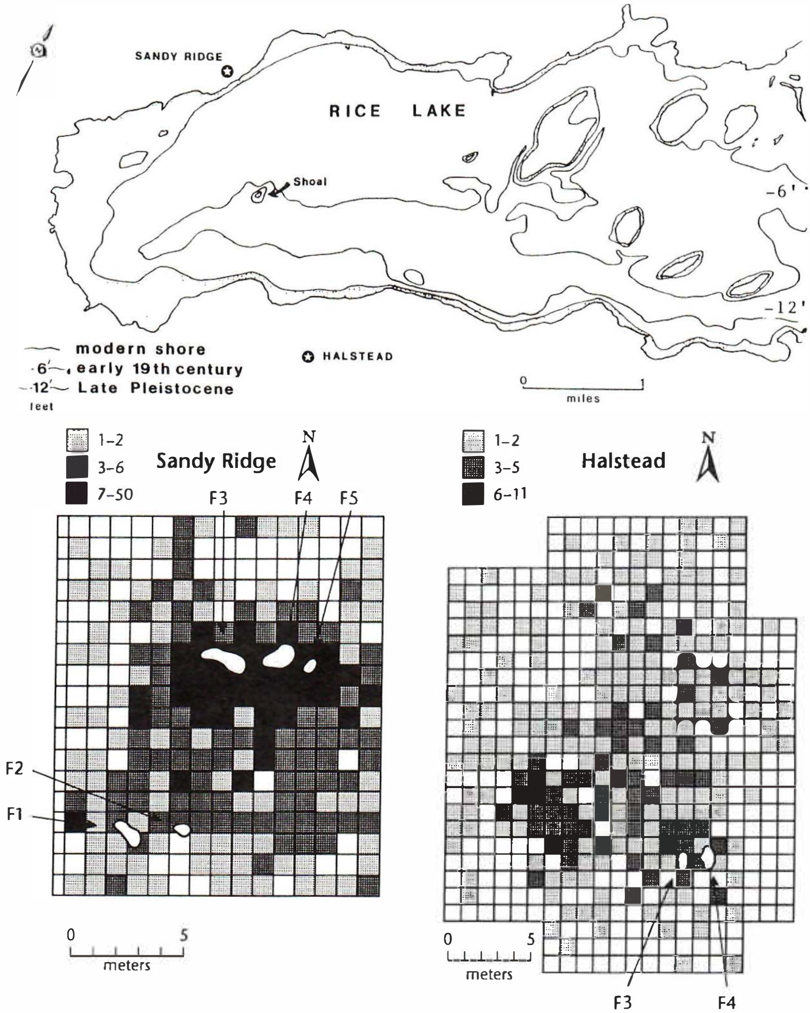

Figure 1. Scraper-retouch densities on two Gainey phase sites.

The Anzick Clovis Burial

Scott Jones and Robson Bonnichsen

The Anzick site, discovered in 1968, is the first Clovis burial locality to be found in North America. This article places the complete artifact inventory on record for the first time.

The site occurs in an intermontane basin between the Crazy Mountains and the Belt Mountains in Montana. Flathead Creek, a tributary of the Shields River, flows near the center of the basin. While excavating talus from a sandstone cliff on the west side of the stream, Ben Hargis and Calvin Sarver accidentally discovered what has since been identified as a Clovis burial. Some of these artifacts were later shared with the landowner, Dr. Melvyn Anzick.

This assemblage of artifacts has a long and colorful history (Allison 1989:1,6). Soon after the discovery, Dr. Anzick contacted Dr. Dee Taylor of the University of Montana, who initiated a testing program at the site. He concluded that the lack of controlled excavation prevented any establishment of association between the fluted points and human remains (Taylor 1969).

Further testing was conducted shortly afterward by Dr. Larry Lahren and Dr. Robson Bonnichsen, both graduate students at the time (at University of Calgary and University of Alberta/Edmonton, respectively). A zone of red ochre was recognized in situ in the wall of a test pit, and another human bone fragment was recovered from the wall profile (Lahren and Bonnichsen 1971). The similarities in shape and technology attributes (Bonnichsen 1977; Young and Bonnichsen 1984), and the red ochre coating on most specimens, suggest that the flaked stone tools were produced by a single cultural group and that the Anzick collection is not a mixed assemblage of artifacts.

During the summer of 1993, Jones (n.d.) initiated a comprehensive comparative analysis of the Anzick assemblage. This research was possible due to Lahren's long-term commitment to reunite the collection at the Montana Historical Society in Helena. Jones's analysis indicates the assemblage is composed of three classes of data: human skeletal remains; bone foreshafts (cf. bone rods); and flaked stone artifacts.

The human skeletal remains are from at least two individuals. This material has yet to be systematically described and is apparently held at Northern Arizona University. Stafford (1994:49) reports the presence of two juvenile cranial fragments: one was stained with red ochre, and the other was bleached white. Lahren and Bonnichsen (1971) recovered a clavicle belonging to a subadult in the red-ochre zone mentioned above.

Eleven bone-tool fragments are from bone foreshafts and/or bone rods (Frison and Zeimens 1980). These specimens, probably made from mammoth bone, include two complete specimens with bi-beveled ends, one specimen with a single bevel and male insertion end (Lahren and Bonnichsen 1974), four

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beveled ends, and five mid-sections. Using the end fragments as a standard, a minimum of five and a maximum of seven foreshafts can be assumed to constitute the assemblage.

A minimum of eight fluted points are present in the Anzick assemblage. Of this total, seven are complete or nearly complete points and one is represented only by the tip end. One of the complete points is manufactured from Wyoming Phosphoria chert. Bifaces compose the largest class of artifacts present (n = 70). Four of these can be refitted and represent two complete bifaces (n = 68). Bifaces are made from chalcedony (n = 39), moss agate (n = 30), and porcellanite (n = 1). Four unifacial tools include two end scrapers and two side scrapers. Flake tools include a single thinning flake resembling a blade and two large spalls exhibiting possible use polish on the margins. Additionally, the assemblage includes 15 biface fragments and three thinning flakes. Material used for flaked stone artifacts came from at least three widely separated source areas in Montana and Wyoming.

Stafford (1994:52) used ^{14}C AMS on the red ochre-stained calvarium, and presents seven dates averaging 10,680 ± 50 yr B.P. A number of other younger dates averaging 8,610 ± 90 yr B.P. are from a bleached calvarium, but the reliability of these dates is tenuous.

Several investigators working with non-campsite assemblages of Clovis artifacts propose that the Simon, Fenn, East Wenatchee, and Drake remains are caches (Frison 1991; Gramly 1991; Stanford and Jodry 1988; Woods and Titmus 1985). Cache implies these specimens were placed in storage to be recovered at a later date. The Anzick assemblage, which shares many similarities with the above assemblages, is clearly a burial. As such, it may serve as a comparative standard for what occurs in a burial assemblage. Could the above assemblages be other Clovis burials that lack human skeletal remains?

References Cited

Allison, N. 1989 Anzick Collection Reunited. *Mammoth Trumpet* 5(2):1,6.

Bonnichsen, R. 1977 Models for Deriving Cultural Information from Stone Tools. Archaeological Survey of Canada Paper No. 60. Mercury Series. National Museum of Man, Ottawa.

Frison, G. C. 1991 The Clovis Cultural Complex: New Data from Caches of Flaked Stone and Worked Bone Artifacts. In *Raw Material Economies of Prehistoric Hunter-Gatherers*, ed. A. Montet-White and S. Holen, pp. 321–333. University of Kansas Publications in Anthropology, 19. Lawrence.

Frison, G. C., and G. M. Zeimens 1980 Bone Projectile Points: An Addition to the Folsom Cultural Complex. *American Antiquity* 45:231–237.

Gramly, R. M. 1991 Blood Residues upon Tools from the East Wenatchee Clovis Site, Douglass County, Washington. *Ohio Archaeologist* 41(4):4–9.

Jones, S. n.d. The Anzick Clovis Collection. Master's thesis in preparation. Oregon State University.

Lahren, L., and R. Bonnichsen 1971 The Anzick Site: A Llano Complex Burial in Southwestern Montana. Paper presented at Society for American Archaeology Annual Meetings, Norman, Oklahoma.

Lahren, L., and R. Bonnichsen 1974 Bone Foreshafts from a Clovis Burial in Southwestern Montana. *Science* 186:147–150.

Stafford, T. W., Jr. 1994 Accelerator C-14 Dating of Human Fossil Skeletons: Assessing Accuracy and Results on New World Specimens. In *Method and Theory in the Peopling of the Americas*, pp. 45–55, ed. by R. Bonnichsen and G. Steele. Center for the Study of the First Americans, Oregon State University, Corvallis.

Stanford, D. J., and M. A. Jodry 1988 The Drake Clovis Cache. *Current Research in the Pleistocene* 5:21–22.

Taylor, D. C. 1969 The Wilsal Excavations: An Exercise in Frustration. *Proceedings of the Montana Academy of Sciences* 29:147–150.

Wilkie, P. J., J. J. Flenniken, and T. L. Ozbun 1991 Clovis Technology at the Anzick site, Montana. *Journal of California and Great Basin Anthropology* 13(2):242–272.

Woods, J. C., and G. L. Titmus 1985 A Review of the Simon Clovis Collection. *Idaho Archaeologist* 8(1):3–8.

Young, D. E., and R. Bonnichsen 1984 *Understanding Stone Tools: A Cognitive Approach.* Center for the Study of Early Man, Orono.

Sailor-Helton: A Paleoindian Cache from Southwestern Kansas

Robert J. Mallouf

Raymond Sailor (deceased), a Seward County rancher, discovered the Sailor-Helton cache in 1957. The cache was excavated by Sailor and Bill Helton, a longtime resident and avocational archaeologist of the southwest Kansas area. Since 1957, Helton and his wife, Ima June, have maintained and cared for the collection. With assistance from the Heltons, the cache site was relocated and formally recorded in 1990.

The cache find-spot is on the High Plains at the upland edge of the Cimarron River basin in a rangeland area of low, rolling relief. Local landforms are composed of Quaternary sand and loess overlying undifferentiated Pliocene and Pleistocene deposits (Dickey, Swafford, and Markley 1965). Lying at the headwaters of two short tributaries to the Cimarron, the location provides a broad vista of the river environs and encompassing prairie. According to informants, the cache was partially exposed by erosion during a period of severe drought. Many of the 166 lithic specimens composing the cache were reportedly found exposed on the ground surface in a circular cluster some 50 cm in diameter (R. Helton 1957). However, most details concerning configuration and depth of the original feature, as well as orientation of specimens within the cache-pit, have been lost.

The cache consists of 10 cores, 151 blades and flakes, and 5 unifacial tools—all of weathered Alibates agate. All the cores originated as large, water-worn cobbles, and two retain much of their original shape, having only been subjected to cursory testing to determine quality of the stone. The remaining eight cores are extensively worked, and are conical to D-shaped (slab-like) in configuration. The latter cores all indicate sequential blade and flake removals

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through use of soft-hammer, direct percussion. The largest of the cores weighs 2960 g, is conical in shape, and has a carefully prepared sub-circular platform surface with a maximum diameter of 191 mm.

The five unifacial tools in the cache assemblage are fashioned on prismatic blades and flakes that appear to have been derived from four of the ten cached cores (Figure 1A). Intentional edge modification is restricted in all five cases to lateral dorsal edges of the blades. The resulting tools were probably intended for scraping and/or cutting tasks. The remaining 151 cache specimens represent a mixture of true prismatic blades, blade-like flakes, and flakes (Figure 1B). While a few of these specimens exhibit minor areas of edge wear, most appear to be raw material that was intended for further modification or expedient use. Many of these specimens can be fitted together, and in a few cases both blades and flakes can be refitted to the cores. The largest of the prismatic blades measures 133 mm in length, 48 mm in width, and 19 mm in thickness, and like some of the other cache blades, exhibits a very strong distal curvature. Most of the cache specimens have small areas of calcium carbonate adhering to their surfaces.

Stone sources that could be exploited for raw material are severely limited in

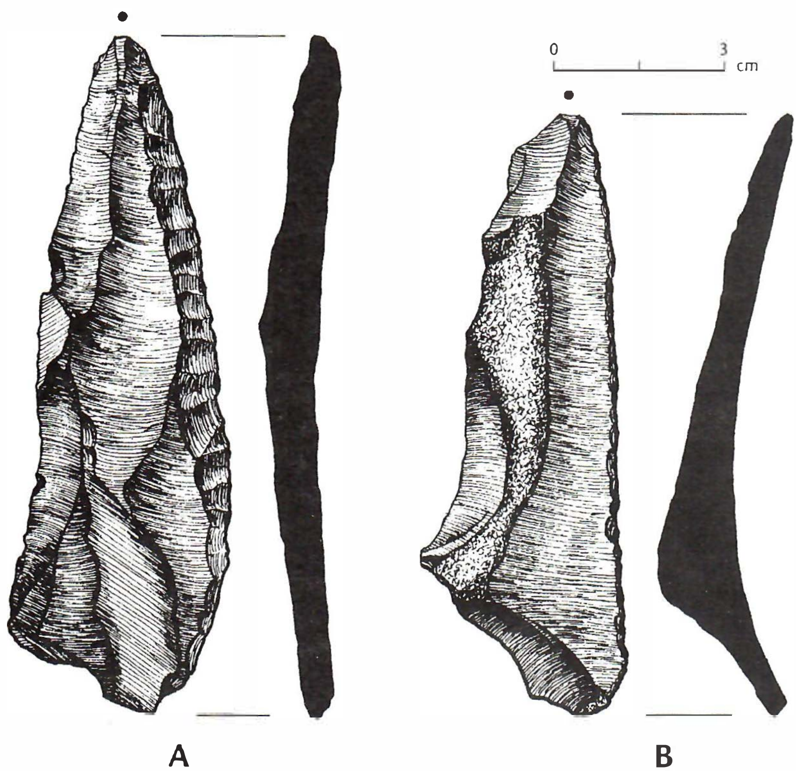

Figure 1. Examples of artifacts from the Sailor–Helton Cache: a, unifacial tool fashioned from a blade; b, blade with Paleoindian technological affinities.

this area of southwest Kansas, and Alibates caches representing various time periods have been found here previously (Mallouf and Wulfkuhle 1991). The closest known sources for Alibates agate are to the south along the Canadian River in the Texas Panhandle, a distance of some 200 km. The fact that weathered, stream-worn cobbles were used in the manufacture of the cache suggests a gravel source downstream from primary quarries in the vicinity of Alibates National Monument. A combined weight of 20.53 kg for the cache assemblage makes it likely that more than one person was involved in its transport from the stone source to stone-free areas in the north.

A strong case for Paleoindian affiliation of the Sailor-Helton cache can be made from several lines of evidence. Raw blades and flakes from the cache exhibit striking similarities with the primarily Alibates Clovis assemblage from Locality No. 1 at the Blackwater Draw Site (J. Hester 1972) in New Mexico. One cache blade in particular has all the hallmarks of Clovis prismatic blade production, including platform preparation, arris configuration, blade shape, and curvature, as revealed by the Clovis Blade Cache at Blackwater Draw (Green 1963) and the Keven Davis Clovis Cache from Texas (Young and Collins 1989). In addition, unifacial blade tools from Sailor-Helton are virtually identical to ones from the Clovis component at Blackwater Draw, including a scraper of "Enterline" form. Sophisticated techniques of core preparation and sequential reduction in the cache are also reflective of early-Paleoindian—probably Clovis—technology.

I wish to thank the Bill Helton and Jack Conover families for their support and assistance, and Roland Pantermuehl for the pen-and-ink drawings. Appreciation is also extended to Virginia Wulfkuhle, Martin Stein, and John Reynolds of the Kansas State Historical Society, and to Ed Day of Alibates National Monument.

References Cited

Dickey, H. P., W. R. Swafford, and Q. L. Markley 1965 Soil Survey of Seward County, Kansas. *Soil Conservation Service Series* 1961, No. 28, United States Department of Agriculture.

Green, F. E. 1963 The Clovis Blades: An Important Addition to the Llano Complex. *American Antiquity* 29:145–165.

Helton, R. 1957 Second Cache Found Near Satanta. *Kansas Anthropological Association Newsletter* 3(2):1.

Hester, J. J. 1972 Blackwater Locality No. 1: A Stratified, Early Man Site in Eastern New Mexico. *Fort Burgwin Research Center,* No. 8, Southern Methodist University.

Mallouf, R. J., and V. A. Wulfkuhle 1991 Notes on the Helton-Harrel Biface Cache from Seward County, Kansas. *The Kansas Anthropologist* 12(1):1–12.

Young, B., and M. B. Collins 1989 A Cache of Blades With Clovis Affinities from Northeastern Texas. *Current Research in the Pleistocene* 6:26–28.

A Preliminary Survey of Iowa Fluted Points

Toby A. Morrow and Juliet E. Morrow

In an effort to form some preliminary impressions regarding the early-Paleoindian occupation of Iowa, the authors initiated a survey of fluted points in the fall of 1992. We consulted a number of sources for information on fluted points in Iowa, including the Iowa Archaeological Society Newsletter, the Journal of the Iowa Archaeological Society, unpublished contract archaeology reports, as well as institutional and private collections. To date, a total of 135 fluted points and preforms have been recorded in Iowa.

The majority (n = 107) of these points are Clovis and similar fluted points, and three of these specimens are fluted preforms. This includes the 20 whole and fragmentary specimens recovered from the Rummells-Maske cache in Cedar County, Iowa (Anderson and Tiffany 1972). Clovis and similar point forms are widely distributed across Iowa (Figure 1A). Raw-material identifications are available for 72 of these Clovis-related points and preforms: Burlington

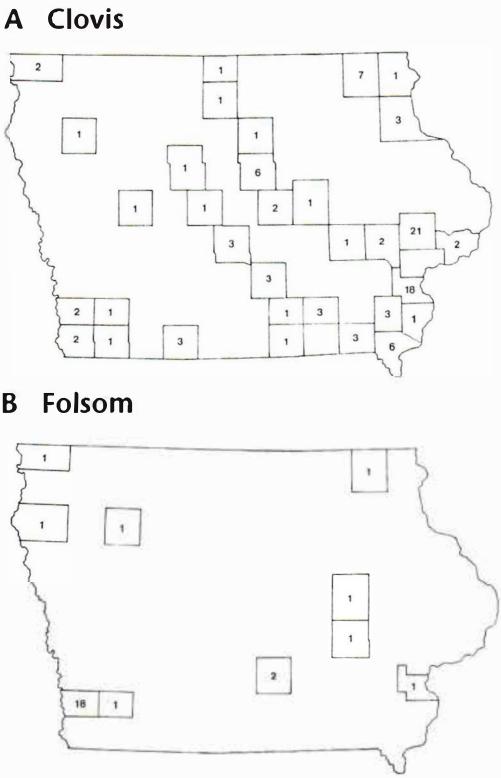

Figure 1. Distribution of points in Iowa.

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chert (n = 50, 69.0%), Hixton silicified sandstone (n = 5, 6.9%), Knife River flint (n = 4, 5.5%), Pennsylvanian-age cherts from southwest Iowa (n = 4, 5.5%), Maynes Creek chert (n = 3, 5.5%), Moline chert (n = 2, 2.7%), other miscellaneous cherts (n = 4, 5.5%).

Of the 135 fluted points and preforms recorded thus far, 27 can be classified as Folsom. Six of the 27 are fluted Folsom preforms. While Folsom specimens are distributed throughout the state, they are comparatively more common in western Iowa (Figure 1B). Raw-material identifications are available for 14 of the Folsom points and preforms: Pennsylvanian-age cherts from southwest Iowa (n = 8, 57.1%), Hixton silicified sandstone (n = 1, 7.1%), Burlington (n = 1, 7.1%), and other miscellaneous cherts (n = 4, 28.6%).

Fluted points similar to the Cumberland or Barnes types appear to be quite rare in Iowa. A single point, made of an unidentified chert, has been recorded from Iowa County in the southeast-central part of the state.

Future work on this project will involve relocating fluted points that have already been entered on the list in order to record more detailed metric attributes and raw-material identifications. The list of fluted points from Iowa is expected to grow as more specimens are found and as previously unrecorded ones are reported.

Reference Cited

Anderson, A. D., and J. A. Tiffany 1972 Rummells-Maske: A Clovis Find-Spot in Iowa. *Plains Anthropologist* 17(55):55–59.

Folsom Occupation in the Knife River Flint Quarry Area, North Dakota

Matthew J. Root and Stanley A. Ahler

The Bobtail Wolf site (32DU955A) is a Paleoindian quarry, workshop, and camp site in the Knife River flint quarry area in western North Dakota. The site covers 1.75 ha on a low rise and surrounding area on a terrace of Spring Creek, a tributary of the Knife River, a few kilometers west of a dense concentration of flint quarries and workshops (Ahler 1986; Loendorf et al. 1984). The major occupation is Folsom, although Hell Gap, Cody, and probably Goshen components also occur. Small quarry pits are present where Folsom or pre-Folsom people dug flint cobbles from a buried gravel lag. On the low rise, Paleoindian deposits occur in an E-Bt-BC soil horizon sequence that developed into late-

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Pleistocene and early-Holocene sediments during the middle to late Holocene. The A horizon of this soil and portions of the E and Bt horizons have recently eroded from the rise, leaving a dense artifact lag. Around the rise, Paleoindian deposits are within the Leonard Paleosol, a widespread late-Pleistocene to early-Holocene soil (Clayton et al. 1976) that marks a now-buried terrace surface.

Lacking charcoal or bone in good context, we radiocarbon-dated three pairs of sediment samples from the top and the bottom of the A horizon of the Leonard Paleosol. Base-soluble and insoluble organic carbon fractions were dated; results suggest no significant contamination by younger soluble humates or older insoluble humates. Six ages from the top of the Ab horizon range from 10,670 ± 190 B.P. (WSU-4444) to 8,280 ± 250 B.P. (WSU-4451); six ages from the bottom range from 10,770 ± 220 B.P. (WSU-4446) to 9,260 ± 200 B.P. (WSU-4448).

Ten Folsom points, one channel flake, two Hell Gap points, and two Scottsbluff points were surface-collected. Excavations during 1992 and 1993 recovered two Folsom points, two channel flakes, two Scottsbluff points, and one lanceolate point (Figure 1), and revealed cultural stratification. Folsom points and channel flakes were excavated from both the Leonard Paleosol and from the Bt horizon on the low rise. Scottsbluff point fragments were recovered from the upper portion of the Bt horizon and from the E horizon. A lanceolate point, technologically similar to Goshen points (dated to ca. 11,000–11,500 B.P.) from the Mill Iron site (Frison 1991:25, 44–46), was recovered from the BC horizon on the rise, stratigraphically below the Folsom artifacts.

The excavated collection includes several hundred thousand flakes and about 1,000 stone tools, offering evidence that the site is a horizontally stratified, multifunctional location. Most tools from the quarry area are cores, tested cobbles, and broken bifacial preforms. The rest of the collection is dominated by expedient flake tools, although cores, bifacial preforms, end scrapers, and bifacial knives also occur. Excavations revealed 12 concentrations of flint-flaking debris at varying elevations within the Leonard Paleosol, which probably mark locations where knappers flaked one to several bifacial preforms from Knife River flint cobbles.

Additional Folsom components occur in nearby sites 32DU955D and 32DU955C, the latter partially excavated in 1993. These localities and the Bobtail Wolf site lie within the Lake Ilo National Wildlife Refuge; further study of all sites will occur through 1996 supported by the U.S. Fish and Wildlife Service.

References Cited

Ahler, S. A. 1986 *The Knife River Flint Quarries: Excavations at Site 32DU508.* State Historical Society of North Dakota, Bismarck.

Clayton, L., S. R. Moran, and W. B. Bickley, Jr. 1970 *Stratigraphy, Origin, and Climatic Implications of Late Quaternary Upland Silt in North Dakota.* North Dakota Geological Survey, Miscellaneous Series 54.

Frison, G. C. 1991 *Prehistoric Hunters of the High Plains.* 2nd ed. Academic Press, San Diego.

Loendorf, L. L., S. A. Ahler, and D. Davidson 1984 The Proposed National Register District in the Knife River Flint Quarries in Dunn County, North Dakota. *North Dakota History* 51:4–20.

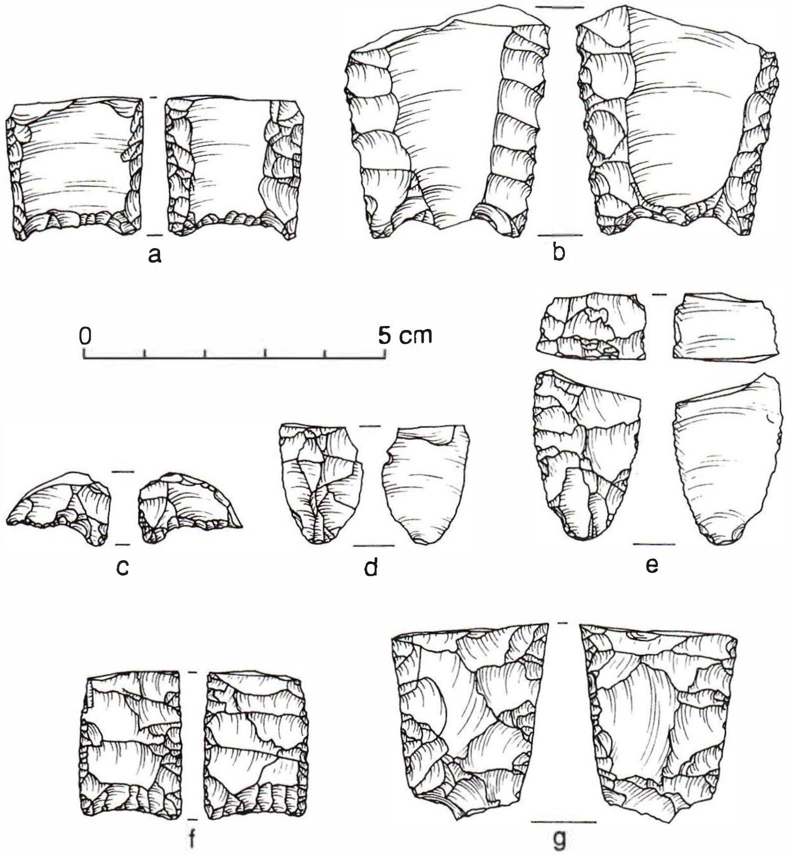

Figure 1. Paleoindian artifacts from the Bobtail Wolf site (32DU955A): (a, c) Folsom points; (b) Folsom point preform; (d, e) Folsom channel flakes; (f) Goshen(?) point; (g) Hell Gap point.

Devil's Nose: A Parkhill Complex Site in Western New York

Kenneth B. Tankersley

Devil's Nose is located in northwestern Monroe County, New York. Physiographically, this area is known as the Erie-Ontario Plain, a flat to gently rolling lowland with basins and strand lines of late-Pleistocene lakes Tonawanda and Iroquois, sand dunes, ground and end moraines, outwash terraces, and drumlins. While a number of early-Paleoindian, Clovis and Gainey Complex sites have been reported from this region (e.g., Calkin and Miller 1977; Gramly 1988; Laub et al. 1988; Vanderlaan 1986), Devil's Nose is the first documented middle-Paleoindian Parkhill Complex site.

The site is situated atop a stratigraphic outlier on the south shore of Lake Ontario and is managed today by Hamlin Beach State Park. During the late Pleistocene, early Lake Ontario (ca. 11,200 to 10,800 B.P.) would have been located several miles to the north (Lewis and Anderson 1989; Tinkler et al. 1992). This landform was probably selected as a short-term habitation site because it was well drained and overlooked several wetlands.

One of the most intriguing aspects of Devil's Nose is that it is stratified. Indeed, late-Pleistocene glacial-outwash cobbles, gravels, and deltaic sands are overlain by reworked, aeolian-deposited sand that form a series of Holocene dunes. Numerous paleosols occur in the sandy sediments, and a prominent and well-developed paleosol marks the interface of the late-Pleistocene/Holocene boundary. The latter paleosol correlates with a middle-Paleoindian (Parkhill Complex) occupation. Chipped-stone artifacts, wood charcoal, and hearth features are exposed through seasonal mass wasting and wind erosion.

In addition to abundant debitage, two fluted bifaces and three unifacially chipped-stone artifacts have been recovered from the site (Figure 1). Morphologically, the artifacts are comparable to those described from the Fisher, Parkhill, Thedford II, Dixon, Mullin, and McLeod sites in southern Ontario (Deller and Ellis 1988, 1992a, 1992b; Ellis and Deller 1988; Storck 1983). Petrographically, all the artifacts are manufactured from Onondaga chert, which crops out 35 km south of the site (Wray 1948).

Both of the fluted bifaces are late-stage Barnes point preforms. The larger and more refined preform exhibits small "lobed" platforms that project from the lateral margins of the biface. These projections were likely used to thin the biface by the same technique used to create basal flutes. Interestingly, this technique has been described for Clovis point reduction in the Mississippi-Missouri-Illinois confluence region (Tankersley and Morrow 1993:125). The other Barnes point preform displays a basal nipple or lobed platform similar to those illustrated by Storck (1983:94) from the Fisher site.

The unifaces include two end scrapers and a knife. The larger of the two end

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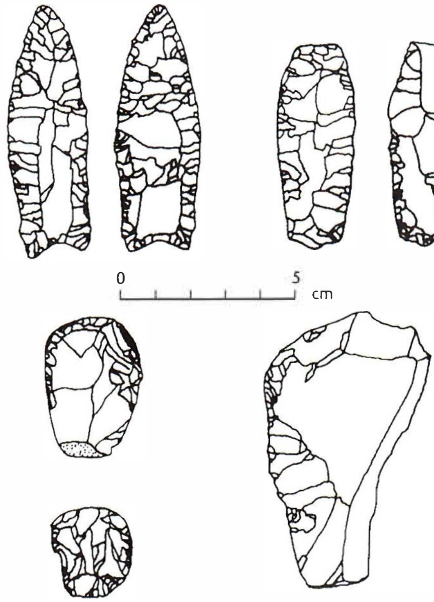

Figure 1. Parkhill Complex artifacts from the Devil's Nose. Top row: Barnes point preforms. Bottom left: two end scrapers. Bottom right: a unifacially chipped stone knife.

scrapers is coated with a thin film of red ochre. The closest source of red ochre crops out approximately 30 km southeast of the site in the Genesee River gorge.

Given the stratified nature of Devil's Nose, the site has significant potential in developing the geochronology of the Parkhill Complex in the Eastern Great Lakes region.

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References Cited

Calkin, P. E., and K. E. Miller 1977 Late Quaternary Environment and Man in Western New York. In, *Amerinds and Their Paleoenvironments in Northeastern North America*, edited by W. S. Newman and B. Salwens, Annals of the New York Academy of Sciences 288:297–315.

Deller, D. B., and C. J. Ellis 1988 Early Palaeo-Indian Complexes in Southwestern Ontario. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. Laub, N. Miller, and D. Steadman, pp. 251–263, Bulletin of the Buffalo Society of Natural Sciences, Buffalo.

Deller, D. B., and C. J. Ellis 1992a *Thedford II*.. Memoirs of the Museum of Anthropology, University of Michigan, No. 24, Ann Arbor.

Deller, D. B., and C. J. Ellis 1992b The Early Paleoindian Parkhill Phase in Southwestern Ontario. *Man in the Northeast* 44:15–54.

Ellis, C. J., and D. B. Deller 1988 Some Distinctive Paleo-Indian Tool Types from the Lower Great Lakes Region. *Midcontinental Journal of Archaeology* 13:111–158.

Gramly, R. M. 1988 Palaeo-Indian Sites South of Lake Ontario, Western and Central New York

State. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. Laub, N. Miller, and D. Steadman, Bulletin of the Buffalo Society of Natural Sciences 33:265–280.

Laub, R., N. Miller, and D. Steadman 1988 *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, Bulletin of the Buffalo Society of Natural Sciences, Buffalo.

Lewis, C. F. M., and T. W. Anderson 1989 Oscillations of Levels and Cool Phases of the Laurentian Great Lakes Caused by Inflows from Glacial Lakes Agassiz and Barlow-Ojibway. *Journal of Paleolimnology* 2:99–146.

Storck, P. L. 1983 The Fisher Site: Fluting Techniques, and Early Paleoindian Cultural Relationships. *Archaeology of Eastern North America* 11:80–97.

Tankersley, K. B., and J. E. Morrow 1993 Clovis Procurement and Land-Use Patterns in the Confluence Region of the Mississippi, Missouri, and Illinois Rivers. In *Highways to the Past*, edited by T. E. Emerson, A. C. Fortier, and D. L. McElrath, pp. 119–129, Illinois Archaeological Survey, Kampsville.

Tinkler, K. J., J. W. Pengelly, W. G. Parkins, and J. Terasmae 1992 Evidence for High Water Levels in the Erie Basin During the Younger Dryas Chronozone. *Journal of Paleolimnology* 2:99–146.

Vanderlaan, S. 1986 The Arc Site. *The Iroquoian* 12:64–73.

Wray, C. F. 1948 Variety and Sources of Flint Found in New York. *Pennsylvanian Archaeologist* 18:25–45.

Physical Anthropology

Paleo-Indian Human Remains of Patagonia—Chile

Patricia Soto-Heim

Since their discovery by Junius Bird in 1935-1937, the human remains of Cerro Sota (C.S.) and Palli Aike (P.A.) Caves in Chilean Patagonia have remained essentially unknown. Lately other human remains have increased the sample from the same cultural period.

In Fell's Cave, Bird (1937, 1938) documented the contemporaneity of humans with extinct fauna: American native horse (*Parahipparium soldasi*) and ground sloth (*Mylodon listai*). Bird also proposed a sequence of five cultural periods beginning about 11,000 yr B.P. The P.A. and C.S. Caves findings, corresponding to the first of these chronological periods, come from one collective cremation burial of seven individuals from C.S. and five individuals from three cremation burials from P.A. The remains, quite incomplete, have been ascribed to the Lagoa Santa type by Shapiro (in Bird 1938; Munizaga 1976; Turner and Bird 1981). They are housed at the Anthropology Department of the American Museum of Natural History of New York. In 1988 at the Lago Sofía (L.S.) Cave, Prieto and Cárdenas discovered some badly preserved human remains from a collective cremation burial, presenting the same cultural pattern of Cerro Sota and Palli Aike Caves. I identified four individuals among the L.S. remains: a fetus or a newborn baby (L.S. 1), a child of 3 to 3½ years (L.S. 2), a subadult or a very young adult (probable female, L.S. 3), and an old adult (L.S. 4) (Soto-Heim 1992).

Of the adult Paleoindian remains, the three Cerro Sota skulls are identified as females and Palli Aike as a male, after their morphological traits (sex). Sex determination of skulls has been analyzed by the discriminant function of Giles and Elliot (1963) (SF3 to SF21) and Defrise-Gussenhoven (1967) (SDE1 to SDE3 according to the estimation of cranial capacity after basion-bregma height, porion-bregma height or skull cap height respectively). This analysis is possible only for C.S. 2 and C.S. 3. The remains of C.S. 1 and P.A. 2 are too incomplete for sex determination. Based on these discriminant functions C.S. 2 and C.S. 3 are identified as females, but the assessments are equivocal.

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Variation of skull shape—narrow, medium and broad—is noted for the four specimens. Skull height, measured at bregma, is moderately high and backward in position; the temporal ridges are moderately divergent (two cases) or very divergent (two cases); the back and the base of the skulls are of medium width in relation to the width of the skull; the foramen magnum is large (two cases). The upper face of these crania tends to be medium in height and width; phenozygy is present; the front is of medium width compared with the face width; the nose is narrow and the maxillo-alveolar arcade is large; the orbits are high. In general, the face profile exhibits a moderate projection (mesognathic) after the four angles of prognathism (upper face, nasal, sub-nasal and Weisbach-Rivet), but the sub-nasal angle reveals a prominent alveolar region (prognathism) for C.S. 2 and a flatter (orthognathism) alveolar region for C.S. 1. The general characteristics of adult skulls show an ovoid or rhomboid contour from the upper view—a narrowness of the back of the skull creating a bun-shaped posterior projection. Seen from the back, the skull shows the marked upper-mastoid crest and a very low occipital squama. In lateral view there appears a marked angulation at the most posterior point of the skull (opisthocranium) and a very high position of the temporal lines on the parietal bone. In frontal view the external area of the supra orbital ridges (Trigonum) is quite marked.

Only one adult mandible is complete enough for a number of measurements to be taken. This mandible has a medium mandibular index; the rami are divergent; the upper ramus is long in relation to the front; the bigonial width is large, but in relation to the bizygomatic width it is narrow. The adult mandibles show high and narrow upper rami and a medium to low robusticity at the mandibular symphysis.

The post-cranial skeleton is represented by an upper limb with a gracile and rounded radius shaft and a round humerus (eurybrachic) with a moderate muscular relief corresponding to a woman (C.S. 3), but a flat humerus (platybrachic) is found in L.S. 3, probably a female as well. This individual also has a clavicle with a rounded shaft and a moderate sinuosity of the internal curvature. The lower limb of P.A. 2 belongs to a male, characterized by a very flat upper portion of the femur shaft (hyper-platymeric) but with a strong pilaster. Otherwise the main post-cranial remains correspond to P.A. 4, a young adult with moderately robust humerus, a very gracile radius, relatively flat-shaped (platolenic) ulna, gracile and flat (platymeric) femur without a raised muscle scar (pilastra) for muscles of the back of the leg.

Stature was estimated using the tables of Genovés (1966) according to the maximum length of the bones. C.S. 3 has a radius of 240.5 mm, and stature (female) of 161 mm; P.A. 4 has a radius of 240 mm, and the female stature is 161 mm, male 162 mm. Ulna measurements for P.A. 4 are 263 mm, statures are 163 mm (female) and 164 mm (male); femur measurements are 430 mm, with statures of 158 mm (female) and 161 mm (male). As P.A. 4 is a subadult or a young adult, the stature estimated is not to be considered definitive of an adult.

The infants are represented mainly by the mandibles, and their characteristics are the large vertical rami, the quite straight symphyseal profile, the anterior buccal mandibular depressions and the shallow mandibular notch.

The Paleoindian human remains of southern Patagonia are of significant interest. The sample includes a number of individuals of both sexes at different stages of development. This allows the anthropological characterization of the population in the geographical region.

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References Cited

Bird, J., 1938. Antiquity and migrations of the early inhabitants of Patagonia. *Geogr. Rev.* 28/2:250–275.

Bird, J., 1983. Enterratorios paleo-indios con cremación en las cuevas de Palli Aike y Cerro Sota en Chile meridional. *Ans. Inst. Pat.* 14:55–65.

Bird, J. et Bird M., 1937. Human artifacts in association with horse and sloth bones in southern South America. *Science*, n.s. 86:36-37. (Natural History). 2e. ed. 196 p., London.

Defrise-Gussenhoven, E. 1967. Echelle de masculinité et féminité. *Bull. Inst. Roy. Sc. Nat. Belgique*, n° 78:31–39.

Giles, E., 1964. Sex Determination by Discriminant Function Analysis of the Mandible. *A.J.P.A.*, 22:129–136.

Giles, E. et Elliot, O., 1963. Sex Determination by Discriminant Function Analysis of Crania. *A.J.P.A.*, 21:53–68.

Munizaga, J. R., 1976. Paleoindio en sudamérica (Restos óseos humanos de las Cuevas de Palli Aike, y Cerro Sota, provincia de Magallanes, Chile). *In*: Homenaje al Dr. Gustavo le Paige, S.J. Univ. del Norte, Chile. 19–30.

Soto-Heim, P. 1992. Le peuplement paléo-indien et archaique d'Amérique de Sud. Etude anthropologique et analyse comparative avec le peuplement sub-actual. *Thèse de doctoral du Muséum National d'Histoire Naturelle.* Paris. 2 Tomes, 672 pp.

Turner, C. G. II, and Bird, J., 1981. Dentition of Chilean Paleoindians and Peopling of the Americas. *Science*, 212:1053–1055.

Lithic Studies

Edwards Chert Use by Folsom Hunters in New Mexico

Daniel S. Amick

Recent investigations of Folsom land use in the American Southwest have produced broad geographic data on raw-material use (Amick 1994). This paper discusses Edwards chert use in the structural basins along the Rio Grande Valley in New Mexico. Direct movement of Edwards chert occurs over 600 km, and previous studies suggest even greater distances of transport (Hofman et al. 1991; Stanford 1991).

Shelley (1984) notes potential difficulties in identifying Edwards chert in New Mexico. Edwards chert is defined in this study as a distinctive tan flint often containing red specks and cream mottling. This stone is common in the dissected country between Abilene and San Angelo, Texas (Banks 1990:59–62). Analytical familiarity with this material was gained during study of the large Shifting Sands assemblage of Edwards chert (Amick et al. 1989; Hofman et al. 1990). Hofman et al. (1991) suggest this variety of Edwards is distinguished by UV fluorescence. Identification of several Edwards artifacts in this study was confirmed by this technique.

This study focuses on diagnostic weaponry components of Folsom technology and includes 1,005 projectile points, 307 preforms, and 836 channel flakes. At least 90% of these artifacts are from private collections. Folsom artifacts of Edwards chert are found in three regions along the Rio Grande: the Tularosa Basin (400–500 km west-northwest of source) with 37 points, 5 preforms, and 2 channel flakes; the southern Jornada del Muerto (575–625 km west-northwest of source) with 12 points and one preform; and the Albuquerque Basin (600–650 km northwest of source) with one point (also noted by Hofman et al. 1991). Edwards shows a pattern of distance decay beyond the Southern Plains.

Heavy use of Edwards chert characterizes Folsom assemblages throughout the Southern Plains. Edwards accounts for 84% (n = 278) of the Folsom artifacts recorded from the Southern Plains in this study. Hofman (1991) documents a similar percentage of Edwards in Folsom weaponry from the

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Southern Plains. Blackwater Draw is about 230 km southwest of Alibates sources and 440 km northwest of Edwards sources, but material from the more distant Edwards sources represents 72% (n = 115) of the Blackwater Draw assemblage while the closer Alibates chert accounts for only 6% (n = 9) (Hester 1972:121 reports similar proportions).

LeTourneau (1992) contends that these differences imply direct procurement of Edwards versus least-cost exchange for Alibates. This explanation is unconvincing since Edwards is superior on technological criteria (Goodyear 1989). Trade should be expected in the superior and more distant stone. The case for Paleoindian trade is also unsatisfying because it implies territoriality among small hunter-gatherer groups with low population densities who inhabit very productive environments (Kelly and Todd 1988). Folsom preference for Edwards is most understandable in utilitarian terms. Folsom patterns of logistical land use and extremely high mobility on the Southern Plains also help explain this reliance on Edwards (Amick 1994). Folsom groups may have geared up at Edwards sources before extended logistical mobility on the Southern Plains (Hofman 1991).

Evidence of Edwards use along the Rio Grande is clustered at only a few sites. Meltzer (1989) suggests this pattern of exotic raw-material use reflects direct movement of people rather than raw-material exchange. Edwards makes up 21% (n = 13) of the Folsom points and preforms recorded from the southern Jornada del Muerto. Twelve artifacts are from one site, and Edwards constitutes 33% of that assemblage.

Edwards accounts for 6% (n = 44) of the Folsom weaponry parts from the Tularosa Basin. Most Edwards material in the Tularosa Basin is concentrated at two localities. Moody Tank and Tres Hermanos contain 79% (n = 35) of all Edwards artifacts recorded in the Tularosa Basin. Edwards accounts for 25% (n = 15) of the artifacts from Moody Tank and 18% (n = 20) of the artifacts from Tres Hermanos. Thus, Edwards often enters the Tularosa Basin in bunches rather than individual trade items. Transport of large bifacial cores (e.g., Stanford and Broilo 1981) may provide the technological basis of such clusters.

Folsom hunters also transported Chuska chert from the San Juan Basin of northwestern New Mexico over long distances (Banks 1990:63–66; Stanford 1991). Although the distance to the Tularosa Basin is the same for Edwards and Chuska sources, Edwards is almost nine times more common. This pattern indicates a closer connection of large-scale Folsom land use patterns in the Tularosa Basin with the Southern Plains (also see Amick 1991). Since this study relies on hunting weaponry, estimates of raw-material transport probably represent the most mobile component of land use.

References Cited

Amick, D. S. 1991 Folsom Landuse Patterns in the Southern Tularosa Basin. *Current Research in the Pleistocene* 8:3–5.

Amick, D. S. 1994 Folsom Diet Breadth and Land Use in the American Southwest. Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Amick, D. S., J. L. Hofman, and R. O. Rose 1989 The Shifting Sands Folsom-Midland Site. *Current Research in the Pleistocene* 6:1–3.

Amick, D. S., and D. J. Stanford 1993 Folsom Occupations in the Tularosa Basin of New Mexico. In *Folsom Archaeology: Early Holocene Human Adaptation*, edited by M. Jodry and D. Stanford, in press. Smithsonian Institution Press, Washington.

Banks, L. D. 1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippi South, the Southern Plains, and Adjacent Southwest.* Memoir No. 4. Oklahoma Anthropological Society, Norman.

Goodyear, A. C. 1989 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleoindian Groups in North America. In *Eastern Paleoindian Lithic Resource Use*, edited by C. Ellis and J. Lothrop, pp. 1–10. Westview Press, Boulder.

Hester, J. J. 1972 *Blackwater Draw Locality No. 1, A Stratified, Early Man Site in Eastern New Mexico.* Publication No. 8. Fort Burgwin Research Center, Southern Methodist University, Ranchos de Taos, NM.

Hofman, J. L. 1991 Folsom Land Use: Projectile Point Variability as a Key to Mobility. In *Raw Material Economies Among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 335–355. Publications in Anthropology No. 19. University of Kansas, Lawrence.

Hofman, J. L., D. S. Amick, and R. O. Rose 1990 Shifting Sands: A Folsom-Midland Assemblage from a Campsite in Western Texas. *Plains Anthropologist* 35:221–253.

Hofman, J. L., L. C. Todd, and M. B. Collins 1991 Identification of Central Texas Edwards Chert at the Folsom and Lindenmeier Sites. *Plains Anthropologist* 36:297–308.

Kelly, R. L., and L. C. Todd 1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53:231–244.

LeTourneau, P. D. 1992 Folsom Use of Alibates and Edwards Cherts: Raw Material Procurement and Technological Organization. *Current Research in the Pleistocene* 9:66–69.

Meltzer, D. J. 1989 Was Stone Exchanged Among Eastern North America Paleoindians? In *Eastern Paleoindian Lithic Resource Use*, edited by C. Ellis and J. Lothrop, pp. 11–40. Westview Press, Boulder.

Shelley, P. H. 1984 Paleoindian Movement on the Southern High Plains: A Reevaluation of Inferences Based on the Lithic Evidence from Blackwater Draw. *Current Research in the Pleistocene* 1:35–36. Center for the Study of the First Americans, University of Maine, Orono.

Stanford, D. 1991 Folsom Mobility as Reflected by the Distribution of Lithic Raw Materials from Montana to Texas. Paper presented at the 56th Annual Meeting of the Society for American Archaeology, New Orleans.

Stanford, D., and F. Broilo 1981 Frank's Folsom Campsite. *The Artifact* 19(3–4):1–11. El Paso Archaeological Society.

Lithic Procurement Patterns at the PaleoCrossing Site, Medina County, Ohio

Kenneth B. Tankersley and John D. Holland

PaleoCrossing is a multicomponent open-habitation site exposed on the slopes of a kame in Medina County, Ohio. To date, more than 200 distinctive early-Paleoindian chipped-stone artifacts have been recovered from the shallow colluvium of the site. Stylistically, these artifacts compare favorably with those

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described for the Gainey cultural complex (e.g., Deller and Ellis 1988; Shott 1986; Simons et al. 1984; Storck and Tomenchuk 1990).

With the possible exception of three unidentified specimens, all the early-Paleoindian artifacts are manufactured from nonlocal cherts. Almost 80% (n = 158) of this assemblage are manufactured from a Mississippian-age, upper Ste. Genevieve formation chert. Wyandotte is the closest source of this material; it crops out in south-central Indiana and northwestern Kentucky 600 linear km southwest of the PaleoCrossing site (Bassett and Powell 1984; Seeman 1975; Smith 1990; Tankersley 1985, 1989). Artifacts manufactured from Wyandotte chert include: 14 finished, broken, and exhausted fluted bifaces; 21 fluted-point preforms broken in various stages of manufacture; 110 triangular end scrapers with evidence of graver spurs; and 13 side scrapers or limaces. As an interesting aside, there are more fluted-point preforms manufactured from Wyandotte chert from the PaleoCrossing site than have been documented from the stone's source area (see Smith 1990:236).

Approximately 11% (n = 21) of the assemblage are manufactured from upper Mercer chert. PaleoCrossing is located about 185 km north of the closest source of stone that is comparable in size and quality to that found at the site (Lepper 1986; Lepper and Meltzer 1991; Stout and Schoenlaub 1945; Tankersley 1989). Artifacts manufactured from upper Mercer chert include: five broken and exhausted fluted bifaces; three fluted-point preforms broken in various stages of manufacture; nine triangular end scrapers with evidence of graver spurs; two side scrapers or limaces; and two large, unifacially retouched, bifacial thinning flakes.

Not surprisingly, 5% (n = 19) of the assemblage are manufactured from Flint Ridge chert; it crops out in the same region as upper Mercer chert (Stout and Schoenlaub 1945; Tankersley 1989). While there are local varieties of the Vanport member, the rock unit that contains Flint Ridge chert, none of them are comparable in size, quality, and fracture pattern to that found in the PaleoCrossing site assemblage. The site is located more than 200 km north of the closest source of Flint Ridge chert that could be used to produce the chipped-stone tools recovered from this site. Artifacts manufactured from Flint Ridge chert include: two broken or exhausted fluted bifaces; two fluted-point preforms displaying a nipple-like basal platform; six triangular end scrapers with evidence of graver spurs; and two side scrapers or limaces.

About 4% (n = 8) of the assemblage are manufactured from Delaware chert. The closest Delaware chert source area occurs approximately 160 km west of the site (Stout and Schoenlaub 1945; Tankersley 1989). Artifacts manufactured from Delaware chert include: a single broken fluted biface; six triangular end scrapers with evidence of graver spurs; and a side scraper.

Finally, there are two artifacts manufactured from a Silurian-age chert that is petrographically comparable to stone found in the Cedarville-Guelph formation: a broken fluted biface and a fluted-point preform exhibiting a basal nipple. The closest source for this stone occurs approximately 225 km from the site (Stout and Schoenlaub 1945; Tankersley 1989).

In summary, almost 80% of the early-Paleoindian artifacts from PaleoCrossing are manufactured from stone that crops out more than 600 km from the site.

The rest of the artifacts are manufactured from stone that occurs between 160 and 225 km away. Although multiple nonlocal stone sources occur at the site, they were used to manufacture the same suite of artifacts: projectile points, end scrapers, side scrapers, and unifacially retouched flake tools. It is also important to note that these materials moved to the site in a west-to-east and north-to-south direction. Onondaga chert, from the Eastern Great Lakes region (Wray 1948), is conspicuously absent from the site.

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References Cited

Bassett, J. L., and R. L. Powell 1984 Stratigraphic Distribution of Cherts in Limestones of the Blue River Group in Southern Indiana. In *Prehistoric Chert Exploitation: Studies from the Midcontinent*, edited by B. M. Butler and E. E. May, pp. 239–249. Southern Illinois University, Center for Archaeological Investigations, Occasional Paper No. 2.

Deller, D. B., and C. J. Ellis 1988 Early Palaeo-Indian Complexes in Southwestern Ontario. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. Laub, N. Miller, and D. Steadman, pp. 251–263, Bulletin of the Buffalo Society of Natural Sciences, Buffalo.

Lepper, B. T. 1986 *Early Paleo-Indian Land Use Patterns in the Central Muskingum River Basin, Coshocton County, Ohio.* Unpublished Ph.D. Dissertation, Department of Anthropology, Ohio State University.

Lepper, B., and D. Meltzer 1991 Late Pleistocene Human Occupation of the Eastern United States. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 175–184, The Center for the Study of the First Americans, Corvallis.

Seeman, M. F. 1975 The Prehistoric Chert Quarries and Workshops of Harrison County, Indiana. *Indiana Archaeological Bulletin* 1:47–63.

Simons, D. O., M. J. Shott, and H. T. Wright 1984 The Gainey Site: Variability in a Great Lakes Paleoindian Assemblage. *Archaeology of Eastern North America* 12:266–279.

Shott, M. J. 1986 *Settlement Mobility and Technology Among Great Lake Paleoindian Foragers.* Unpublished Ph.D. Dissertation, Department of Anthropology, University of Michigan, Ann Arbor.

Smith, E. E. 1990 Paleoindian Economy and Settlement Patterns in the Wyandotte Chert Source Area, Unglaciated Southcentral Indiana. In *Early Paleoindian Economies of Eastern North America.* edited by K. B. Tankersley and B. L. Isaac, pp. 217–258, Research in Economic Anthropology, Supplement 5, JAI Press, Greenwich.

Storck, P. L., and J. Tomenchuk 1990 An Early Paleoindian Cache of Informal Tools at the Udora Site, Ontario. In *Early Paleoindian Economies of Eastern North America.* edited by K. B. Tankersley and B. L. Isaac, pp. 45–94, Research in Economic Anthropology, Supplement 5, JAI Press, Greenwich.

Stout, W., and R. A. Schoenlaub 1945 *The Occurrence of Flint in Ohio.* Ohio Department of Natural Resources, Division of Geological Survey, Bulletin No. 43.

Tankersley, K. B. 1985 Mineralogical Properties of Wyandotte Chert as an Aid to Archaeological Fingerprinting. In *Lithic Resource Procurement: Proceedings From the Second Conference on Prehistoric Chert Exploitation*, edited by S. C. Vehik, pp. 251–264, Center for Archaeological Investigations, Occasional Paper, No.4.

Tankersley, K. B. 1989 A Close Look at the Big Picture: Early Paleoindian Lithic Procurement in the Midwestern United States. In *Paleoindian Lithic Resource Use*, edited by C. Ellis and J. Lathrop, pp. 259–292, Westview Press, Boulder.

Wray, C. F. 1948 Varieties and Sources of Flint Found in New York State. *Pennsylvania Archaeologist* 18:25–45.

Taphonomy–Bone Modification

Distribution of Mammalian Osteological Elements Recovered from Waterscreened Features, House Fill, and Overburden of the Wall Ridge Earthlodge (13ML176), Mills County, Iowa

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Matrix from the Wall Ridge site (Glenwood culture, Nebraska phase: A.D. 1,000–1,300, Green 1990), partially but systematically waterscreened in 1984 by the Office of the State Archaeologist of Iowa, produced 19 species of mammals (Table 1). As both mega- and micromammal remains were recovered from many excavation units, this faunal sample appeared ideal to (1) compare the relative abundance of species between the three major interpretive components (house fill, feature fill and overburden) in the lodge and (2) to evaluate possible differences in interpretation resulting from two counting techniques used to establish MNI from NISP. In Table 1 (bottom) the MNI values for each excavation unit were calculated independently, assigned to their interpretive components (feature, house fill, or overburden) and totaled. MNI values also were derived from the combined NISP for each of the three major components in the lodge (Table 1-top). The latter technique reduced the MNI by approximately 55%. The reduction did not apply equally to all taxa. *Bison* (bison), *Castor* (beaver), *Odocoileus* (deer), *Ondatra* (muskrat), *Procyon* (raccoon) and *Scalopus* (mole) were reduced by more than 70%; *Cervus* (wapiti), *Mustela* (mink), *Peromyscus* (deer mouse), *Synaptomys* (bog lemming), and *Microtus* spp. (vole) were unaffected. However, an $\underline{x}^2$ test of each data set indicated that there is no significant difference in either faunal composition or relative abundance of species between the features, house fill, and overburden. Although the absolute $\underline{x}^2$ values and probabilities vary between the two tests, uniformity of the vertebrate sample between the three components is documented by both counting procedures. The results imply that the specimens recovered from the house fill, feature fill, and the overburden in this earthlodge are genetically related and thus represent the time of occupation. Moreover, these data suggest

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that vertebrate samples collected from waterscreened features in previously excavated Glenwood lodges may be regarded as representative for the entire associated lodge.

Both NISP and MNI values decrease toward the surface at Wall Ridge. If a significant portion of the micromammal sample from the lodge was impacted by burrowing in the manner characterized by the "rodent zone" concept of Bocek (1986), it would be expected that micromammal density would be greatest in the overburden. Even with approximately 1000 years of accumulation time available for intrusion and bioturbation, the opposite was observed; micromammal remains were scarce near the surface, as projected by Morlan (in press), and concentrated in features, primarily refuse-filled pits, either on or beneath the house floor. Concentration of micromammal remains below the rodent zone, also noted in the late-prehistoric Walth Bay earthlodges (Semken and Falk 1991), is reinforced at Wall Ridge by total bone counts (identified plus unidentified): 2,353 bones were recovered from topographically lower features, 1,337 from house fill, and 111 from overburden. Thus post-depositional burrowing, which clearly can be responsible for both intrusive remains and site bioturbation (Johnson 1989), does not appear to be a major factor in rodent-bone accumulation and distribution in Glenwood earthlodges.

Most of the features in the Wall Ridge earthlodge represent large refuse-filled pits, and the contained vertebrate remains apparently were deposited into the pits along with the associated cultural debris. Refuse similar to that in the lodge undoubtedly surrounded the subsurface lodge at the time of occupation; erosion from the peripheral midden after lodge destruction probably accounts for the similar taxonomic distribution in the overburden. The presence of a deer thoracic vertebra (too large for upward transport) and a rice-rat element (apparently extirpated from southwest Iowa post A.D. 1200) in the overburden supports this interpretation.

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References Cited

Bocek, B. 1986 Rodent Ecology and Burrowing Behavior: Predicted Effects on Archaeological Site Formation. *American Antiquity* 51:589–603.

Green, W. 1990 *Glenwood Culture, Paleoenvironment and Diet: Analysis of Plant and Animal Remains from the Wall Ridge Earthlodge (13ML176), Mills County, Iowa*, Office of the State Archaeologist, University of Iowa Research Paper, vol. 15, no. 6. Iowa City.

Johnson, D. L. 1989 Subsurface Stone Lines, Stone Zones, Artifact-Manuport Layers, and Biomantles Produced by Bioturbation via Pocket Gophers (*Thomomys bottae*). *American Antiquity* 54:370–389.

Morlan, R. E. In press. Rodent Bones in Archaeological sites. *Canadian Journal of Archaeology*.

Semken, H. A., Jr., and C. R. Falk 1991 Micromammal Taphonomy of Three Late Prehistoric Plains Village Tradition Refuse Pits, Walworth County, South Dakota. In *Beamers, Bobwhites, and Blue Points: Tributes to the Career of Paul W. Parmalee*, J. R. Purdue, W. E. Klipper and B. W. Styles, eds., pp. 111–124. Illinois State Museum Scientific Papers, vol. 23. Springfield.

Table 1. Minimum number of individuals of mammals (alphabetically arranged) recovered from the Wall Ridge Earthlodge. **Table 1A:** MNI based on combined sample recovered from each interpretive unit. **Table 1B:** MNI calculated by summation of the MNI from each excavation unit assigned to an interpretive unit. *Blarina brevicauda,* recovered during Phase I excavations, along with some other identified specimens, are site specific but can not be assigned to one of the analyzed components. It is listed in Table 1 to provide a complete faunal list for Wall Ridge earthlodge.

Table 1A

Taxon	Features			House Fill			Overburden			Total	
	Obs.	Exp.	Chi^2	Obs.	Exp.	Chi^2	Obs.	Exp.	Chi^2	%	Obs.
Bison bison	1	0.61	0.26	0	0.32	0.32	0	0.08	0.08	1.32	1
Blarina brevicauda	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0.00	0
Canis sp.	2	1.82	0.02	1	0.95	0.00	1	0.24	0.24	3.95	4
Castor canadensis	1	1.21	0.04	1	0.63	0.21	0	0.16	0.16	2.63	2
Cervus elaphus	0	0.61	0.61	1	0.32	1.48	0	0.08	0.08	1.32	1
Geomys bursarius	7	6.66	0.02	3	3.47	0.06	1	0.87	0.02	14.47	11
Microtus ochrogaster	7	5.45	0.44	1	2.84	1.19	1	0.71	0.12	11.84	9
Microtus pennsylvanicus	1	0.61	0.26	1	0.32	0.32	0	0.08	0.08	1.32	2
Microtus pinetorum	0	1.21	1.21	2	0.63	2.96	0	0.16	0.16	2.63	2
Mustela vison	1	1.21	0.04	1	0.63	0.21	0	0.16	0.16	2.63	2
Odocoileus sp.	2	2.42	0.07	1	1.26	0.05	1	0.32	1.48	5.26	4
Ondatra zibethicus	3	4.24	0.36	3	2.21	0.28	1	0.55	0.36	9.21	7
Oryzomys palustris	10	9.08	0.09	4	4.74	0.11	1	1.18	0.03	19.74	15
Peromyscus leucopus	3	2.42	0.14	1	1.26	0.05	0	0.32	0.32	5.26	4
Procyon lotor	1	0.61	0.26	0	0.32	0.32	0	0.08	0.08	1.32	1
Scalopus aquaticus	1	1.21	0.04	1	0.63	0.21	0	0.16	0.16	2.63	2
Sciurus sp.	1	1.21	0.04	1	0.63	0.21	0	0.16	0.16	2.63	2
Sylvilagus sp.	4	4.24	0.01	2	2.21	0.02	1	0.55	0.36	9.21	7
Synaptomys cooperi	1	1.21	0.04	1	0.63	0.21	0	0.16	0.16	2.63	2
Total	46		3.93	25		8.26	7		4.19	100.	78

Table 1B

Taxon	Features			House Fill			Overburden			Total	
	Obs.	Exp.	Chi^2	Obs.	Exp.	Chi^2	Obs.	Exp.	Chi^2	%	Obs.
Bison bison	4	2.37	1.12	0	1.27	1.27	0	0.36	0.36	2.40	4
Blarina brevicauda	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0.00	0
Canis sp.	5	4374	0.01	2	2.54	0.11	1	0.72	0.11	4.79	8
Castor canadensis	5	4.15	0.17	2	2.22	0.02	0	0.63	0.63	4.19	7
Cervus elaphus	0	1.19	1.19	1	0.63	0.21	0	0.18	3.75	1.20	1
Geomys bursarius	11	11.26	0.01	6	6.03	0.00	2	1.71	0.05	11.38	19
Microtus ochrogaster	7	5.34	0.52	1	2.86	1.21	1	0.81	0.05	5.39	9
Microtus pennsylvanicus	1	1.19	0.03	1	0.63	0.21	0	0.18	0.18	1.20	2
Microtus pinetorum	0	1.19	1.19	2	0.63	2.94	0	0.18	0.18	1.20	2
Mustela vison	1	1.19	0.03	1	0.63	0.21	0	0.18	0.18	1.20	2
Odocoileus sp.	7	8.30	0.20	4	4.44	0.04	3	1.26	2.41	8.38	14
Ondatra zibethicus	12	14.82	0.54	8	7.93	0.00	5	2.25	3.38	14.97	25
Oryzomys palustris	17	15.41	0.16	8	8.25	0.01	1	2.34	0.76	15.57	26
Peromyscus leucopus	3	2.37	0.17	1	1.27	0.06	0	0.36	0.36	2.40	4
Procyon lotor	6	3.56	1.68	0	1.90	1.90	0	0.54	0.54	3.59	6
Scalopus aquaticus	6	5.34	0.08	3	2.86	0.01	0	0.81	0.81	5.39	9
Sciurus sp.	4	3.56	0.06	2	1.90	0.00	0	0.54	0.54	3.59	6
Sylvilagus sp.	9	11.86	0.69	10	6.35	2.10	1	1.80	0.35	11.98	20
Synaptomys cooperi	1	1.19	0.03	1	0.63	0.21	0	0.18	0.18	1.20	2
Total	99		7.87	53		10.52	14		14.81	100.	166

An Appraisal of the Paleoecology and Taphonomy of the Lubbock Landfill Site, Southern High Plains of Texas

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The Lubbock Landfill site (41LU87) is located on the Southern High Plains of northwest Texas in Blackwater Draw at the northern outskirts of the city of Lubbock. All sediments from the site have been water-processed to recover any micromaterials present. A total of 11,078 specimens were recovered, the vast majority of which (97.36%) were from the matrix concentrates.

Materials appeared to be distributed throughout the excavated columns, and concentrations were difficult to detect owing to the variable size of excavation levels (up to 77 cm thick) within and between units. Additionally, stratigraphic correlations were made after the field work. To ameliorate the situation and impose a level of resolution, a number of procedures were followed that permitted the reconstruction of potential surfaces (Johnson 1993). Radiocarbon ages of ca. 10,250 yr B.P. at the top of stratum 2 and ca. 8,800 yr B.P. on the A horizon of stratum 3 (Holliday 1993) and the radiocarbon sequence at Lubbock Lake (Holliday et al. 1983, 1985) provided a chronological framework. Stratum 2 dates between about 10,250 and 11,000 yr B.P., a time period equivalent to substratum 2A at Lubbock Lake, including the Lubbock Lake Folsom local fauna (10,300 to 10,800 yr B.P.). Lower stratum 3 was dated at ca. 10,000 yr B.P., a time period equivalent to lower substratum 2B at Lubbock Lake, including the Lubbock Lake Plainview local fauna (10,000 yr B.P.) (Johnson 1986, 1987; Johnson and Holliday 1989).

Stratum 3 species are *Ictalurus* spp. (catfishes), *Rana* spp. (frogs), *Phrynosoma cornutum* (Texas horned toad), *Microtus pennsylvanicus* (meadow vole), *Synaptomys cooperi* (southern bog lemming). Stratum 2 species are *Scirpus* sp. (bullrush), cf. *Equisetum* sp. (horsetail), *Ictalurus* spp., *Chrysemys scripta* (pond slider), *Rana* spp., *Spermophilus* sp. (ground squirrel), *Cynomys ludovicianus* (prairie dog), *Geomys bursarius* (pocket gopher), *Microtus pennsylvanicus, M. ochrogaster* (prairie vole), *Ondatra zibethicus* (muskrat), and *Bison antiquus* (ancient bison). Stratum 1 species are *Ictalurus* spp., *Rana* spp., *Chrysemys scripta, Microtus pennsylvanicus,* and *Bison antiquus* (Johnson 1993).

Locally, stratum 1 and its associated vertebrate fauna indicate the past presence of a free-flowing stream and surrounding marshy banks with emergent vegetation. Fish were small, indicating shallow depth of water and small pools of water. The draw environs were those of a stream flowing through a wet meadows that graded into a prairie (Johnson 1993). This scenario is similar to that interpreted from the data at Lubbock Lake and for the region (Johnson 1986, 1987).

Locally, stratum 2 and lower stratum 3 represent an aggrading marsh with open

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shallow waters and fluctuating marshy margins. The fish and frogs were small. The area was a boggy one with a high water table (Johnson 1993). This scenario is similar to that at Lubbock Lake and the region for this time period (Johnson 1986, 1987).

The extirpated microtine species are important markers as both extralimital and environmentally sensitive forms. They fit part of the larger pattern for the region (Johnson 1986) of a climatic regime marked by cooler summers, warmer winters, and more equitable climatic conditions than those of present day (Johnson, 1987). Increased rainfall and humidity prevailed, and northern, cool-climate grasses dominated the meadows and draw.

The major taphonomic questions investigated were the presence of cultural modifications, presence of concentrations, and nature of the deposits (primary or secondary). All *Bison* material was weathered, and all lacked evidence of cultural modification. Given that the bones were exposed for several years, the high-energy positions of some indicated disturbance immediately prior to burial (Shipman 1981; Weigelt 1989).

Based on the frequency distribution and vertical distribution plots of the matrix materials, several events took place (Johnson, 1993). Matrix materials associated with in situ bison material indicate evidence of both the resharpening of lithic tools and the breakage of bone. While the materials on this "surface" were weathered and disturbed by carnivore and other natural activities, they apparently were not disturbed by water action and redeposition. These data indicated an intact cultural surface in primary context that also recorded disturbance processes prior to burial. The presence of sequential hearths (based on burned bone and a hearthstone) indicates that additional activities occurred, such as food preparation and camping.

The Lubbock Landfill site appeared to have been occupied repeatedly by Folsom-age peoples. At least one probable bison-butchering event occurred in addition to possible camping and/or food preparation activities. Disturbances to the area included carnivores, possible trampling and gravity movement, and water-wave actions (Johnson 1993). Although the overall trend from stratum-1 through stratum-3 time periods was toward climatic change, the fluctuations of the marsh margins probably reflected a seasonally related pattern and may correspond to the fluctuating pond margins at Lubbock Lake during this time (Johnson 1987).

The presence of the Lubbock Lake Folsom local fauna at the Lubbock Landfill, the least documented and most abbreviated of the early-Holocene faunas for the region (Johnson 1986), underscores the importance of the locality and its great potential to contribute to the Paleoindian paleoecology of the Southern High Plains. Furthermore, food preparation and camping events are not well documented for the Paleoindian Period on the Southern Plains. Lastly, the vast majority of specimens were recovered in matrix concentrates. Without using this recovery technique, the real nature of this locality would not have been discovered.

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References Cited

Brown, D. O. 1993 Archaeological Investigations at the City of Lubbock Landfill, Lubbock County, Texas. Hicks & Company, Inc., Austin, *Archeology Series*, 22:1–126.

Holliday, V. T. 1993 Geoarchaeological Investigation of the Wind Pit. In: David O. Brown, Archaeological Investigations at the City of Lubbock Landfill, Lubbock County, Texas. Hicks & Company, Inc., Austin, *Archeology Series*, 22:43–47.

Holliday, V. T., E. Johnson, H. Haas, and R. Stuckenrath 1983 Radiocarbon Ages from the Lubbock Lake Site, 1950–1980: Framework for Cultural and Ecological Change on the Southern High Plains. *Plains Anthropologist*, 28(101):165–182.

Holliday, V. T., E. Johnson, H. Haas, and R. Stuckenrath 1985 Radiocarbon Ages from the Lubbock Lake Site, 1981–1984. *Plains Anthropologist*, 20(110):277–291.

Johnson, E. 1986 Late Pleistocene and Early Holocene Vertebrates and Paleoenvironments on the Southern High Plains, U.S.A. *Géographie physique et Quaternaire*, 40(3):249–261.

Johnson, E. 1987 *Lubbock Lake. Late Quaternary Studies on the Southern High Plains.* Texas A&M University Press, College Station.

Johnson, E. 1993 Paleoecologic and Taphonomic Assessment of 41LU87 Based on the 1992 Test Excavations. In: David O. Brown, Archaeological Investigations at the City of Lubbock Landfill, Lubbock County, Texas. Hicks & Company, Inc., Austin, *Archeology Series*, 22:77–102.

Shipman, P. 1981 *Life History of a Fossil. An Introduction to Taphonomy and Paleoecology.* Harvard University Press, Cambridge.

Weigelt, J. 1989 *Recent Vertebrate Carcasses and Their Paleobiological Implications.* University of Chicago Press, Chicago.

The Sand Creek Mammoth Site, Llano Estacado of Texas

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A mammoth (*Mammuthus columbi*) site has been discovered along an arroyo in Yellowhouse Canyon about 20 miles downstream from Lubbock Lake (Johnson 1987). The site is in the heavily dissected landscape along the eastern escarpment of the Llano Estacado (Southern High Plains). The area also is a richly diverse ecotone between the Southern High Plains and Rolling Plains and has abundant natural resources.

The site is exposed in the walls of an arroyo that is a tributary of the North Fork of the Double Mountain Fork of the Brazos River. Mammoth bone is eroding out of late-Pleistocene lacustrine sediments. The lake beds are stratified and a total of 2 m thick. The size of the paleo-lake basin is not yet determined, but the exposure is ca. 30 m wide. The sediments are olive-gray sandy clay, similar to late-Pleistocene lake beds reported from the region

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(Reeves 1990). Thin lenses of organic-rich clayey mud are below the bone, and similar sediment caps the lake deposit. Samples of these organic sediments were collected for radiocarbon dating in order to provide a bracketed age for the mammoth; ages are pending.

A partial mammoth skeleton was exposed, with a large Potter chert tool associated with the skeleton (in place next to a vertebra), and at least one of the limb bone segments exhibits features from dynamic fracturing (Johnson, 1985). The exposed materials were mapped and photographed. Bones were selectively collected. An additional helically fractured longbone segment and a large bone flake were noted.

Limited testing was conducted in order to determine whether or not any materials remained in situ in undisturbed deposits and to secure samples for radiocarbon dating. The test units indicated an intact surface where the bones were originally laid. This surface was found in three test units and suggested a similar vertical distribution for the bones found in the deposits. It appeared, from the observation of this surface, that the bones were not exposed for a long period of time after the animal died and that the sever weathering noted on the surface-mapped bones was caused by recent re-exposure of the remains.

Of the six units opened, three produced in situ material that yielded a thoracic vertebra, a rib segment that conjoined with another segment mapped on the surface, a small tusk segment, six bone flakes, and two more helically fractured longbone segments (one of which had been partially exposed in an eroded wall). One of the bone flakes was a large cone flake from the zone of impact created by the blow that broke the longbone (Johnson 1985). Similar pieces occurred in the Clovis-age megafauna-processing station at Lubbock Lake (Johnson and Holliday 1985; Johnson et al. 1987), where one of the activities was the fracturing of mammoth longbones proposed for use as blanks for bone foreshafts and wrenches (Johnson, 1985, 1989). Of the 694 bone segments and scrap mapped, 397 (57%) came from the surface while 297 (43%) were recorded in situ from the test excavation.

Potter chert is a locally available lithic resource coming from the Ogallala Formation, locally exposed throughout Yellowhouse Canyon and the upper Brazos River drainage (Holliday and Welty 1980; Johnson, 1994). The specimen is quite large (length-width-thickness: 24.0 x 17.6 x 8.9 cm; weight: 5,680 g), tabular, and rectanguloid in shape. Bifacial flaking occurs on one corner with some apparent use-wear in the form of microflaking and crushing; cortex has been removed only in the area of flaking.

This tool was found embedded in the lake sediments. The tool probably was not washed in; no other rock of similar size was observed in or near the site indicating that the area was not subjected to high-energy overland flow. Nor did the lake-basin deposits indicate a high-energy regime. Nevertheless, archaeological sites of late-Holocene age are in the area, and the artifact could have traveled down to the bone level as the site was eroded. Cut marks were not noted on any of the bone segments and pieces recovered, but human-induced helical fractures and bone flakes occur.

Only three Clovis-age sites (the presumed age of this mammoth site) have been excavated on the Llano Estacado (Johnson, 1991): a Clovis-type site

(Hester 1972), Miami (Sellards 1938), and Lubbock Lake (Johnson 1987). Such sites, representing some of the earliest peoples on the Llano Estacado, are rare, and the one at Sand Creek is in jeopardy of imminent destruction due to the active erosion occurring at the site and in the drainage in general. The lake beds have abundant molluscs, and the potential for recovering paleo-environmental data are high. The immediate significance of the discovery is in the site's rarity and the paleoecological and cultural potential for enhancing the understanding of the relationship and interaction between these early peoples and the late-Pleistocene ecosystem of the Southern Plains.

This work is part of the ongoing research of the Lubbock Lake Landmark into the Quaternary ecological and cultural changes on the Southern Plains. Funding for the survey was provided by the Texas Archeological Society as part of their 1993 TAS Field School; funding for the mapping and test excavations was provided by the Museum of Texas Tech University and Lubbock Lake Foundation.

References Cited

Hester, J. J. 1972 *Blackwater Locality No. 1. A Stratified, Early Man Site in Eastern New Mexico.* Fort Burgwin Research Center, Southern Methodist University, Dallas.

Holliday, V. T., and C. M. Welty 1980 Lithic Tool Resources of the Eastern Llano Estacado. *Bulletin of the Texas Archeological Society,* 52:201–214.

Johnson, E. 1985 Current Developments in Bone Technology. In *Advances in Archaeological Method and Theory,* Vol. 8, edited by M. B. Schiffer, pp. 157–235. Academic Press, New York.

Johnson, E. 1987 *Lubbock Lake: Late Quaternary Studies on the Southern High Plains.* Texas A&M University Press, College Station.

Johnson, E. 1989 Human-modified Bones from Early Southern Plains Sites. In *Bone Modification,* edited by R. Bonnichsen and M. H. Sorg, pp. 431–471. Center for the Study of the First Americans, University of Maine, Orono.

Johnson, E. 1991 Late Pleistocene Cultural Occupation on the Southern Plains. In *Clovis Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 215–236. Center for the Study of the First Americans, Oregon State University, Corvallis.

Johnson, E. 1994 Archaeological Survey Along the Mobil ESTE CO_2 Pipeline Corridor from Denver City to Clairemont, Texas. Museum of Texas Tech University, *Lubbock Lake Landmark Quaternary Research Center Series,* 6.

Johnson, E., and V. T. Holliday 1985 A Clovis-Age Megafaunal Processing Station at the Lubbock Lake Landmark. *Current Research in the Pleistocene,* 2:17–19.

Johnson, E., V. T. Holliday, and L. Kreutzer 1987 Significance of Bone Orientation Data for the Clovis-Age Bone Bed at the Lubbock Lake Landmark. *Current Research in the Pleistocene,* 4:77–78.

Reeves, C. C. Jr. 1990 A Proposed Sequential Development of Lake Basin, Southern High Plains, Texas and New Mexico. In *Geologic Framework and Regional Hydrology: Upper Cenozoic Blackwater Draw and Ogallala Formations,* Great Plains, edited by T. C. Gustavson, pp. 209–232. Bureau of Economic Geology, University of Texas, Austin.

Sellards, E. H. 1938 Artifacts Associated with Fossil Elephant. *Bulletin of the Geological Society of America,* 49:999–1010.

Methods

Dispersing Aggregated Soils and Other Fine Earth in the Field for Recovery of Organic Archaeological Materials

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Recent advances in hair recovery and identification (Bonnichsen et al. 1992, Bonnichsen et al. 1994), and the application of the polymerace chain reaction (PCR) to archaeological specimens make it important to properly disperse aggregated fine earth that may possibly contain hair and other original organic materials. Dispersion of large amounts of aggregated fine earth in the field without chemically or mechanically damaging organic archaeological specimens is considerably different from laboratory dispersion of aggregated fine earth for particle-size distribution analysis, (Gee and Bauder 1986).

Dispersion of archaeological samples must 1) avoid introducing any organic material (detergents, for example) into the process if ^{14}C dating is anticipated, 2) avoid mechanical agitation at energy levels great enough to damage organic remains, 3) avoid human contamination, 4) avoid chemical damage to organic remains from oxidation or extremely high or low pH levels, and 5) achieve sufficient dispersion to allow hair, insect skeletons, etc. to become separated from mineral particles.

Dispersion by use of a water solution of sodium hexametaphosphate (NaPO3)6 (hereafter HMP) with gentle agitation can achieve the five objectives. HMP disperses fine earth by introducing Na+ ions into the cation exchange sites and displacing extant cations including Ca++, Mg++, K+, and NH4+, among others. Layer lattice silicates and organic colloids saturated with Na+ disperse, thus disrupting the aggregates (clods, peds, lumps) of fine earth and releasing any entrapped organic remains. Therefore, the amount of HMP needed to achieve dispersion depends primarily on the cation exchange capacity of the fine earth from both inorganic and organic sources.

Cation exchange capacities of fine earth material range from <1 meq/100g for sand and loamy sand to >75 meq/100g for clay-textured materials in which

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the layer silicates are predominantly smectite and similar 2:1 lattice materials. Allophanic materials may have CEC values of up to 500 meq/100g.

To have sufficient Na+ to fully saturate the CEC of fine earths add 1 g of HMP per kg of fine earth per meq/100 g of cation exchange capacity. Thus a fine earth with a cation exchange capacity of 20 meq/100g would require 20 g/kg of HMP for dispersion. Although dispersion may occur at less than complete sodium saturation, the possible failure to recover unique and valuable archaeological specimens makes it advisable to use adequate amounts of HMP when dispersing fine earth in the field.

We have found the following procedure practical and effective for a range of samples with textures from loamy sand to clay; however, we have not used it with samples high in carbonates nor with those cemented with iron and manganese oxides. HMP (technical grade) is added to newly excavated earth in 10L plastic bags with watertight, zipper-like top closures at a rate appropriate to the estimated CEC of the sample. Clean, filtered stream water is added to achieve a liquid:solid ratio of no less than 2:1. The bag is closed, massaged to aid in dispersing aggregates, and set aside for at least two hours. Fine-textured samples with large aggregates should be massaged once or twice during this interval if aggregates are detected by feeling the outside of the closed bag after the mixture has sat for 30 or 40 minutes (the suspension may sit more than 2 hours; overnight treatment often facilitates work flow during a dig). In cool weather hot water will greatly accelerate dispersion. When dispersion appears complete, the contents of the bag are washed into a tub of approximately 100L volume, fitted near the top with an overflow pipe, that in turn is capped with very fine mesh clean plastic netting (Bonnichsen et al. 1994).

Water is added to the suspension, preferably under pressure to break up any remaining aggregates, to achieve a liquid:solid ratio of approximately 10:1, and the diluted suspension is allowed to sit for at least 10 minutes to allow organic material to rise toward the surface. Then water is slowly added to start the supernatant liquid, with any floating organic matter, flowing through the discharge pipe and into the netting. Continue decanting until all floating organic matter has discharged through the overflow and been trapped on the netting. Workers wear rubber or plastic gloves during the transfer, decanting and netting removal processes to reduce possibilities of contamination by contemporary human DNA. The netting with any archaeological or paleoenvironmental specimens is labeled, dried and made part of the specimen collection of the dig. Fine earth in the tub is screened for other artifacts.

References Cited

Bonnichsen, R., M. T. Beatty, M. D. Turner, and M. Stoneking 1994 (in press) What Can Be Learned From Hair? A Hair Record From the Mammoth Meadow Locus, Southwestern Montana. In Prehistoric *Mongoloid Dispersions,* T. Akazawa and E. Szathmary, eds., Oxford University Press, Cambridge.

Bonnichsen R., C. W. Bolen, M. D. Turner, J. C. Turner, and M. T. Beatty 1992 Hair From Mammoth Meadow II, Southwestern Montana. *Current Research in the Pleistocene.* 9:75–78.

Gee, G. W., and J. W. Bauder 1986 Particle-Size Analysis. In *Methods of Soil Analysis* (Second Edition), A. Klute, ed., Chapter 15, American Society of Agronomy, 677 So. Segoe Rd., Madison, WI.

The Pre-Clovis Debate: A Bibliographic Analysis

J. Kulisheck

The 40-odd-year debate regarding the antiquity of humans in the Western Hemisphere—the "Pre-Clovis" debate—has persisted long enough in archaeology to be considered a historical phenomenon. More than a simple series of clashes regarding the age of sites and finds, the debate is about how archaeologists assess the validity of claims about the archaeological record. I evaluated changes in the nature of the Pre-Clovis debate since 1933 using a bibliographic analysis (Oldroyd 1990:347). This type of analysis counts the total number of works published regarding Pre-Clovis finds, by year (Figure 1). The technique assumes that a high number of publications reflects controversy, an assumption confirmed by qualitative examination of the literature.

Several trends are observable in Figure 1. There is a lack of activity through the 1930s and '40s, followed by an upsurge in the '50s. A decline in the mid-1960s is followed by a gradual climb, which becomes precipitous after 1977. The initial paucity of publications following the Folsom discovery may be a consequence of the nature of that find. Its acceptance defined what the Pleistocene

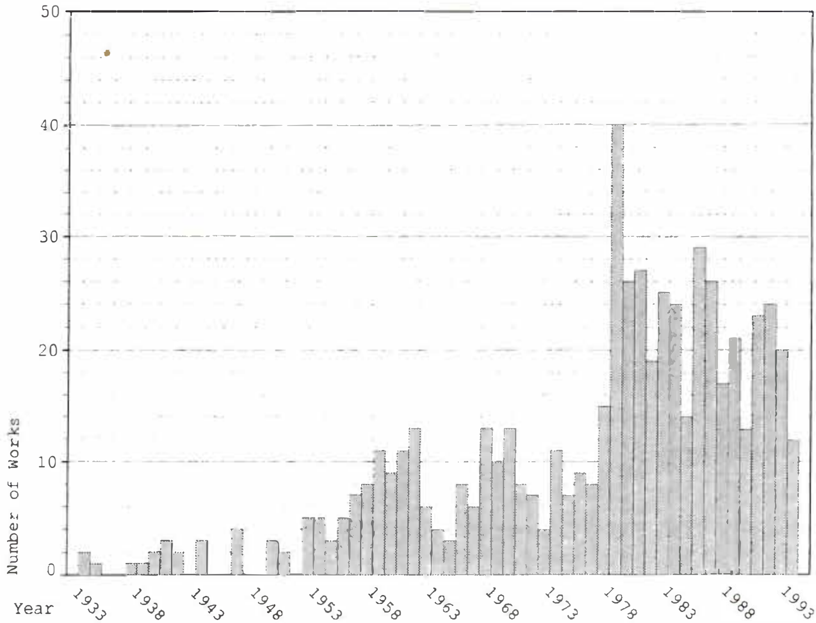

Figure 1. Number of works published regarding pre-Clovis finds.

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record in the Americas should look like and how it should be found; its age was also great enough to provide the time depth needed to explain later phenomena, no longer necessitating an older Paleolithic (Kidder 1936:144–145). Work of the period instead sought to define the spatio-temporal extent of the newly defined Paleoindian record (Roberts 1940).

Progress on this task, apparently, is what made the upsurge of the 1950s possible. The appearance of a fully developed lithic industry, with no apparent Far East antecedents, led Krieger and others to propose a "pre-projectile point stage" to justify the Paleoindian record in evolutionary terms (Krieger 1964:42–51; Willey and Phillips 1958:82–86). The demand for pre-projectile sites was soon satisfied (Carter 1957; Harrington and Simpson 1961).

The decline in the 1960s represents the second shift in how Paleoindian origins were understood. The development of radiocarbon dating allowed Haynes to correlate the appearance of Clovis finds with the opening of an ice-free corridor from Beringia (C. Haynes 1964; 1992:363), which seemed to explain the origin of Clovis and eliminate the need for a pre-projectile stage in one fell swoop.

The resurgence that followed the mid-'60s decline, especially after 1977, is not so easily explained as the 1950s upsurge. Like archaeology itself at this time, the pre-Clovis debate became multifaceted. Not only were new sites introduced, but new experimental dating techniques also appeared (Taylor 1991), along with new methods of identifying reputed human modification of materials such as bone (Bonnichsen 1979), and the incorporation of non-archaeological evidence (Meltzer 1989:472–475; 1993:162–165). Because "the pre-Clovis debate" had become many debates, the decline visible through the 1980s is gradual, even though aspects of controversy appeared to be resolved, such as calibration of amino-acid racemization dating (Taylor et. al. 1985).

While the character of the pre-Clovis debate appears too complex to be teased apart by the bibliographic analysis, Figure 1 demonstrates that the debate has been uneven in tempo. The shape of the distribution suggests that the debate is more than disagreements regarding the age of sites, but is rather a discourse about how great human antiquity is demonstrated, and why such a long archaeological record needs to be established in the Americas at all.

I wish to thank M. Adler and D. Meltzer for their comments on earlier drafts of this paper.

References Cited

Bonnichsen, R. 1979 *Bone Technology*. Center for the Study of Early Man, University of Maine, Orono.

Carter, G. F. 1957 *Pleistocene Man at San Diego*. Johns Hopkins University Press, Baltimore.

Harrington, M. R., and R. D. Simpson 1961 Tule Springs, Nevada, With Other Evidences of Pleistocene Man in North America. *Southwest Museum Papers* 18, Los Angeles.

Haynes, C. V. Jr. 1964 Fluted Points: Their Age and Dispersion. *Science* 145:1408–1413.

Haynes, C. V. Jr. 1992 Contributions of Radiocarbon Dating to the Geochronology of the Peopling of the New World. In *Radiocarbon After Four Decades: An Interdisciplinary Perspective*, edited by R. E. Taylor, A. Long, and R. S. Kra, pp. 355–374. Springer-Verlag, New York.

Kidder, A. V. 1936 Speculations on New World Prehistory. *Essays in Anthropology in Honor of A. L. Kroeber*, edited by R. Lowie, pp. 143–151. University of California Press, Berkeley.

Krieger, A. D. 1964 Early Man in the New World. In *Prehistoric Man in the New World,* edited by J. D. Jennings and E. Norbeck, pp. 23–81. University of Chicago Press, Chicago.

Meltzer, D. J. 1989 Why Don't We Know When the First People Came to North America? *American Antiquity* 54:471–490.

Meltzer, D. J. 1993 Pleistocene Peopling of the Americas. *Evolutionary Anthropology* 1:157–165.

Oldroyd, D. R. 1990 *The Highlands Controversy: Constructing Geological Knowledge through Fieldwork in Nineteenth-Century Britain.* University of Chicago Press, Chicago.

Roberts, F. H. H. Jr. 1940 Developments in the Problem of the North American Paleo-Indian. *Smithsonian Miscellaneous Collections* 100:51–116.

Taylor, R. E. 1991 Frameworks for Dating the Late Pleistocene Peopling of the Americas. In *The First Americans: Search and Research,* edited by T. D. Dillehay and D. J. Meltzer, pp. 77–111. CRC Press, Boca Raton.

Taylor, R. E., L. A. Payen, C. A. Prior, P. J. Slota Jr., R. Gillespe, J. A. J. Gowlett, R. E. B. Hedges, A. J. T. Jull, T. H. Zabel, D. J. Donahue, and R. Berger 1985 Major Revisions in the Pleistocene Age Assignments for North American Human Skeletons by ^{14}C Accelerator Mass Spectrometry: None Older Than 11,000 ^{14}C Years B.P. *American Antiquity* 50:136–140.

Paleoenvironments: Plants

The Central Texas Pollen Record: A Reinterpretation

C. Britt Bousman

Pollen from Boriack and Weakly Bogs in central Texas provide a floral record spanning the last 16,500 years (Bryant 1977; Holloway et al. 1987). Linear regressions of sample depth and radiocarbon age suggest that Boriack Bog spans 16,500–3,000 yr B.P. and Weakly Bog spans 3,000–100 yr B.P. (Collins et al. 1993). Three-sample moving averages of arboreal and grass-pollen percentages from both bogs show that late-Pleistocene and Holocene plant communities were very dynamic (Figure 1).

The unsmoothed data (Bryant 1977) hint at grasslands immediately before 16,500 yr B.P. Woodlands occur between 16,500–12,500 yr B.P., and these pollen spectra suggest cool and moist conditions. The reduction of spruce, probably the cold-adapted *Picea glauca* (Holloway and Bryant 1984), by 15,000 yr B.P. suggests

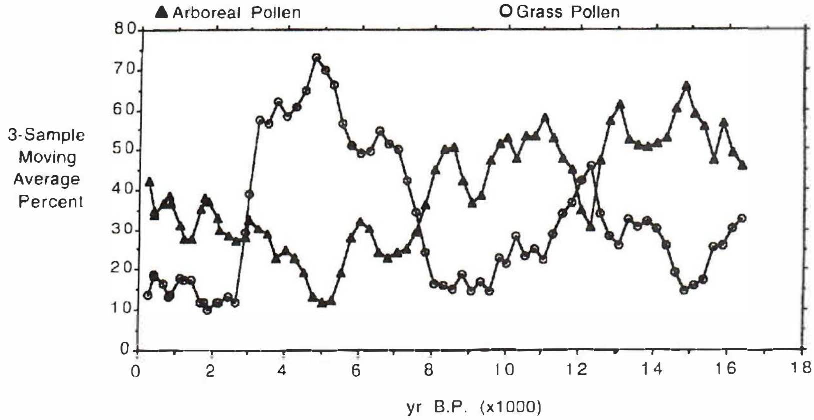

Figure 1. Three-sample moving averages of arboreal and grass pollen from Boriack Bog (Lee County) and Weakly Bog (Leon County).

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warming soon after the Last Glacial Maximum. Pedogenic carbonate $d^{18}O$ ratios in south Texas also provide evidence of early warming (Bousman 1992).

A brief shift to grasslands between 12,500–11,800 yr B.P. represents a dry episode. This appears coeval with cool conditions evident in $d^{18}O$ ratios in south Texas (Bousman 1992). These may be responses to a large surge of glacial meltwater down the Mississippi River (Fairbanks 1989; Overpeck et al. 1989) that reduced sea-surface temperatures in the Gulf of Mexico and stimulated cooler-drier terrestrial conditions (Broecker et al. 1989).

From 11,800 yr B.P. to 9,500 yr B.P. woodlands return to the region, but afterwards arboreal pollen drops. This drop may be related to a rerouting of meltwater down the Mississippi River between 10,000–9,000 yr B.P. (Broecker et al. 1989; Fairbanks 1989).

Woodland plant communities are reestablished by 8,700 yr B.P., but by 7,500 yr B.P. grass pollen again dominates. Arboreal pollen continues to drop until 6,800 yr B.P. After a slight rise in arboreal pollen around 6,000 yr B.P., arboreal pollen declines until 5,000 yr B.P. Other areas of Texas also suffered under severe drought conditions at this time (Holliday 1989; Meltzer 1991).

After 5,000 yr B.P. arboreal pollen slowly rebounded possibly because late-Holocene climates became increasingly more moist. Two small grass spikes occurred at 1,500–1,600 yr B.P. and 400–500 yr B.P., and buried soils in nearby floodplains are contemporaneous (Bousman and Fields 1988). Apparently pedogenesis may relate to these vegetation changes.

These pollen data suggest that significant paleoenvironmental changes occur before, during and after Paleoindian occupations. These biotic fluctuations must have dramatically altered the availability of resources exploited by prehistoric hunter-gatherers. The possibility that biotic changes are linked to the routing of glacial meltwaters down the Mississippi River may be significant for understanding late-Pleistocene climatic patterns in the circum-Gulf of Mexico region.

I wish to thank Vaughn Bryant for generously providing the original data from Boriack Bog, and Michael B. Collins, Ross Fields, Steve Hall and Paul Goldberg for useful suggestions. This study was funded by a grant from the Texas Historical Commission and I wish to thank Nancy Kenmotsu and James Bruseth of the THC.

References Cited

Bousman, C. B. 1992 Preliminary Oxygen-Isotope Evidence for Late Pleistocene-Early Holocene Climatic Change. *Current Research in the Pleistocene* 9:78–80.

Bousman, C. B., and Ross C. Fields 1988 Results of the geoarchaeological investigations. In *Archeological survey of the 1989–1993 permit area, Jewett Mine Project, Freestone and Leon Counties, Texas.* Reports of Investigations, Number 63. Prewitt and Associates, Austin.

Broecker, W. S., J. P. Kennett, B. P. Flower, J. T. Teller, S. Trumbore, G. Bonani, and W. Wolfi 1989 Routing of Meltwater from the Laurentide Ice Sheet During the Younger Dryas Cold Episode. *Nature* 341:318–321.

Bryant, V. M., Jr. 1977 A 16,000 Year Pollen Record of Vegetation Change in Central Texas. *Palynology* 1:143–156.

Collins, M. B., C. B. Bousman, and T. Perttula 1993 Quaternary environments and archeology in Northeastern Texas. In *Archeology in the Eastern Planning Region, Texas: a planning document*, N. A.

Kenmotsu and T. K. Perttula (eds.), Department of Antiquities Protection, Cultural Resource Management Report 3, Texas Historical Commission.

Fairbanks, R. G. 1989 A 17,000-Year Glacio-Eustatic Sea Level Record: Influence of Glacial Melting Rates on the Younger Dryas Event and Deep-Ocean Circulation. *Nature* 342:637–642.

Holliday, V. T. 1989 Middle Holocene drought on the southern High Plains. *Quaternary Research* 31:74–82.

Holloway, R. G., and V. M. Bryant, Jr. 1984 *Picea glauca* pollen from late glacial deposits in Central Texas. *Palynology* 8:21–32.

Holloway, R. G., L. M. Raab, and R. Stuckenrath 1987 Pollen analysis of late-Holocene sediments from a Central Texas bog. *The Texas Journal of Science* 39:71–79.

Meltzer, D. J. 1991 Altithermal archaeology and paleoecology at Mustang Springs, on the southern High Plains of Texas. *American Antiquity* 56:236–267.

Overpeck, J. T., L. C. Peterson, V. Kipp, J. Imbrie, and D. Rind 1989 Climate Change in the Circum-North Atlantic Region during the Last Deglaciation. *Nature* 338:553–557.

A Preliminary Pollen and Algae Sequence from East Bearskin Lake, Cook County, Minnesota

James K. Huber

Pollen and algae from East Bearskin Lake have provided paleoenvironmental data for research undertaken in conjunction with archaeological investigations at the East Bearskin Point site. Based on lithic materials, the East Bearskin Point site has a Paleoindian component, estimated to date between 10,500 and 7,000 yr B.P. in this area.

East Bearskin Lake is located approximately 40 km N/NW of Grand Marais and approximately 7 km S of the United States/Canada border in Cook County, Minnesota. The coring site is located at approximately 90°23′04″ N 48°02′05″ W.

A core 991 cm long was extracted from 5.48 m of water near East Bearskin Site 02-315. The core is composed of: 0–405 cm, gyttja; 405–750 cm, clay; 750–760 cm, black and very dark gray laminated clay (varves ?); 760–991 cm, silty clay.

At present, pollen counts have been completed on the upper 760 cm of the core at 20-cm intervals. In the upper 20 cm of the core 5-cm intervals have been counted. Below 760 cm pollen is less abundant; however, pollen counts are continuing at 5 cm on the entire core.

The pollen sequence from East Bearskin Lake has been divided into seven pollen assemblage zones (Figure 1). Zone EB-1 is dominated by *Cyperaceae* (sedge) and other herbaceous plants with some *Picea* (spruce), *Salix* (willow), and *Fraxinus* (ash) indicating a tundra-like or open boreal environment. *Betula* (birch) and *Picea* are the most abundant pollen types in Zone EB-2, suggesting a shrub parkland. Zone EB-3 represents a spruce-pine forest with deciduous components. An increase in *Pinus banksiana/P. resinosa* (jack/red pine), *Betula,* and *Alnus* (alder) and a decrease in *Picea* characterize Zone EB-4, indicating a

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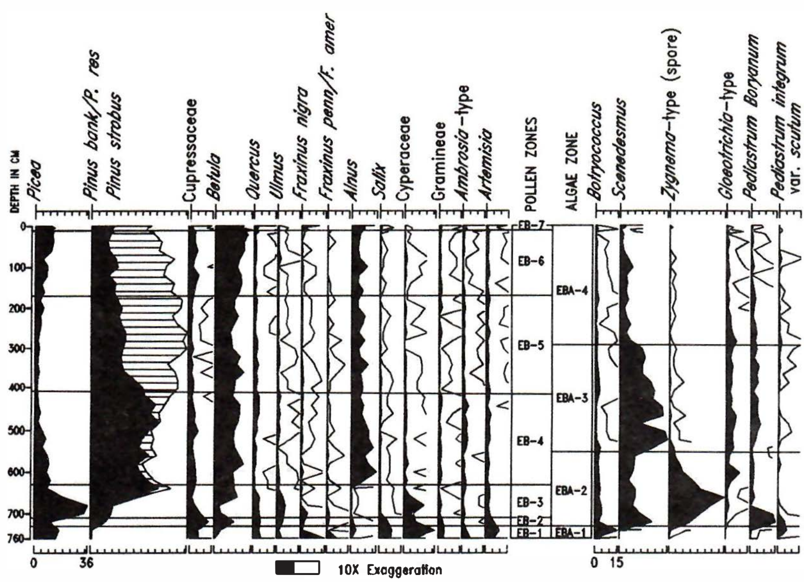

Figure 1. Pollen percentage diagram of selected taxa from East Bearskin Lake, Cook County, Minnesota.

mixed conifer-hardwood forest. A shift from *Pinus banksiana/ P. resinosa* to *Pinus strobus* (white pine) and a small decrease in *Betula* and *Alnus* characterize Zone EB-5. Zone EB-6 reflects a decline in pine and an increase in birch and spruce. A small *Ambrosia* (ragweed) rise in Zone EB-7 is attributed to deforestation by Euro-American settlers about 1890 (Maher 1977). The pollen zones at East Bearskin Lake are similar to other sequences found in northeastern Minnesota (Cushing 1967; Huber 1992, and others).

Nonsiliceous algae associated with the pollen sequence record changes in the trophic status of East Bearskin Lake (Figure 1). After an initial period of colonization (Zone EBA-1), changes in the nonsiliceous algae abundance indicate that the trophic conditions and/or water chemistry in East Bearskin Lake has changed through time. Increased *Scenedesmus* (Cronberg 1982) and *Pediastrum* (Crisman 1978) abundance has been interpreted as an indicator of change in lake productivity.

During the time of possible human occupation in the East Bearskin Lake watershed, a progression from a tundra-type or open boreal environment to a mixed conifer-hardwood forest occurred, while the trophic status of the lake shifted. Continued close-interval analyses of the lower portion of the East Bearskin Lake core will aid in interpreting changing environmental conditions during the end of the Pleistocene.

References Cited

Crisman, T. L. 1978 Algal Remains in Minnesota Lake Types: A Comparison of Modern and Late-

Glacial Distributions. *Verhandlungen der Internationale Vereinigung fur Theoretische und Angewandte* 20:445–451.

Cronberg, G. 1982 *Pediastrum* and *Scenedesmus* (Chlorococcales) in Sediments from Lake Vaxjosjon, Sweden. *Archiv fur Hydrobiologie Supplement* 60:500–507.

Cushing, E. J. 1967 Late-Wisconsin Pollen Stratigraphy and the Glacial Sequence in Minnesota. In *Quaternary Paleoecology*, edited by E. J. Cushing and H. E. Wright, Jr., pp. 59–88. Yale University Press, New Haven.

Huber, J. K. 1992 An overview of the vegetational history of the Arrowhead Region, northeast Minnesota. In *Field Trip Guidebook for the Glacial Geology of the Laurentian Divide Area, St. Louis and Lake Counties, Minnesota*, Minnesota Geological Survey, Guidebook Series No. 18, ISSN-0192-6268, Prepared for the 39th Midwest Friends of the Pleistocene Field Trip, Biwabik, Minnesota, 1992, pp. 55–64. University of Minnesota, St. Paul.

Maher, L. J., Jr. 1977 Palynological Studies in the Western Arm of Lake Superior. *Quaternary Research* 7:14–44.

Preliminary Pollen Analysis of Seven Paleosol Sites in Indiana and Ohio

Camie A. Knollenberg and James K. Huber

In order to more fully understand the organic zones associated with the Sangamon and Sidney soils and their environment of deposition, pollen analysis was undertaken on ten samples from seven paleosol sites located north of the Wisconsin glacial boundary in Indiana and Ohio. The sites are Russelville Quarry in Putnam County, Indiana; Bergendorfer Farm, Sefton Farm, and Snyder Farm in Fayette County, Indiana; Wildman Woods in Wayne County, Indiana; New Paris Water Works in Preble County, Ohio; and Brush Creek in Shelby County, Ohio. The paleosols at Brush Creek (Forsyth 1965) and New Paris (Gooding 1975) are interpreted as the Sidney Soil; the rest are considered to be the Sangamon Soil (Gooding 1963).

The New Paris Water Works sample (Figure 1) is dominated by 40% *Pinus banksiana/P. resinosa*-type pollen (jack/red pine), 17% *Picea* (spruce), 7% *Salix* (willow), and 29% *Cyperaceae* (sedge). A bulk soil sample taken from this site yielded a date of 23,450 ± 500 yr B.P. (I-8928) (Gooding, unpublished). Except for the high percentage of *Cyperaceae*, the pollen spectrum is similar to Zone I in the Smith Farm and Darrah Farm diagrams, Wayne County, Indiana (Kapp and Gooding 1964), and indicates an open boreal forest.

The Brush Creek Peat sample (Figure 1) is characterized by 54% *Pinus banksiana/P. resinosa* and 24% *Cyperaceae* with *Picea* and *Gramineae* (grass) at less than 5%. The pollen from this sample suggests an open pine forest and is most

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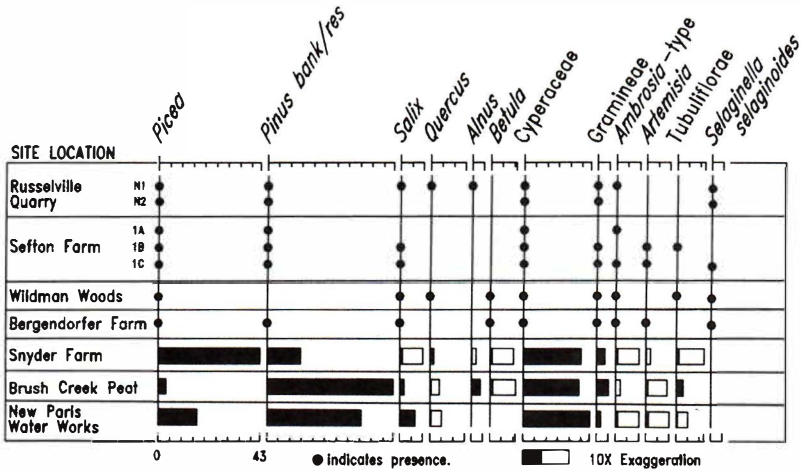

Figure 1. Pollen percentage diagram of selected taxa from seven paleosol sites in Indiana and Ohio. Sites are presented by geography from west to east.

similar to the upper portion of the Brush Creek pollen diagram presented by Forsyth (1965). Peat from this site yielded a date of >37,000 yr B.P. (W-415) (Forsyth 1965).

Picea (44%) is the most prominent pollen type in the Snyder Farm sample (Figure 1), followed by *Cyperaceae* (25%) and *Pinus banksiana/P. resinosa* (14%), indicating an open boreal forest. The presence of algae in conjunction with the pollen indicates that ponded water or pools occurred part of the time during deposition. Wood taken from this site yielded a date of 19,700 ± 180 yr B.P. (ISGS-2164).

Picea, Pinus banksiana/P. resinosa, and *Cyperaceae* are present at Bergendorfer Farm, Sefton Farm, and Russelville Quarry (Figure 1). Radiocarbon dates for these sites are: Bergendorfer Farm, soil organics, 21,640 ± 150 yr B.P. (ISGS-2203), soil organics, 37,500 ± 1400 yr B.P. (ISGS-1400), and soil organics, 44,000 ± 2000 yr B.P. (ISGS-2207); Sefton Farm, wood, >46,100 yr B.P. (ISGS-2163); Russelville Quarry, wood, 19,510 ± 140 yr B.P. (Beta-51899), wood, 19,940 ± 140 yr B.P. (ISGS-2167), and soil organics, 22,000 ± 120 yr B.P. (ISGS-2205). *Pinus* is absent at Wildman Woods (Figure 1). The pollen counts from these sites are too low for more than a tentative interpretation and are expressed only as present in Figure 1. However, the presence of these taxa suggests that a conifer forest may have existed in the vicinity of these sites during the time of paleosol formation. *Selaginella selaginoides* (mountain moss), indicative of arctic and arctic-montane environments (Hultén 1958), occurs (Figure 1), suggesting a cool environment. Soil organics from this site yielded a date of 42,800 ± 1400 yr B.P. (ISGS-2204). Algae found in the Bergendorfer Farm, Wildman Woods, and Russelville Quarry samples indicate that at least occasional pools of water occurred at these sites during their formation.

More detailed palynological investigations of these paleosols will aid in refining the Pleistocene history of the area. Pollen records in conjunction with algae data will also contribute to understanding the formation of the Sangamon and Sidney soils.

References Cited

Forsyth, J. L. 1965 Age of the Buried Soil in the Sidney, Ohio, Area. *The American Journal of Science* 263:571–597.

Gooding, A. M. 1963 Illinoian and Wisconsin Glaciations in the Whitewater Basin, Southeastern Indiana and Adjacent Areas. *The Journal of Geology* 71:665–682.

Gooding, A. M. 1975 The Sidney Interstadial and Late Wisconsin History in Indiana and Ohio. *The American Journal of Science* 275:993–1011.

Hultén, E. 1958 *The Amphi-Atlantic Plants and Their Phytogeographical Connections*. Kungl. Svenska Vetenskapskademiens Handlingar, Fjärde Serien. Band 7. Nr 1, Almquist & Wiksell, Stockholm, 340 pp.

Kapp, R. O., and A. M. Gooding 1964 Pleistocene Vegetational Studies in the Whitewater Basin, Southeastern Indiana. *The Journal of Geology* 72:307–326.

Fire in the Cerrado 32,000 Years Ago

M. L. Salgado-Labouriau and K. R. Ferraz-Vicentini

A palm swamp ("vereda") in central Brazil, about 70 km south of Goiania, was cored for paleoclimatic and paleovegetational studies of this warm semi-humid tropical region during the last glaciation and postglacial times. At present the region has a savanna-like vegetation known as "cerrado" that is crossed by many small rivers and creeks with swamps and narrow gallery forests.

The radiocarbon dates from the lower part of this core (Crominia 1) yielded ages (Figure 1) of 32,390 yr B.P. (Beta Analytics 45716), 32,580 yr B.P. (B.A. 64283), 32060 yr B.P. (B.A. 45717), and were coeval with the Pleniglacial time of the tropical Andean mountains. The next dates are 13,150 yr B.P. (Bondy 00956) and 6,680 yr B.P. (B.A. 45715), including the post-glacial and Holocene. The Crominia section ends at about 3,500 yr B.P. (extrapolated age) because the top soil was removed by recent farming.

The detailed palynological analysis has shown six vegetational and climatic phases (Ferraz-Vicentini 1993). Charcoal particles were also found in the core (Figure 1), indicating that the burning of the vegetation was a common feature from over 32,400 to 3,500 yr. B.P.

Burned wood (Coutinho 1990) was found in cerrado soils dated as old as 8,600 yr B.P. and in lake sediments in cerrado (Oliveira 1992) between 13,700 and 6,800 yr B.P. There are no records of evidence of fire older than these besides the Crominia site.

These records open the possibilities of human-induced fire at the cerrado region because it is well known that pre-Columbian Indians and Europeans

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burned the fields during the dry season. Nevertheless, there is no evidence yet of human presence in central Brazil before 11,000 yr B.P. (Prous 1992). The oldest date is from a rockshelter in the Serranpolis region, Gois (Schmitz et al. 1989) dated 10,580 ± 150 yr B.P. Therefore, it is probable that the burning of these savannas had a natural cause between <32,400 (level CR1-02) and ca. 20,000 yr B.P. (level CR1-32). The charcoal particles and burned wood found between ca. 10,400 (level CR1-40) and ca. 5,000 yr B.P. (level CR1- 46) could have been caused at least in part by the early inhabitants of the Crominia region in central Brazil.

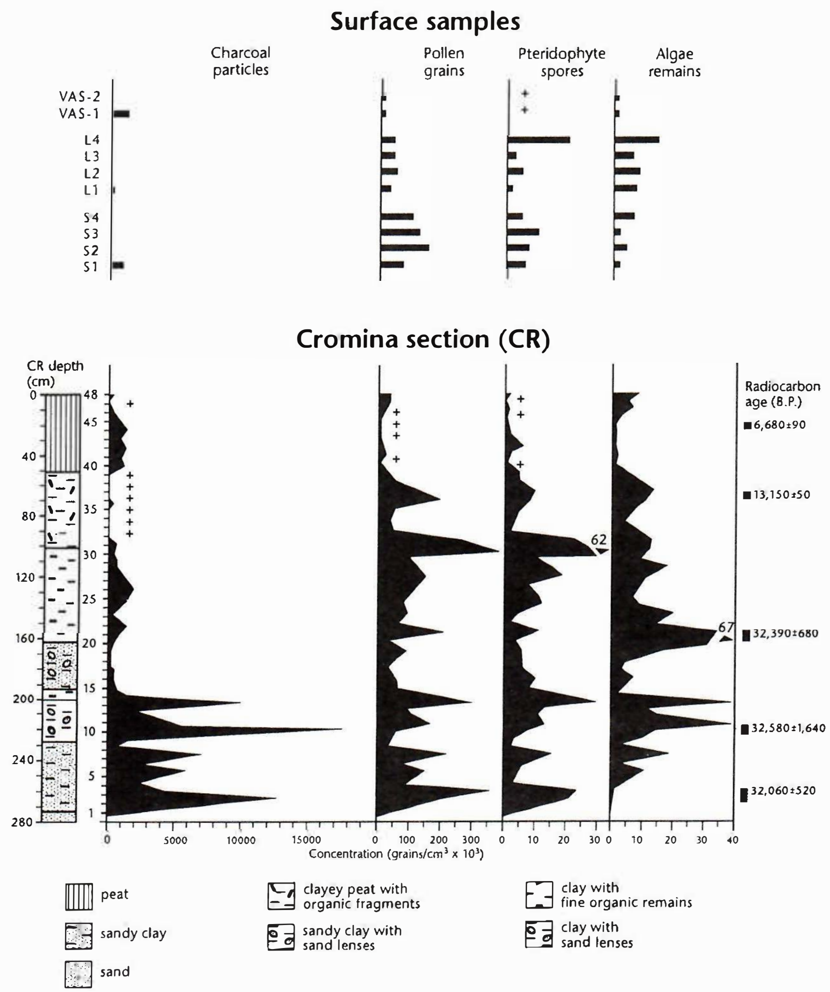

Figure 1.

Special thanks are extended to L. Martin, J.-M. Flexor, B. Turcq, K. Suguio, F. Soubis for this core; and the ORSTOM (four samples) and Betty Meggers (one sample) for radiocarbon dating.

References Cited

Coutinho, L. M. 1990 Fire in the Ecology of the Brazilian Cerrado. *Ecological Studies*, Springer-Verlag, vol.84:12–35.

Ferraz-Vicentini, K. R. 1993 Annise Palinolgica de uma vereda em Cromnia, GO. Thesis, University of Braslia.

de Oliveira, P. E. 1992 A palynological record of Late Quaternary vegetational and climatic change in southeastern Brazil. Thesis, Ohio State University.

Prous, A. 1992 *Arqueologia Brasileira.* Editora Universidade de Brasilia (UnB), 605 pp.

Schmitz, Pe. I., A. S. Barbosa, A. L.Jacobus, and M. B. Ribeiro 1989 Arqueologia nos Cerrados do Brasil Central. Serranpolis I. *Pesquisas Antropologia* n.44, 208 pp.

Paleoenvironments: Vertebrates

The Mid-Pleistocene Stratigraphic Co-occurrence of *Mammuthus columbi* and *M. imperator* in the Ocotillo Formation, Borrego Badlands, Anza-Borrego Desert State Park, California

George T. Jefferson and Paul Remeika

The Borrego Badlands are presently the focus of intensive paleontological and geological research. Here, Irvingtonian vertebrate fossils (Borrego Local Fauna) are well documented from the terrestrial Ocotillo Formation (OF) (Remeika 1992; Remeika and Jefferson 1993; Remeika and Pettinga 1991). A review of *Mammuthus* cranial material recovered from this 377-m-thick unit suggests that *M. columbi* and *M. imperator* were locally contemporaneous during the middle Pleistocene. At face value, this observation counters standard models of mammoth history (Madden 1981; Maglio 1973), which assert that *M. imperator* and *M. columbi* exhibit an ancestor-descendent relationship. The taxonomy of Maglio (1973), which recognizes *M. columbi, M. imperator,* and *M. meridionalis,* is followed herein.

A morphologic transition from *M. meridionalis* through *M. imperator* to *M. columbi* has been described (Agenbroad 1984; Graham 1986; Kurtén and Anderson 1980; Madden 1981; Maglio 1973). This presumed evolutionary lineage is based on a variety of dental parameters, including an increase in tooth-plate numbers, increased lamellar frequency, and a decrease in enamel thickness through time. Maglio (1973) and Madden (1981) consider the transition between *M. imperator* to *M. columbi* to have occurred during the late Illinoian or early Rancholabrean, between 500 and 400 ka B.P. Agenbroad (1980) places this change at approximately 130 ka B.P.

Well-preserved specimens referable to both *M. columbi* and *M. imperator* have been recovered from one horizon within the base of the Mammoth Cove Sandstone member (MCMS) of the OF (Remeika and Jefferson 1993). Stratigraphic range of these materials is less than 5 m, and some occur within the

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same bed. This association is very significant because it not only documents the co-occurrence of, but also revises and constrains the timing of the transition between the two taxa.

The MCSM consists of a complex sequence of interstratified distal alluvial fan and fluvial-floodplain deposits of local provenance. Basinward, the unit pinches out into the lacustrine Brawley Formation (Dibblee 1954). Paleomagnetic calibration of Scheuing and others (1988) suggests the basal MCSM contact within the Brawley Formation is less than 1.66 Ma B.P. The Jaramillo subchron, which ranges from 980 to 910 ka B.P., and the Matuyama/Brunhes Chron boundary have been identified (Scheuing 1989; Scheuing et al. 1988) in the overlaying Inspiration Wash member of the OF. The latter is overlain by tephra tentatively identified as the Bishop Tuff (K. Beratan pers. comm., 1993; M. Rymer 1991, pers. comm. 1993), dated at 750 ka B.P. (Sarna-Wojcicki and Pringle 1992; Sarna-Wojcicki et al. 1984). This places the basal MCSM within the lower Matuyama Chron with an approximate age of 1 Ma B.P.

Locally, the stratigraphic range of *Mammuthus imperator* is restricted to the basal sandstones of the MCSM, where it is represented by three measurable dental specimens (Table 1). In ABDSPV 1227/5126, a nearly complete individual, the anterior few plates on both upper and lower M/3s are worn away. Length of the M/3s exceeds 240 mm. The dentary is relatively gracile (maximum depth and width at mid M/3, 14.0 cm, and 16.4 cm), conforming to the morphology of *M. imperator* (Madden 1980). In the M/3 of ABDSPV 978/3881, a partial skull and mandible, the posterior-most plates are lightly worn and the anterior few plates are missing. Ten plates are preserved in this specimen. A fragmented cheek tooth from ABDSPV 1021/4214, is provisionally assigned to *M. imperator* based on an average enamel thickness of 2.5 mm.

Although *Mammuthus columbi* ranges throughout the OF, it is represented by two measurable dental specimens from the basal sandstones of the MCSM (Table 1). The M/3s in ABDSPV 1025/4260, a complete mandible comparable to the robust morphology (maximum depth and width at mid M/3, 21.5 cm, and 18.6 cm) of *M. columbi* (Madden 1980), are in an early eruptive stage. The posterior portions of the teeth remain imbedded in the dentary, and approximately half of the crown displays ten plates in wear. This implies a total plate number of more than 20. Although the anterior one-third of ABDSPV 178/789 is missing, the posterior 6 of the 12 preserved plates in this M/3 exhibit no wear.

Accepted diagnostic dental parameters for *Mammuthus columbi* and *M. imperator* (Table PD) exhibit an overlapping range of values. Those specimens herein considered *M. columbi* accordingly fall within the upper range of *M. imperator,* and likewise those placed in *M. imperator* fall within the lower range of *M. columbi.* But more importantly, the *M. imperator* and *M. columbi* dentaries are morphologically distinct, and the M/3s are separable into two groups with average plate numbers of 12 and 19, and average lamellar frequencies of 4.48 and 6.08 respectively. No intermediate forms have been recovered, and it is improbable that these materials sample only the end members of a morphologically variable population. Therefore, we suggest that *M. columbi* and *M. imperator,* as presently defined, locally existed sympatrically, and that the Borrego Badlands yield the earliest recorded representatives of *M. columbi.*

Table 1. Dental parameters of *Mammuthus.*

T	SP	TP	NP	W	LF	ET
C	789	/3	12+ (18+)	94	6.09 (3)	2.21 (6)
C	4260	/3	10+ (20+)	85+	6.07 (3)	2.17 (6)
I	3981	/3	10+ (12)	104	4.73 (4)	2.70 (6)
I	5126	3/	12+ (15)	110	5.04 (6)	2.57 (6)
I	5126	/3	10+ (12)	92	4.22 (4)	2.27 (6)

T	PD	TP	NP	W	LF	ET
C	Mg	3	20–24	–	5–7	2.0–3.0
C	Ma	3/	18–20 21	75–120 98	5.2–8.8 6.2	1.2–3.2 2.0
C	Ma	/3	18–23 21	73–111 93	3.7–8.5 6.2	1.2–3.2 2.1
I	Mg	3	16–19	–	IC	IC
I	Ma	3/	15–19 17	81–125 101	4.0–8.7 6.0	1.6–3.4 2.5
I	Ma	/3	14–22 17	61–129 95	3.6–7.8 5.5	1.9–3.6 2.7
M	Mg	3/	11–14 13	86–126 105	3.7–6.1 4.9	2.6–4.1 3.3
M	Mg	/3	10–14 12	69–119 97	3.5–5.9 4.9	2.4–4.1 3.4

T = taxon

SP = ABDSP, Anza-Borrego Desert State Park specimen numbers

TP = tooth position

NP = number of plates, + indicates minimum number, ( ) estimate number based on stage of wear

W = maximum width.

LF = lamellar frequency, number of plates/10 cm, ( ) number of averaged measurements

ET = enamel thickness in mm, ( ) number of averaged measurements

PD = published data

C = *M. columbi*

I = *M. imperator*

M = *M. meridionalis*

IC = intermediate condition between *M. meridionalis* and *M. columbi*

Ma = from Madden (1981), range and average; these data do not include advanced *M. columbi* which Madden places in *M. jacksoni* (= *M. jeffersonii*)

Mg = from Maglio (1973), range only

References Cited

Agenbroad, L. D. 1980 Quaternary mastodon, mammoth and men in the New World. *Canadian Journal of Anthropology* 1(1):99–101.

Agenbroad, L. D. 1984 New World mammoth distribution. In *Quaternary Extinctions: A Prehistoric Revolution,* edited by P. S. Martin and R. G. Klein, pp. 90–108. University of Arizona Press, Tucson.

Dibblee, T. W., Jr. 1954 Geology of the Imperial Valley region, California. *California Division of Mines Bulletin* 170(2):21–28.

Graham, R. 1984 Taxonomy of North American mammoths. In *The Colby Mammoth Site—Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming,* edited by G. Frison and L. C. Todd, Appendix 2, Part 1:165–169, University of New Mexico Press, Albuquerque.

Kurtén, B., and E. Anderson 1980 *Pleistocene mammals of North America.* Columbia University Press, New York 442 p.

Madden, C. T. 1980 Earliest dated *Mammuthus* from North America. *Quaternary Research* 13:147–150.

Madden, C. T. 1981 Mammoths of North America. Doctoral Dissertation, Department of Anthropology, University of Colorado, Boulder 271 p.

Maglio, V. J. 1973 Origin and evolution of the Elephantidae. *Transactions of the American Philosophical Society,* New Series 63:1–149.

Remeika, P. 1992 Preliminary Report on the Stratigraphy and Vertebrate fauna of the middle Pleistocene Ocotillo Formation, Borrego Badlands, Anza-Borrego Desert State Park, California. *Abstracts of Proceedings, 6th Annual Mojave Desert Quaternary Research Symposium, San Bernardino County Museum Quarterly* 39(2):25–26.

Remeika, P., and J. R. Pettinga 1991 Stratigraphic revision and depositional environments of the middle to late Pleistocene Ocotillo Conglomerate, Borrego Badlands, Anza-Borrego Desert State Park, California. *AnzaBorrego Foundation Symposium on the Scientific Value of the Desert,* Borrego Springs, California, Abstract 13.

Remeika, P., and G. T. Jefferson 1993 The Borrego Local Fauna: revised basin-margin stratigraphy and paleontology of the western Borrego Badlands, Anza-Borrego Desert State Park, California. In *Ashes, Faults and Basins,* edited by R. E. Reynolds and J. Reynolds, San Bernardino County Museum Association Special Publication 93(1):90–93.

Rymer, M. J. 1991 The Bishop Ash bed in the Mecca Hills. In *Geological excursion in southern California and Mexico,* edited by M. J. Walawender and B. B. Hanna, pp. 388–396, Geological Society of America Annual Meeting Guidebook, San Diego.

Sarna-Wojcicki, A. M., and M. S. Pringle, Jr. 1992 Laser-fusion $^{40}Ar/^{39}Ar$ ages of the Tuff of Taylor Canyon and Bishop Tuff, E. California–W. Nevada. *EOS, Transactions of the American Geophysical Union,* Abstracts to Meetings p. 241.

Sarna-Wojcicki, A. M., H. R. Boweman, C. E. Meyer, P. C. Russell, M. J. Woodward, G. McCoy, J. J. Rowe Jr., P. A. Baedecker, F. Asaro, and H. Michel 1984 Chemical analyses, correlations, and ages of upper Pliocene and Pleistocene ash layers of east-central and southern California. *U.S. Geological Survey Professional Paper* 1293:1–40.

Scheuing, D. F. 1989 The effect of structure on paleomagnetic data collected in complexly deformed terrains: a case study from the San Jacinto Fault Zone, southern California. Manuscript on File, Anza-Borrego Desert State Park, and Lamont-Doherty Geological Observatory 22 p.

Scheuing, D. F., L. Seeber, K. W. Hudnut, and N. L. Bogen 1988 Block rotation in the San Jacinto Fault Zone, southern California. *EOS, Transactions of the American Geophysical Union,* Abstracts to Meetings 69:1456.

Late Pleistocene Faunal Diversity in Ultima Esperanza (Chile): Further Data from Cueva Del Medio

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During the Quaternary, while the Pampean region was a center of sedimentary deposition, erosion processes were predominant in Patagonia (e.g., Ameghino 1889; Pascual et al. 1965). Thus, the record of Patagonian Quaternary vertebrates is restricted almost exclusively to archaeological sites in caves (e.g., Fell, Pali Aike, Las Buitreras, Los Toldos). This record ranges from 12,000 to 10,000 yr B.P. (Nami 1992).

Strictly paleontological sites are scarce and include, in Argentina, Bahía Sanguinetto (southern San Jorge Gulf province of Santa Cruz) (Parodi 1930), and the findings of J. Fernández (pers. comm. 1991) in the department of Ñorquinco (province of Neuquén) in a peat layer dated to between 10,800 and 12,600 yr B.P. In Chile, there have been recent paleontological finds in Cueva del Lago Sofía 4 (Ultima Esperanza) (Canto 1991; Prieto 1991).

Cueva del Medio is located at latitude 51°35′ S and longitude 72°38′ W in Ultima Esperanza, Chile. It is a significant site in the peopling of the southern end of the South American continent. Furthermore, the faunal remains recovered make it a source of paleontological data (see Menegaz and Nami 1992; Nami and Menegaz 1991). Cueva del Medio is exceptional among cave sites for its broad record of the late-Pleistocene fauna. Other sites providing evidence of the fauna of this time span have recently been discovered: Cueva del Lago Sofía 1 (Prieto 1991) and Dos Herraduras Oeste (Borrero et al. 1991).

Excavation of the site began in 1986 and is still in progress. To date, six archaeological expeditions have been conducted; approximately 80 m^2 has been excavated.

Some bone specimens belong to the Paleoindian component, where numerous cultural remains were found (Nami 1987; 1992; in preparation). Other bone remains were found in deeper levels, without cultural associations. The radiocarbon dates obtained by conventional methods for the Paleoindian component are as follows: 9,595 ± 115 yr B.P. (PITT-0244); 9,770 ± 70 yr B.P. (Beta- 40281); 10,310T± 70 yr B.P. (Grn-14913); 10,350 ± 130 yr B.P. (Beta-58105); 10,430 ± 80 yr B.P. (Beta-52522); 10,550 ± 120 yr B.P. (Grn- 14911); 10,930 ± 230 yr B.P. (Beta-39081); 12,290 ± 180 yr B.P. (PITT-0343). Dates obtained by AMS will soon be published; they confirm the above mentioned dates except for the 12,290 ± 180 yr B.P. date.

The faunal analysis of the Paleoindian and deeper levels carried out to date

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has revealed the presence of the following taxa: *Mylodon* (?) *listai*, *Hippidion saldiasi*, *Panthera onca mesembrina*, *Felis* sp., *Dusicyon* cf. *culpaeus*, *Dusicyon* sp., *Dolichotys patagonum* and Rheidae (systematics in Menegaz and Nami 1992). Of importance is the finding of three morphs of camelids, two of which have no extant representatives. The three morphs are: a) *Lama* morphotype *owenii*, which comprises the material corresponding to the known upper size limit of the South American branch of the family; b) *Lama guanicoe*, the remains of which are indistinguishable in form and size from those of the specimens living today in the area; c) *Lama gracilis*, a species recorded for the first time in the area, the remains of which correspond to the known lower limit of the size range of South American camelids. This last species, recently defined (Menegaz et al. 1989), has been identified in other Patagonian sites (e.g., lower levels of Los Toldos) near the Pleistocene-Holocene boundary and in the Pleistocene in the Pampean region (cf. Menegaz et al. 1989).

As a result of the mentioned paleontological findings, in a previous paper we proposed a hypothesis of faunal diversity in Ultima Esperanza during the Pleistocene-Holocene transition (Nami and Menegaz 1991). In the same area, the recent findings of *Megamys* sp. and *Smilodon* sp. in Cueva del Lago Sofia reinforce this hypothesis of diversity. The faunal physiognomy of this area, although still to be characterized in detail, is proposed as distinctive and emerges as different from the Pampean faunal record (see Pascual et al. 1965) and even from that of extra-Andean Patagonia for the same time span (cf. Menegaz et al. 1989).

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References Cited

Ameghino, F. 1889 Contribución al conocimiento de los mamíferos fósiles de la República Argentina. *Actas de la Academia de Ciencias de Córdoba* 6:32–1028, Córdoba.

Borrero, L. A., J. L. Lanata, and P. Cárdenas 1991 Reestudiando cuevas: Nuevas excavaciones en Ultima Esperanza, Magallanes. *Anales del Instituto de la Patagonia* 20:101–110, Punta Arenas.

Canto, J. 1991 Posible presencia de una variedad de Smilodon en el Pleistoceno Tardíos de Magallanes. *Anales del Instituto de la Patagonia* 20:97–99, Punta Arenas.

Marshall, L., A. Berta, R. Hofftetter, R. Pascual, O. A. Reig, M. Bombín, and A. Mones 1984 Mammals and Stratigraphy: Geochronology of the Continental Mammal-bearing. Quaternary of South America. *Paleovetebrata Mam. Extraor.* 1984:1–76.

Marshall, L., and R. Pascual 1978 Una escala temporal radiométrica preliminar de las Edades Mamífero del Cenozoico Medio y Tardío Sudamericano. *Obra del Centenario Museo de La Plata* 5:11–28, La Plata.

Marshall, L., R. Pascual, G. Curtis, and R. Drake 1977 South American Geochronology, Radiometric Time Scale for Middle to Late Tertiary Mammal Bearing Horizons in Patagonia. *Science* 195:1320–1325.

Menegaz, A. N, F. J. Goin, and E. Ortiz Jaureguizar 1989 Analisis morfológico y morfométrico multivariado de los representantes fósiles y vivientes del genero Lama (*Artiodactyla, Camelidade*), sus implicaciones sistematicas, biogeográficas, ecológicas y biocronológicas. *Ameghiniana* 26 (3–4): 153–172.

Menegaz, A., and H. G. Nami 1992 Hallazgos de fauna pleistocénica en el sitio Cueva del Medio: Recursos faunísticos para antiguos sudamericanos. In press: *Estudios Geológicos*, Madrid.

Nami, H. G. 1987 Informe sobre la segunda y tercera expedición en la Cueva del Medio. Perspectivas Arqueológicas para la Patagonia Austral. *Anales del Instituto de la Patagonia* (Serie Ciencias Sociales), 17:71–105, Punta Arenas.

Nami, H. G. 1992 New Assessments on Early Human Occupations in the Southern Cone. En prensa: *Prehistoric Mongoloid Dispersals*, edited by T. Akazawa and E. Szathmary, Oxford University Press.

Nami, H. G. in prep. Cazadores-recolectores del Pleistoceno final en Patagonia Austral y las excavaciones arqueológicas de Cueva del Medio.

Nami, H. G., and A. Menegaz 1991 Cueva del Medio: aportes para el comocimiento de la diversidad faunística hacia el Pleistoceno-Holoceno en Patagonia austral. *Anales del Instituto de la Patagonia* (Serie Ciencias Sociales) 20:117–132, Punta Arenas.

Parodi, I. 1930 Nuevos restos de mamíferos de la fauna pampeana en Patagonia. *Physis* 10:21–34.

Pascual, R., E. Hortega Hinojosa, D. Gondar, and E. Tonni 1965 Las Edades del Cenozoico Mamalífero de la Argentina, con especial atención a aquellas del territorio bonaerense. *Anales de la Comisión de Investigaciones Científicas* 6:165–193, La Plata.

Prieto, A. 1991 Cazadores Tempranos y Tardíos en Cueva del Lago Sofía 1. *Anales del Instituto de la Patagonia* 20:75–96, Punta Arenas.

Woodland Musk Oxen in Oklahoma

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Heavy spring rains in 1992 and 1993 caused local flooding in north central and east central Oklahoma. The runoff quickly swelled and overtaxed several reservoirs managed by the U.S. Army Corps of Engineers. To alleviate steadily building pressure, the Corps released unprecedented volumes of water from Keystone Reservoir on the Arkansas River and from Eufaula Reservoir on the Canadian (Figure 1). These flows flushed extant river channels and cut into bordering flood plains and terraces. In the following months, avocational archeologists and paleontologists recovered artifacts and fossils believed to date to late-Pleistocene times. Among the fossils are numerous mastodon teeth, some mammoth teeth, and occasional remains of what appear to be *Bison antiquus*. We have been striving to record, measure, and photograph these fossils as well as the Paleoindian artifacts. In the process, we were much surprised when a series of skull parts and horn cores attributable to woodland musk oxen came to light. These recent findings led us to compile information on other musk-oxen remains found in the state.

In discussions of species, we have followed McDonald and Ray's (1989) thoughts and recommendations. Potentially 15 different musk oxen are discernible from our review of the literature and of unpublished finds. By far, the majority are in the eastern half of the state (Figure 1). These include nine specimens found in 1992 and 1993 as well as three early historical finds. These latter are discussed by Hay (1924:178–179), and they include the type specimen

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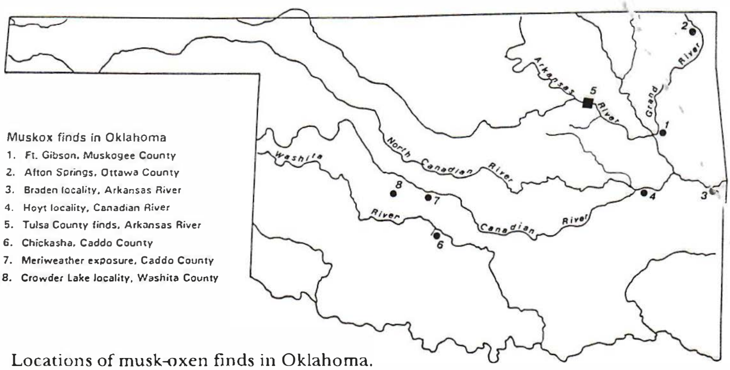

Figure 1. Locations of musk-oxen finds in Oklahoma.

(frontal, horn cores, and occipital) for *Symbos cavifrons* (woodland musk ox), which was collected from a Native American's house near Ft. Gibson in 1851. The other two early finds consist of a molar and atlas (attributed to *S. promptus*), recovered in 1901 by W. H. Holmes at Afton Springs (in what is now Ottawa County; Figure 1) and the occipital-frontal-horn cores (classified as *S. cavifrons*) found along the Arkansas River 23 km upstream from Ft. Smith. This latter find is 50 km east of the Hoyt locality along the Canadian River, where a horn core and two frontal-occipital horn-core sections (one juvenile) were recovered after the recent floods. The Hoyt finds are believed attributable to *Bootherium bombifrons* (Harlan's musk ox) (Dalquest et al. 1994). Parts of six different skulls are now known for the Arkansas River downstream from Keystone Dam. At least one horn core-frontal section is that of a juvenile, whereas the other parts (including one very nice frontal-occipital horn-core specimen) appear to be adults. Preliminary measurements and comparisons are interpreted to indicate that all Tulsa County finds are representative of *B. bombifrons.* A detailed study of the Tulsa County and Hoyt locality finds is being prepared for publication.

Although only three musk-ox finds are known for western Oklahoma, it is noteworthy that they are within 50 km of each other (Figure 1). A frontal-maxilla section is reported for a gravel quarry in a Washita River terrace near Chickasha in Grady County (Stovall and Self 1936). From the unpublished Meriweather exposure (gleyed sediments in the highest terrace south of the Canadian River) in northeastern Caddo County comes a cervical vertebra, which Russell Graham has identified as musk ox. Recently, skull fragments and a horn core identifiable as musk ox reportedly were found in gleyed sediments in northern Washita County. The finds from Caddo and Washita counties are especially intriguing because they come from discrete geologic contexts that are potentially datable. Bone scraps from the Washita County deposit yielded a radiocarbon date of 18,295 ± 270 B.P. (GX- 16061; Kirtland et al. 1991). A bison molar from the Meriweather exposure was subjected to uranium/thorium dating at Southern Methodist University and reportedly (Hofman 1989) yielded an age of 276,000 ± 16,000 years ago (McKinney 203E1). Although these dates seem reasonable given the setting and stratigraphy of the locations, questions can be raised about the reliability of the samples and techniques used for dating. Clearly, however, opportunities exist for refining the chronology and recovering proxy environmental information about musk oxen on the Southern Plains. Much care and interdisciplinary research are needed if these sites are going to contribute substantial information.

Thus far, our preliminary findings support the conclusion that Oklahoma's musk-oxen remains are representative of *Bootherium bombifrons.* We are hopeful of discerning Pleistocene deposits in eastern Oklahoma, where such remains are still in primary contexts. A notable problem at present is attributing post-cranial remains to this species.

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References Cited

Dalquest, W. W., F. B. Stangl, Jr., and D. G. Wyckoff 1994 Pleistocene-Holocene Mammals from Eastern Oklahoma. Unpublished manuscript submitted for the C. S. Churcher festschrift, National Museum of Canada.

Hay, O. P. 1924 *The Pleistocene of the Middle Region of North America and Its Vertebrated Animals.* Carnegie Institute of Washington, Washington, D.C.

Hofman, J. L. 1989 Late Pleistocene and Early Holocene Deposits in Western Oklahoma: Archaeological Implications. Unpublished paper given at the South-Central Section meeting of the Geological Society of America, Arlington, Texas.

Kirtland, H., Jr., J. Dill, and W. Selfridge 1991 Some Late Pleistocene Vertebrates from Western Oklahoma. *Proceedings of the Oklahoma Academy of Science* 71:55.

McDonald, J. N., and C. E. Ray 1989 The Autochthonous North American Musk Oxen Bootherium, Symbos, and Gidleya (*Mammalia: Artiodactyla: Bovidae*). Smithsonian Institution, *Contributions to Paleobiology* 66. Washington, D.C.

Stovall, J. W., and J. T. Self 1936 A New Specimen of Symbos from Chickasha, Oklahoma. *Proceedings of the Oklahoma Academy of Science* 16:74.

The Rud Bison Site: A *Bison Bison Occidentalis* Locale in Western Wisconsin

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The Rud Bison site is located in Rognholt Valley of Buffalo County, Wisconsin. The terrain consists of rolling interfluves and narrow valleys with level floodplains. Rognholt Valley is drained by a perennial stream that has eroded a channel over 2 m into Holocene floodplain deposits. The site was discovered on the Elmer Rud farm in the 1930s when bison elements, including one complete and one partial skull, were exposed by stream erosion. Archival records describe the context as bones embedded in a blue-grey clay beneath 6 feet of peat. Survey during 1992 found additional bison bones at the 1930s locality (Rud I) and another bison-bone deposit (Rud II). The taxonomic assignment to *Bison bison occidentalis* is based on characteristic horn-core morphology (see McDonald 258–259; Wilson 1974). Rud I represents the easternmost known occurrence of *Bison bison occidentalis* in North America (McDonald 1981:85–95).

Rud I

Surveys along the stream channel on the old Rud Farm in April 1992 located a concentration of nearly 100 well-preserved bison elements, including a *Bison bison occidentalis* cranium with a tip-to-tip horn-core spread of 740 mm. The cranium was found in recent stream deposits and recovered along with adjacent exposed bones. Exploratory excavations at Rud I in June 1992 recovered additional faunal specimens, including a partial subadult bison cranium. Bison elements recovered from the stream were not in anatomical order, although some vertebrae and phalanges were clustered.

At least four individual bison are represented at Rud I, based on the two craniums recorded in the 1930s and two craniums recovered in 1992. Bone preservation at Rud I was exceptional. The majority of the Rud I bison elements were intact; some had abrasions that may represent trampling marks. A few bones exhibited "trails" of a marrow-like substance that had seeped out of the ends of long bone shafts. The diaphysis of a broken tibia contained a yellowish mineralized material, with cell structure, that appears to be bone marrow.

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Rud II

Additional survey during June 1992 located the Rud II bone deposit 1 km upstream from Rud I. The recovered Rud II faunal assemblage consisted of a badly broken cranium of a bison and 22 other elements located under slumped sediments that included peat and blue-grey clay. The Rud II assemblage paralleled the excellent bone preservation at Rud I. Examination of erupting molars on a mandible indicate the age of death at 1.6–1.7 years. A stratigraphic profile of the stream bank near Rud II revealed a top-bottom sequence of 10 cm of black silt, 60 cm of peat, 66 cm of black silt, over gray silts. The peat deposits are exposed along much of the surveyed stream, indicating the former existence of a bog that most likely developed during the early to middle Holocene.

Potential for Megafauna Finds

The Rud I and II bison finds attest to the high potential for late-Pleistocene/early-Holocene megafauna finds in similar stream valley settings in western Wisconsin. Many of this region's drainages have peat deposits underlain by "blue-grey" clays, and other megafauna finds, including mastodon, have been associated with these settings (Boszhardt et al. 1993). It is likely that these ponds served as watering holes for late-Pleistocene and early- to middle-Holocene mammals. Bison bone beds in similar settings in Polk County, Wisconsin, and Clearwater County, Minnesota, appear to be localities where humans killed and butchered *Bison b. occidentalis* (Eddy and Jenks 1935:535; Palmer 1954:313–319; Pond 1937:51–53; Shay 1971). Although no evidence of human activities has yet been associated at Rud, Rognholt Valley has the potential to produce a human-bison association.

References Cited

Boszhardt, R. F., J. L. Theler, and D. G. Wilder 1993 *Megafauna of Western Wisconsin.* Reports of Investigations No. 161, Mississippi Valley Archaeology Center, University of Wisconsin–La Crosse.

Brown, C. E. n.d. Unpublished manuscripts. Archives Division, State Historical Society of Wisconsin.

Eddy, S., and A. E. Jenks 1935 A Kitchen Middens with Bones of Extinct Animals in the Upper Lakes Area. *Science* 81, No. 209.

McDonald, J. H. 1981 *North American Bison: Their Classification and Evolution.* University of California Press.

Palmer, H. A. 1954 A Review of the Interstate Park, Wisconsin Bison Find. *Iowa Academy of Science,* 61:131–319.

Pond, A. W. 1937 Wisconsin Joins the Ranks of Oldest Inhabited Areas in America. *The Wisconsin Archeologist* 17(3):51–54.

Shay, T. C. 1971 *The Itasca Bison Kill Site: An Ecological Analysis.* Minnesota Historical Society.

Late Quaternary Stratigraphy, Paleontology, and Archaeology of the Sheep Rock Spring Site (24JF292), Jefferson County, Montana

Michael C. Wilson and Leslie B. Davis

The Sheep Rock Spring site, 24JF292, Jefferson Co., Montana (NW1/4 SW1/4 SE1/4 Sec. 17, T2N, R3W; elev. 1,637 m), is a multicomponent open campsite in alluvial/colluvial deposits along Sheep Creek, on the south slope of Bull Mountain. Buried cultural deposits were exposed in 1980 in a cut for a spring access road, and the Montana Department of State Lands requested an evaluation as to National Register eligibility.

Testing by GCM Services, Inc., demonstrated an extensive occupation area (Herbort 1985). Correlation of profiles was made difficult by the record of cutting and filling on the tributary alluvial fan that dominates the site. Mazama tephra (ca. 6,850 B.P.) was identified in some sections. Backhoe trenching of the fan revealed a rock-lined, basin-shaped hearth 120–140 cm below surface, associated with bison (*Bison* sp.) limb bones and shatter, and the proximal end of a large bifurcate-based projectile point or knife. Hearth charcoal was dated to 9,420 ± 220 yr B.P. (Beta-12887). Dori Passman, Department of State Lands, later collected a lanceolate projectile point that had evidently eroded from within the upper 1.3 m of the roadcut. This point closely resembles small- to medium-sized Ruby Valley points as defined at the Barton Gulch site (24MA171), 65 km to the south in the Ruby River drainage, where the Alder complex has been radiocarbon dated to 9,410 ± 140 yr B.P. (Davis et al. 1989).

In 1993, a 17-day geoarchaeological evaluation of the site focused upon distal fan deposits and creek alluvium. Detailed profiling of strata demonstrated strong age gradients laterally and vertically. A 5.2-m-deep pit revealed seven occupation surfaces, as yet undated. Pelican Lake projectile points from two buried surfaces midway down the profile document late middle-Prehistoric-period occupations, ca. 3,000 to 1,800 yr B.P. Deposits beneath the fan include, from oldest to youngest, (1) a bouldery diamict from a rock avalanche that originated in the valley wall opposite Sheep Rock, (2) a cobbly debris flow down Sheep Creek valley, and (3) stratified channel and floodplain alluvium with several paleosols. A bulk sample from a paleosol at the top of this alluvium and beneath distal fan sediments gave a date of 5,430 ± 90 B.P. (Beta-65824); the soil displayed an ochric epipedon and probably formed over a period of 1,000 or fewer years. Occupation debris, including flakes and butchered bones of very large bighorn sheep (*Ovis canadensis* ssp., cf. *O. c. catclawensis*), was found about 60 cm below the top of the alluvium. An AMS date on bone collagen of 9,380 ± 50 yr B.P. (Beta-65825) is virtually identical to the hearth date and suggests that this alluvium is the lateral-facies equivalent of part of the fan sequence.

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A significant late-Pleistocene paleontological assemblage was discovered in association with the underlying paleosurface of the avalanche diamict. The bones postdate the slide event and were buried when unstable debris on slide boulders slumped or was washed into the spaces between boulders. Elements attributable to cheetah (*Acinonyx trumani*), horse (*Equus* sp.), camel (*Camelops* sp.), and large mountain sheep (*Ovis canadensis catclawensis*) have been recovered. There is no evidence of a cultural association for this material; however, its probable late-Pleistocene age leaves open such a possibility, as will be pursued in future excavations. This is the first occurrence of *A. trumani* in an open (i.e., non-cave or rockshelter) site.

The mountain-sheep humerus dated to 9,380 yr B.P. is close in size to Pleistocene material, suggesting that size reduction was still underway in the early Holocene. Dwarfing in sheep could be similar to the gradual reduction seen in bison (Wilson 1980), rather than a brief, rapid change (Harris and Mundel 1974; Gilbert and Martin 1984).

The dates from Sheep Rock Spring, ca. 9,400 yr B.P., are essentially contemporaneous with those from several Paleoindian contexts elsewhere in the Northern Rockies of Montana and Wyoming, and have important implications for documenting cultural diversity on a regional scale. Three charcoal dates from Alder complex earth-ovens at Barton Gulch average 9,400 yr B.P. An AMS age of 9,390 ± 90 yr B.P. dates the bottom of the "Cody floor" (Level 3, apparently Scottsbluff) at Mammoth Meadow I (24BE559), in southwestern Montana (Bonnichsen et al. 1992). Level 1 at Myers-Hindman (24PA504) in the Yellowstone valley was dated to 9,400 ± 200 yr B.P. (Lahren 1974) on bone associated with varied point types, including Ruby Valley points (Alder complex). A bone-apatite carbon age of 9,340 ± 120 yr B.P. for stratum I at the MacHaffie site (24JF4), west-central Montana (Davis et al. 1991), should date a pre-Folsom or Folsom complex occupation and appears unreliable. An age on bulk natural charcoal of 9,290 ± 120 yr B.P. dates an occupation atop Unit B at the Indian Creek site (24BW626), southwest of MacHaffie (Davis and Greiser 1992). In Wyoming, Layer 4 at Mummy Cave (48PA201) (Wedel et al. 1968; McCracken et al. 1978) yielded an age of 9,230 ± 150 yr B.P. for an apparent Alder complex occupation. The Medicine Lodge Creek site (48BH499) yielded a date of 9,360 ± 380 yr B.P. for an occupation bearing bifurcate-based points (Frison 1976). These examples of possibly contemporaneous Paleoindian archaeological complexes within a limited geographic area provide important clues as to the coexistence, ca. 9,400 yr B.P., of Northern Rockies hunter-gatherer groups who may or may not have been historically related. The scope and range of adaptive variability may have been greater than is yet understood, as will be assessed by further investigation.

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References Cited

Bonnichsen, R., M. Beatty, M. D. Turner, J. C. Turner, and D. Douglas 1992 Paleoindian Lithic

Procurement at the South Fork of Everson Creek, Southwestern Montana: A Preliminary Statement. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford, and J. S. Day, pp. 285–321. Denver Museum of Natural History and University Press of Colorado.

Davis, L. B., S. A. Aaberg, and W. P. Eckerle 1989 Montane Paleoindian Occupation of the Barton Gulch Site, Ruby Valley, Southwestern Montana. *Current Research in the Pleistocene* 6:7–9.

Davis, L. B., J. P. Albanese, L.S. Cummings, and J. W. Fisher, Jr. 1991 Reappraisal of the MacHaffie Site Paleoindian Occupational Sequence. *Current Research in the Pleistocene* 8:17–20.

Davis, L. B., and S. T. Greiser 1992 Indian Creek Paleoindians: Early Occupation of the Elkhorn Mountains' Southeast Flank, West-Central Montana. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford, and J. S. Day, pp. 225–283. Denver Museum of Natural History and University Press of Colorado.

Frison, G. C. 1976 The Chronology of Paleo-Indian and Altithermal Cultures in the Bighorn Basin, Wyoming. In *Cultural Change and Continuity: Essays in Honor of James B. Griffin*, edited by C. E. Cleland, pp. 147–202. Academic Press, New York.

Gilbert, B. M., and L. D. Martin 1984 Late Pleistocene Fossils of Natural Trap Cave, Wyoming, and the Climatic Model of Extinction. In *Quaternary Extinctions*, edited by P. S. Martin, and R. G. Klein, pp. 138–147. University of Arizona Press, Tucson.

Harris, A. H., and P. Mundel 1974 Size Reduction in Big Horn Sheep (*Ovis canadensis*) at the Close of the Pleistocene. *Journal of Mammalogy* 55:678–680.

Herbort, D. 1985 *Cultural Resource Investigation and Assessment of the Golden Sunlight Mines/State of Montana Land Exchange.* Report by GCM Services, Inc., Butte, for Golden Sunlight Mines, Inc., Whitehall, Montana.

Lahren, L.A. 1976 *The Myers-Hindman Site: An Exploratory Study of Human Occupation Patterns in the Upper Yellowstone Valley from 7000 B.C. to A.D. 200.* Unpublished Ph.D. Dissertation, University of Calgary.

McCracken, H., W. R. Wedel, R. Edgar, J. H. Moss, H. E. Wright, Jr., W. M. Husted, and W. Mulloy 1978 *The Mummy Cave Project in Northwestern Wyoming.* Buffalo Bill Historical Center, Cody, Wyoming.

Wedel, W. M., W. Husted, and J. Moss 1968 Mummy Cave: Prehistoric Record from the Rocky Mountains of Wyoming. *Science*, 160:184–186.

Wilson, M. C. 1980 Morphological Dating of Late Quaternary Bison on the Northern Plains. *Canadian Journal of Anthropology* 1:81–85.

Paleoenvironments: Geosciences

Moraines in the Chillón Valley, Central Perú: Evidence for Pleistocene Tropical Glaciers 1000 m above Sea Level

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The Checta petroglyph site, at Quebrada Alcaparrosa in the Chillón River valley, is located at 11°41′ S, 76°53′ W, north of Lima, Perú (Figures 1a, 1b). It is Site PV46-951b in Silva's (1994) survey of archaeological sites in the Chillón Valley. Petroglyphs there (Guffroy 1979) are associated with a habitation site which Silva (1994) believes is no older than 2,000–3,000 years.

The petroglyphs are found along the upper ridge of a coherent sedimentary deposit on the east side of Quebrada Alcaparrosa (Figure 1c). Previously, this ridge was called an "alluvial terrace" (Martinez-Vizcardo 1959; Palacios-Montoya et al. 1992; Torres-Guerra 1987). The description of the sediments as alluvial was accepted by archaeologists and anthropologists working in the Perúvian coastal strip.

During a recent visit to the site with archaeologists from the Museo de Arqueología y Antropología, the author found that the sedimentary deposits in Quebrada Alcaparrosa are dominantly glacial. The "terrace" is in fact a lateral moraine, formed by movement of a valley glacier down the quebrada (Figure 1c). The upper ridge is formed from two lateral moraines feeding out of side valleys into the quebrada. These moraines rest upon earlier glacial deposits. Thus, in Quebrada Alcaparrosa, there is evidence for two to three advances and recessions.

The glacial deposits are exposed on the east side of the quebrada, while a modern intermittent stream channel hugs the western side. Polished blocks of country rock (Coastal Batholith, granodiorite and diorite) are exposed in the bottom of the stream channel, and these blocks often bear striations parallel to the trend of the quebrada.

The stratigraphy of the glacial deposits is best seen from within the stream channel. Directly above the bedrock there is a section 5 to 7 m thick of reworked

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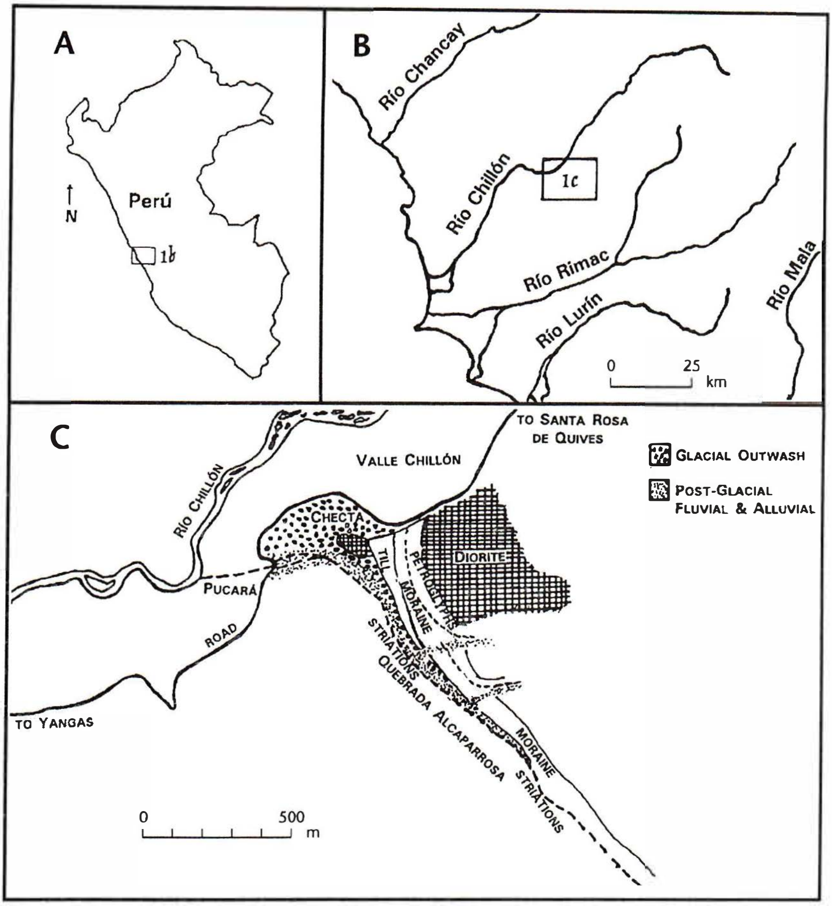

Figure 1. **A,** Reference map of Perú. Box shows location of Figure 1B. **B,** Map showing coastal river valleys in and near Lima. Box shows location of Figure 1C. **C,** Geologic map of Checta and Quebrada Alcaparrosa.

glacial sediments, now dominantly fluvial. Above the bench of reworked sediments is a glacial sequence: a lower till (Till A), a moraine (Moraine A), an upper till (Till B), and an upper moraine (Moraine B).

The glacial sediments range in size from very fine clay particles to boulders 3–4 m in diameter. The fragments are primarily angular with a portion subangular. There are thick individual layers in outwash exposures near the mouth of the quebrada, which have a poorly defined turbidite stratigraphy.

On the west side of the quebrada, there are a few small exposures of glacial stratigraphy that have not been completely eroded. The base of the sequence there appears to be a kame deposit, which is overlain by a till (equivalent to Till A) and a moraine (equivalent to Moraine A).

The sediments in the quebrada record a sequence of events, including the transitions from glacial to glacio-fluvial to fluvial to alluvial conditions. The glacial sequence has been eroded on the western side of the quebrada, leading to the deposition of clearly fluvial, size-sorted deposits, which are now being reworked. On the east slope of the quebrada, the glacial sediments are cut by arroyos filled with alluvium derived both from the glacial sediments and from the hillsides above.

Traditionally, geologists have only reported the presence of glacial deposits at elevations above 3000 m in the Andes (Clapperton 1972; Mercer and Palacios 1977). However, the moraines in Quebrada Alcaparrosa are evidence that glaciers in the tropics occurred at much lower elevations than previously thought.

There is a previously unexplained time progression of human habitation in the coastal strip of Perú: the oldest settlements (10,000–12,000 yr B.P.) are found close to the present-day coastline, and the age of initial habitation is progressively younger with altitude (Marcus and Silva 1988). Our observations indicate that the habitation pattern in the coastal valleys of Perú was climate-controlled, and it is unlikely that any major sites older than approximately 12,000 years can be found at elevations higher than about 500 m.

If glaciers were present at lower elevations during the last ice age, even medial drainages of the coastal river valleys would have been uninhabitable until after the glaciers receded. Recession apparently began 10,000–12,000 yr B. P. (Clapperton 1972), but chronological data are sparse. In Quebrada Alcaparrosa, the time of last recession represents a maximum age for the formation period of the petroglyphs and initial habitation of this part of the Chillón valley.

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References Cited

Clapperton, C. M. 1972 The Pleistocene moraine stages of west-central Perú. *Jour. Glaciology* 11:255–263.

Guffroy, J. 1979 Les Petroglyphes de Checta, valleé du Chillón, Perú, Thése pour le Doctorat, Université de Paris, 2 Volumenes, Paris, 540 pp.

Marcus, J., and J. E. Silva 1988 Part I, The Chillón Valley "Coca Lands", Archaeological Background and Ecological Context. In *Conflicts Over Coca Fields in XVIth-Century Perú*, by M. Rostworowski de Diez Canseco, Mem. Museum Anthro. U. Michigan 21, Ann Arbor MI, 1–31.

Martinez-Vizcardo, M. 1959 Estudio Geológico Preliminar de la Zona Oeste de Santa Rosa de Quives (Provincia de Canta). Unpublished Thesis, Eng. Geol., Universidad Nacionál Mayor de San Marcos, Lima - Perú, 52 pp + maps + photos.

Mercer, J. H., and O. Palacios M. 1977 Radiocarbon dating of the last glaciation in Perú. *Geology* 5:600–604.

Palacios-Moncayo, O., J. Caldas-Vidal, and C. Vela-Velásquez 1992 Geología de los Cuadrángulos de Lima, Lurín, Chancay y Chosica. *Boletin No. 43, Serie A: Carta Geológica Nacionál*, Instituto Geológico Minero y Metalúrgico del Perú, Lima - Perú, 163 pp.

Silva, J. in progress 1994 Ph.D. Dissertation. Anthropology, University of Michigan, Ann Arbor, Michigan.

Torres-Guerra, J. A. 1987 Estudio Geodinámico entre Yangas y Nuevo San José (curso medio de Río Chillón). Unpublished Thesis, Eng. Geol., Universidad Nacionál Mayor de San Marcos, Lima - Perú, 186 pp + maps, photos.

Archaeological Implications of Changing Levels of Yellowstone Lake, Yellowstone National Park, Wyoming

Kenneth L. Pierce, Kenneth P. Cannon and George M. Crothers

Compliance-mandated studies were conducted in 1992–93 on the "Fishing Bridge Peninsula" at sites less than 10 m above Yellowstone Lake (Figure 1). This area had dynamic post-glacial landform and occupation changes in the last 10,000 years (Cannon et al. 1994; Pierce et al. 1993). The peninsula is composed of Pleistocene deltaic sediments, late-Pleistocene and Holocene shoreline deposits of sand and gravel, and Holocene aeolian sands.

Prehistoric uplift and subsidence patterns are more than an order of magnitude larger and longer than those based on historic surveys between 1923 and 1984, which show 1 m of doming within the 0.6 Ma Yellowstone caldera, with subsidence after 1985 (Dzurisin and Yamashita 1987; Pelton and Smith 1979). Explanations proposed for such inflation and deflation include magma intrusion, tectono-magmatic interaction, and—our favored mechanism—geothermal sealing with pressure buildup followed by cracking and pressure release (Dzurisin et al. 1990; Fournier 1989). The following history integrates geologic and archaeological observations for these changing lacustrine and riverine levels and landforms.

The current uplift has backflooded the Yellowstone River forming a 5-km-long pool from the bedrock threshold at Le Hardy Rapids upstream to Yellowstone Lake. Gravels are locally submerged beneath 4 m of mud as old as 2,700 yr B.P. We estimate about 4.5–6.5 m of tilting for a 4-km reach, based on 2.5 m of submergence of river gravels (estimated paleoriver depth = 2 m) and 2–4 m of back tilt of gravels (estimated depositional river gradient = 0.5 to 1 m/km). In addition, submerged shorelines near the lake outlet (Hamilton and Bailey 1990) and drowned valleys to the southwest are both graded to a lake about 5 m lower at 2,800 yr B.P.

The culmination of the next (second) older cycle may be represented by beach deposits within 1 m of the present lake, where a weakly developed soil and mid-Holocene artifacts suggest an age of 4,000–5,000 yr B.P.

The third(?) older cycle is recorded by an S-shaped meander 0–3 m above the present Yellowstone River. A spit was later built across the meander (Meyer and Locke 1986), and shorelines cut into it. Backflooding of the once vigorously flowing river was underway 8,200 yr B.P. Using the same assumptions as for the current cycle, 5–7 m of tilting occurred over 4-km distance. This backflooding cycle correlates approximately with the Museum shoreline at Fishing Bridge, which is older than 6,800 ± 90 yr B.P. (Beta-65467, CAMS-8670) and 6,680 ± 80 yr B.P. (Beta-65468, CAMS-8671).

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The fourth, fifth, and sixth cycles are suggested by three higher river terraces that formed after deglaciation about 15,000 yr B.P. The river terrace of the fourth(?) cycle grades to the Hamilton Store shoreline, which is older than 8,940 ± 60 yr B.P. (Beta-65466, ETH-8669). It was occupied by people using Cody Complex artifacts, 8,750 and 10,060 yr B.P. (Frison 1991:Table 2.2).

Near Fishing Bridge, Meyer and Locke (1986) show that the 9,000-year-old Hamilton Store shoreline is downwarped 3 m (we surveyed 1.8 m) and the Museum shoreline (ca. 7,000 yr B.P.) is horizontal. An offshore graben trends northward towards Fishing Bridge, but no fault scarps are apparent onshore. Local faulting or related deformation near Fishing Bridge seems unlikely because the 7,000-yr-old Museum shoreline is undeformed.

The backflooded reach of the Yellowstone River spans only the upper fourth of the historic doming (Dzurisin and Yamashita 1987; Pelton and Smith 1979). If prehistoric doming followed this century's pattern, then *total* doming since 2,700 yr B.P. would be four times that determined for the 4-km reach, or about 20 m. For the third(?) older backflooding cycle, interpretation is complicated by downwarping of the slightly older Hamilton Store shoreline and unrecognized onshore faulting; nevertheless, the backflooding of a previously vigorously flowing Yellowstone River was the same as that which occurred 5,000 years later, and therefore seems also attributable to doming of a similar amplitude (20 m).

Native American visitors to the Fishing Bridge Peninsula (Figure 1) near the Pleistocene-Holocene transition probably encountered landforms similar to

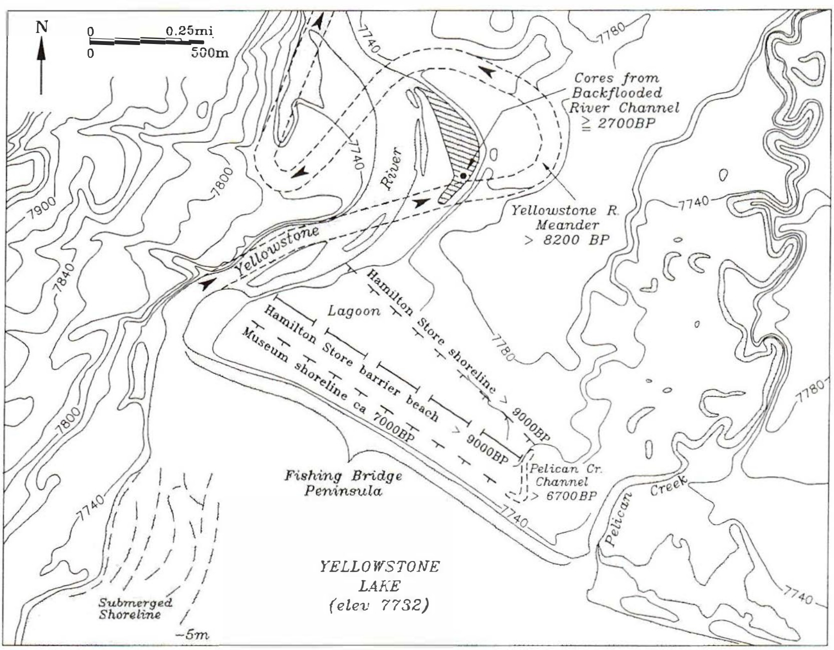

Figure 1. Map of Fishing Bridge peninsula area showing shorelines and beaches of Yellowstone Lake, some older courses of Yellowstone River, and contours (in feet above mean sea level).

those at the mouth of Pelican Creek. An active barrier beach was built at the Hamilton Store shoreline, forming a shallow lagoon behind it. Several spits also extended westward into the lagoon. North from lagoon shoreline, aeolian sand partially buried older beach deposits.

Generous funding for this project was provided by the National Park Service, Yellowstone National Park and the Federal Highway Works Administration. We appreciate the supportof F. A. Calabrese and Doug Scott of the Midwest Archeological Center, and Ann Johnson and Adrienne Anderson of the Rocky Mountain Regional Office. John Andresen critically reviewed this document, and Carrol Moxham drafted Figure 1. We would also like to extend our gratitude to Meyer Rubin for some of the radiocarbon dates, Grant Meyer for participating in field discussions, Dan Dzurisin for providing present river-gradient data, and Wayne Hamilton for his insights.

References Cited

Cannon, K. P., G. M. Crothers, and K. L. Pierce 1994 Archaeological Investigations Along the Fishing Bridge Peninsula, Yellowstone National Park, Wyoming: The Archaeology, Geology, and Paleoenvironment. Manuscript on file at the Midwest Archaeological Center, Lincoln, Nebraska.

Dzurisin, D., and K. M. Yamashita 1987 Vertical Surface Displacements at Yellowstone Caldera, Wyoming, 1976–1986. *Journal of Geophysical Research* 92(13):13,753–13,766.

Dzurisin, D., J. C. Savage, and R. O. Fournier 1990 Recent Crustal Subsidence at Yellowstone Caldera, Wyoming. *Bulletin of Volcanology* 52:247–270.

Fournier, R. O. 1989 Geochemistry and Dynamics of the Yellowstone National Park Hydrothermal System. *Annual Reviews of Earth and Planetary Sciences* 17:13–53.

Frison, G. C. 1991 *Prehistoric Hunters of the High Plains*. Second Edition. Academic Press, New York.

Hamilton, W. L., and A. L. Bailey 1990 Holocene Deformation History of the Yellowstone Caldera at Yellowstone Lake Inferred from Abandoned Shorelines and Sediments. Report 90-3, Yellowstone Physical Science Laboratory, Division of Research, Yellowstone National Park, Wyoming.

Meyer, G. A., and W. W. Locke 1986 Origin and Deformation of Holocene Shoreline Terraces, Yellowstone Lake, Wyoming. *Geology* 14:699–702.

Pelton, J. R., and R. B. Smith 1979 Recent Crustal Uplift in Yellowstone National Park. *Science* 206:1179–1182.

Pierce, K. L., K. P. Cannon, G. M. Crothers, G. Meyer, and M. Rubin 1993 Backflooding Upstream from the Resurgent Some of the 0.6 Ma Yellowstone Caldera-Two Backflooding Cycles in the Last 8,000 Years (abs.). *Eos* 74(43):592.

Special Focus: Beringia

Early Cultural Complexes in Southwestern Alaska

Robert E. Ackerman

Spein Mountain Site (BTH 062-065)

Initial testing of the site was conducted in 1979 as part of an archaeological survey, supported by the National Geographic Society, in the western foothills of the Kuskokwim Mountains. In 1992, a full-scale excavation was supported by the Arctic Social Science Program of the National Science Foundation. The site consists of four locations along a long ridge adjacent to the Kisaralik River. The major effort was spent excavating in the area of 063, the main encampment area.

The site is a single component buried within a loess deposit that rests on shattered regolith. Analysis of the lithic debris revealed that cobbles were brought up from the river bank to the ridge and reduced in the production of bifacial tools. Out of an inventory of 4,279 lithic items, 180 (4.2%) fall into the tool-form category (projectile points, gravers, scrapers, bifacial preforms, etc.) while the remaining 4,099 items are workshop debris. The dominant tool forms were lanceolate projectile points, followed by bifacial preforms, bifacial adze blades, gravers or notches on flakes, and scrapers. Many of the projectile points were snapped off above the haft area, indicating an in-camp replacement of the broken points. Some points with the tips snapped off were resharpened in the haft and then discarded later at camp.

The large amount of bifacial reduction flakes as well as small retouch flakes indicates on-site projectile-point production, resharpening, rehafting and discard of broken points at location 063, which probably served as the base camp during the hunting season. A soil sample from a pit feature towards the center of location 063 contained minute flecks of charcoal that provided an age of 10,050 ± 70 yr B.P. (Beta-64471/CAMS -8281). Pollen analysis of sediment taken from a pit feature revealed an abnormally high amount of grass pollen (*Poaceae* 85.8 %) (P. J. Mehringer, Jr., pers. comm. 1993), suggesting that the pit was lined with grass. Other species in the pollen spectrum suggest an alpine tundra with shrubs but no tree forms. Today, both white and black spruce are

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present in the Kisaralik River valley. The pollen data indicate that the site was occupied towards the end of the birch zone (Ager 1982; Short et al. 1993) but prior to the expansion of alder and spruce into the area. This is supported by the radiocarbon date of 10,050 yr B.P.

The Spein Mountain complex, with the emphasis on lanceolate points and the exclusion of a microblade technology, is comparable to the Mesa site complex in north central Alaska (Kunz 1982) and the Nenana complex in central Alaska (Powers et al. 1983; Hoffecker et al. 1993). Recent dates in excess of 11,000 yr B.P. for sites with microblades (C. Holmes, pers. comm. 1993) indicate that the early lanceolate-to-ovate projectile-point complex without microblades and the reportedly later microblade industries of the Denali complex are likely contemporary cultural complexes that derive from rather different cultural traditions.

Cave 1, Lime Hills

In 1993, with field support provided by the Alaska Division of Geological & Geophysical surveys (DGGS), we tested a limestone cave, discovered by Tom Bundtzen (DGGS) in 1992 in the Lime Hills region of southwestern Alaska. In the upper 50 cm of the cave sediments we recovered an antler base of a wide point, a base-to-midsection fragment of a bone arrowhead with opposing slots for microblades, a microblade fragment, and a stone adze head. Dates of 9530 ± 60 yr B.P. (Beta 67667/CAMS-9896), 8480 ± 260 yr B.P. (WSU 4504), 8480 ± 190 yr B.P. (WSU 4505), and 8150 ± 80 yr B.P. (Beta 67668/CAMS-9897) were obtained for this occupation level. The artifacts appeared to be similar to those of the Denali complex (West 1967, 1981) noted at our other sites. The lower sediments from 50 cm to over 1 m in depth contained faunal remains of caribou, bison, possibly bear, fox, porcupine, ground squirrel, hare, and several types of microtine rodents (C. Gustafson, pers. comm. 1993). Two caribou bones, dating 13,130 ± 180 yr B.P. (Beta 67671) and 15,690 ± 140 yr B.P. (Beta 67669), may have been altered by humans. A bison astragalus dated at 27,950 ± 560 yr B.P. (Beta 67670) was obviously a bone brought into the cave from a fossil locality. Though still tenuous, the lower levels of cave 1 suggest an earlier human presence in southwestern Alaska than had been anticipated and require further study.

References Cited

Ager, T. 1982 Vegetational History of Western Alaska During the Wisconsin Glacial Interval and the Holocene. In *Paleoecology of Beringia*, edited by R. M. Hopkins, J. V. Matthews, Jr. , C. E. Schweger, and S. B. Young, pp. 75–93. Academic Press, New York.

Hoffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–53.

Kunz, M. K. 1982 The Mesa Site: An Early Holocene Hunting Stand in the Iteriak Valley, Northern Alaska. In, Archaeological Investigations by the U. S. Geological Survey and the Bureau of Land Management in the National Petroleum Reserve in Alaska, edited by E. S. Hall, Jr. and R. Gal. *Anthropological Papers of the University of Alaska* 20(1–2):113–122.

Powers, W. R. , R. D. Guthrie, and J. F. Hoffecker 1983 Dry Creek: Archeology and Paleoecology of a Late Pleistocene Alaskan Hunting Camp. Report submitted to the National Park Service. Contract CX-9000-7-0047.

Short, S. K., S. A. Elias, C. F. Waythomas, and N. E. Williams 1992 Fossil Pollen and Insect Evidence for Postglacial Environmental Conditions, Nushagak and Holitna Lowland Regions, Southwest Alaska. *Arctic* 45(4):381–392.

West, F. H. 1967 The Donnelly Ridge Site and the Definition of an Early Core and Blade Complex in Central Alaska. *American Antiquity* 32(3):360–382.

West, F. H. 1981 *The Archaeology of Beringia.* Columbia University Press, New York.

Late-Pleistocene and Early-Holocene Vegetation of Beringia: Implications for Archaeological Interpretations

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The linkage of variations in paleoenvironmental data and artifact assemblages has been a common theme in interpretations of the cultural history of Alaska (e.g., Anderson 1968; Giddings 1952; Hoffecker et al. 1993; Holmes 1975). This intertwining of archaeological and paleoenvironmental data is particularly understandable in the Arctic, where resource availability and diversity are relatively low and closely related to climatic and vegetational factors (e.g., Dunbar 1968; Pruitt 1960). Some of the most dramatic changes in Beringian environments occurred during the transition from full-glacial to modern climatic conditions c. 14,000 to 6,000 yr B.P. Rapidly changing vegetational associations and their consequent impact on the distribution and numbers of subsistence resources (e.g., Lozhkin 1992) probably had the most direct effect on human activities in post-glacial Beringia. Little is known about the population histories of terrestrial and marine mammals during this period, but research over the last ten years has notably improved understanding of past vegetational variations within Eastern Beringia (Alaska) and parts of Western Beringia (northeastern Siberia; Anderson and Brubaker 1993; Lozhkin et al. 1993).

The effects of post-glacial climatic amelioration on the vegetation are first evident in northwestern Alaska, where a mesic *Betula nana/glandulosa* (birch) shrub tundra was established c. 14,000 yr B.P. The presence of heaths and *Sphagnum* moss suggests that tussock formation may have been widespread in areas of intermediate drainage. Herb-dominated full-glacial tundra continued

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in areas of eastern and southwestern Alaska (Hu unpublished data) and in the upper Kolyma region of northeastern Siberia. *Betula* shrub tundra was not established in these areas of Alaska until c. 12,500 to 12,000 yr B.P. In eastern Alaska, the absence of heath pollen and *Sphagnum* spores implies the presence of a dry-shrub community, perhaps similar to the tall *B. glandulosa* tundra currently occupying well-drained sites of the Alaska Range foothills. Although a *Betula-Alnus* (alder) shrub community briefly existed in the upper Kolyma region c. 12,500 to 12,000 yr B.P., an exclusively *Betula* shrub tundra never dominated the landscape.

The first forests were established on both sides of Bering Straits at c. 11,000 yr B.P., although *Populus* (poplar) pollen occurs as early as 14,000 yr B.P. in northwestern Alaska. *Populus* (probably *P. balsamifera*, cottonwood) formed gallery forests along rivers draining the southern Brooks Range and also occurred as clonal stands on south-facing, well-drained hillslopes (Anderson et al. 1988). In interior Alaska, however, these trees may have formed more extensive forests (Hu et al. 1993). Unforested mid to low elevations throughout Alaska continued as *Betula* shrub tundra. In southwestern Alaska, *Artemisia* (wormwood) and graminoids (key elements of the full-glacial vegetation) populated higher elevation sites, with shrub *Betula* and *Populus* restricted to mid to low elevations. In western Beringia, shrub tundra continued as the dominate vegetation in southern Chukotka (Lozhkin, unpublished data) and *Larix* (larch) forests established at lower elevations in the upper Kolyma region.

Between 10,000 and 9,000 yr B.P., *Picea glauca* (white spruce) invaded eastern Alaska, reaching the south-central Brooks Range, upper Kuskokwim drainage, and northwestern foothills of the Alaska Range by 8,500 yr B.P. These forests, perhaps including *Populus* and *Betula papyrifera* (tree birch), occurred in well-drained lowland soils and on south-facing slopes. In northwestern Alaska, *Alnus* shrubs first appeared at this time and began their eastward migration, whereas in southwestern Alaska *Populus*/ shrub *Betula*/ herbaceous communities characterized the regional vegetation. Modern *Larix-Pinus pumila* f (dwarf stone pine) forests established in the upper Kolyma region c. 9,500 yr B.P. In contrast, the widespread appearance of the modern Alaskan *P. mariana–P. glauca* (black spruce) forests did not occur until c. 6,000 yr B.P.

Paleoenvironmentally based explanations of Beringian prehistory often presume that the composition of the late-glacial and early-Holocene vegetation communities were similar to today. However, the above vegetation history illustrates that the Beringian plant communities did not migrate intact from one or more refugia, but rather that the major taxa responded individually to changing climatic conditions. Such behavior resulted in considerable variation in spatial patterns and times of plant establishment across Beringia and cautions against a strictly uniform approach when interpreting archaeological data within a paleoenvironmental framework.

If the paleovegetational record is a reliable gauge, it is likely that the distribution, abundance, and availability of prey species that were focal for human forgers differed significantly from their present and ethnohistorical settings. Furthermore, the geographic distribution of archaeological assemblages (Ackerman 1992; Dixon 1993; Hoffecker et al. 1993; Morlan 1987; West 1981) might argue that regional variations in tool kits and lithic technology ultimately reflect adaptations to equivalent-scale variations in vegetation, climate, and/or subsistence resources, rather than indicating different episodes of human migration as previously suggested (Ackerman 1992; Dixon 1993; Hoffecker et al. 1993). Yet historical processes (i.e., culture transmission, human migration) cannot be excluded a priori as an important source of assemblage variability, because artifacts reflect the interaction between both cultural information and the environment. Other regional factors, such as the distribution of toolstone sources (Bamforth 1986), may also be expected to have an affect on the structure of lithic technologies. All these factors suggest that explanations of human arrival in Eastern Beringia that rely on single-variable environmental causes are clearly too simplistic (e.g., Hoffecker et al. 1993) and that it is time for Beringian archaeologists to form more sophisticated models that incorporate historical processes with current paleoenvironmental thinking.

References Cited

Ackerman, R. E. 1992 Earliest Stone Industries on the North Pacific Coast of North America. *Arctic Anthropology* 29(2):18–27.

Anderson, D. D. 1968 A Stone Age Campsite at the Gateway to America. *Scientific American* 218(6):24–33.

Anderson, P. M., and L. B. Brubaker 1993 Vegetation History of Northcentral Alaska: A Mapped Summary of Late Quaternary Pollen Data. *Quaternary Science Reviews* 12. In press.

Bamforth, D. 1986 Technological Efficiency and Tool Curation. *American Antiquity* 51(1):38–50.

Dixon, E. J. 1993 *Quest for the Origins of the First Americans.* University of New Mexico, Albuquerque, NM.

Dunbar, M. J. 1968 *Ecological Development in Polar Regions.* Prentice Hall, NJ.

Giddings, J. L. 1952 *The Arctic Woodland Culture of the Kobuk River.* The University Museum, University of Pennsylvania, Philadelphia, PA.

Holmes, C. E. 1975 A Northern Athapaskan Environment System in Diachronic Perspective. *The Western Canadian Journal of Anthropology* 3–4:92–124.

Hoeffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–53.

Hu, F. S., L. B. Brubaker, and P. M. Anderson 1993 A 12,000 Record of Vegetation Change and Soil Development from Wien Lake, central Alaska. *Canadian Journal of Botany* 71:1133–1142.

Lozhkin, A. V. 1992 Climates of Arctic Regions of North East Siberia During the Late Pleistocene-Holocene Transition: Data from Mammoth Burials of the Indigirka Lowlands. *The 22nd Arctic Workshop Program and Abstracts*: 8–9.

Lozhkin, A. V., P. M. Anderson, W. R. Eisner, L. G. Ravako, D. M. Hopkins, L. B. Brubaker, P. A. Colinvaux, and M. C. Miller 1993 Late Quaternary Lacustrine Pollen Records from South-western Beringia. *Quaternary Research* 39:314–324.

Morlan, R. E. 1987 The Pleistocene Archaeology of Beringia. In *The Evolution of Human Hunting*, edited by M. H. Nitecki and D. V. Nitecki, pp. 267–307. Plenum, New York.

Pruitt, W. O. 1960 *Behavior of the Barren Ground Caribou.* Biological Papers of the University of Alaska, No. 3. Fairbanks, AK.

West, F. H. 1981 *The Archaeology of Beringia.* Columbia University Press. New York.

New AMS Dates from the Dry Creek Paleoindian Site, Central Alaska

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The Dry Creek site, located in the northern foothills of the Alaska Range, is situated in a loess deposit 2 m thick containing alternating beds of loess, sandy loess, and buried soils (Figure 1). The suite of conventional radiocarbon dates, particularly those from the lower part of the deposit, contains serious reversals (Figure 1), due to small samples or contamination by airborne lignite fragments (Thorson and Hamilton 1977).

The two oldest archaeological components at the site are the pre-microblade Nenana Complex and the microblade-rich Denali Complex (Hoffecker et al. 1993; Powers and Hoffecker 1989). A discontinuous sandy unit (Sand 1), correlated with the Younger Dryas (Bigelow et al. 1990), separates these components.

Our dating strategy focused on Paleosol 1 and Paleosol 2 because: 1) the conventional date from Paleosol 1 (on cultural charcoal from the Denali Complex) provides the only upper limiting age for a possible Younger Dryas horizon; 2) we suspected this date was too old because it makes the Denali Complex at least 300 years older than any other well-dated microblade site in central Alaska; 3) the original radiocarbon series from Paleosol 2 was very scattered and tighter chronological control was needed.

The new AMS determinations tightened the chronology of Paleosol 2 and confirmed the original conventional age of Paleosol 1. All the samples were plant remains or natural charcoal from wild fires. The AMS dates from Paleosol 2 range between about 9,300 and 10,500 ^{14}C yr B.P. These analyses suggest that the oldest ages from the conventional suite are unreliable. The 9,000–9,700 ^{14}C yr ages from the conventional and AMS series overlap at the 2-sigma range. The 10,540 ± 70 age from the AMS series does not agree with the acceptable conventional dates. Based on the degree of overlap (Figure 1), Paleosol 2 was probably forming between about 9,000 and 9,900 ^{14}C yr B.P.

The new suite of AMS dates for Paleosol 1 ranges between about 8,900 and 10,600 ^{14}C yr B.P. The two older AMS determinations agree well with the original conventional age of 10,690 ± 250; the youngest AMS determination does not. The overlapping ages suggest that Paleosol 1 was probably forming episodically between about 9,900 and 11,000 ^{14}C yr B.P.

The narrow temporal separation of the two paleosols is not surprising given their close stratigraphic superposition. Paleosol 2 is a thicker and more continuous upper member of Paleosol 1. The new AMS determinations have not altered the age of Paleosol 1 and suggest that if the underlying sand does represent the Younger Dryas, then it was a shorter-lived phenomenon than elsewhere around the north Pacific (Engstrom et al. 1990; Mathewes et al.

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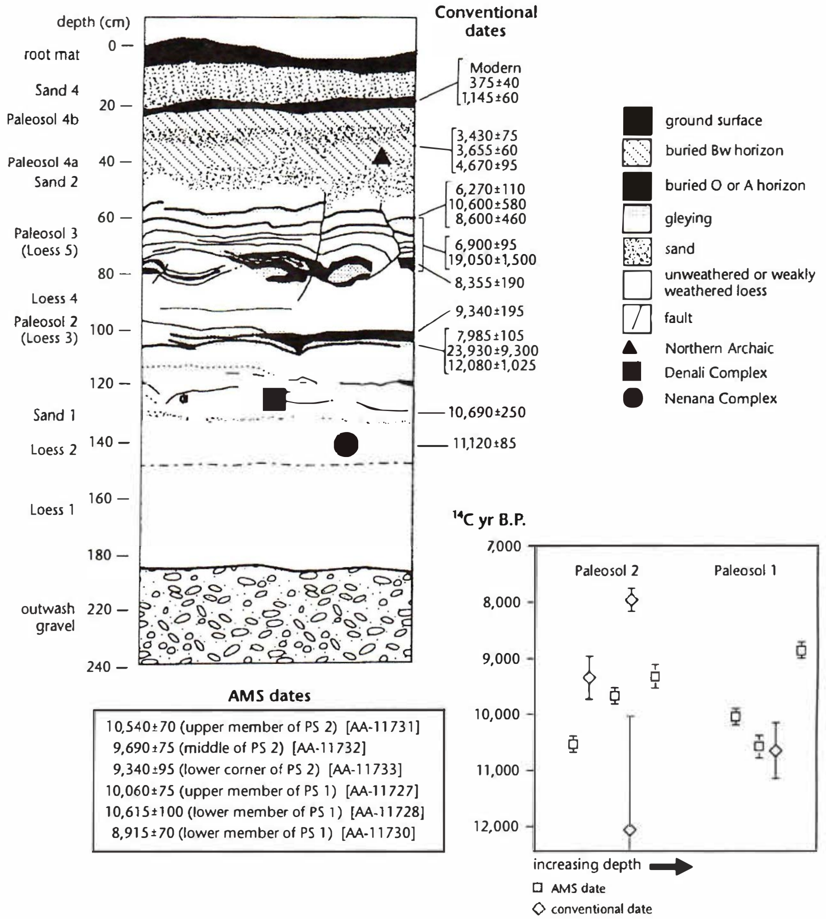

Figure 1. Schematic drawing of the Dry Creek loess profile with associate conventional and AMS determinations. The graph depicts age vs. depth of the radiocarbon dates; error bars are the 95%

1993). These new determinations also indicate that the original age on the Denali Complex at this site is accurate.

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References Cited

Bigelow, N. H., J. E. Begét, and W. R. Powers 1990 Latest Pleistocene Increase in Wind Intensity Recorded in Eolian Sediments from Central Alaska. *Quaternary Research* 34:160–168.

Engstrom, D. R., B. C. S. Hansen, and H. E. Wright, Jr. 1990 A Possible Younger Dryas Record in Southeastern Alaska. *Science* 250:1383–1385.

Hoffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–53.

Mathewes, R. W., L. E. Heusser, and R. T. Patterson 1993 Evidence for a Younger Dryas-like Cooling Event on the British Columbia Coast. *Geology* 21:101–104.

Powers, W. R., and J. F. Hoffecker 1989 Late Pleistocene Settlement in the Nenana valley, Central Alaska. *American Antiquity* 54:263–287.

Thorson, R. M., and T. D. Hamilton 1977 Geology of the Dry Creek site: a Stratified Early Man Site in Interior Alaska. *Quaternary Research* 7:149–176.

Human Adaptation at the Southern Margin of the Laurentide and Cordilleran Ice Sheets

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Prehistorians note that archaeological sites usually occurs at the border between two ecological systems. For example, sites may occur along coastal, riverine, and mountain edges. One of the most important edges, critical to human settlement and subsistence patterns, is the ice-marginal environment that occurred along the edges of the world's great ice sheets. These edges have long been assumed to have been barren, cold areas, unsuitable for animal or human life. In this presentation, we establish the presence of Paleoamerican sites along the southern margin of the Cordilleran and Laurentide ice sheets, in what are now the Saskatchewan, Missouri and Columbia River drainage systems.

Principles controlling productivity in ice-marginal environments are important for understanding how humans adapted to Beringia. M. Turner (pers. comm. 1994) proposes that contrary to popular perception, ice-marginal environments were attractive to human and animal populations. In most plant taxa, growth is limited by plant nutrients such as potassium, phosphate, and fixed nitrogen. Ice margins are enriched in both potassium and phosphate, especially in areas where glaciers have overridden igneous or metamorphic terrain, releasing potassium and phosphates. Studies of Antarctic and Greenland ice of Pleistocene and Holocene age indicate that the large continental sheets also contained significant amounts of nitrates, which are released in meltwater.

On the east side of the Rocky Mountains, the large Laurentide ice sheet displaced the Saskatchewan and Missouri rivers to the south. Topographic depression from the weight of the ice sheet led to creation of Glacial Lake Agassiz, which covered part of southern Saskatchewan and most of southern Manitoba. Huge south-flowing meltwater channels, carrying water and ice from

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the disintegrating ice sheets, eventually contributed to the damming of the Missouri and Yellowstone Rivers. This blockage resulted in the formation of large temporary lakes in Northern Montana and the Dakotas (Clayton and Moran 1982).

Although late-Pleistocene catastrophic flooding probably eliminated deposits that might contain archaeological remains east of the Rocky Mountains, a few sites occur in late-Pleistocene contexts that appear to represent discrete cultural patterns. These include isolated mammoth kills (Davis and Wilson 1985), cobble-tool industries (Chlachula, this volume), industries that lack diagnostic projectile points (Fedje 1986), Clovis (Davis 1993), and Goshen (Frison 1991) cultural complexes. These patterns appear to represent adaptations to rapidly evolving conditions that existed as the ice-sheet recession and landform creation and modification patterns occurred along the southern margin of Alpine glaciers and the Laurentide ice sheet. After Pleistocene extinctions, which occurred about 11,000 years ago, a series of regional co-traditions developed along the flanks of the Rocky Mountains and in the Northwestern Plains. These included Windust (Bonnichsen n.d.), Hell Gap/Agate Basin, Folsom, and Plano (see Bobrowsky et al. 1990, Buchner and Pettipas 1990, and Wilson 1990, for summaries).

West of the Rocky Mountains, widely scattered Clovis finds attest to the presence of a highly adaptive, yet basically similar, big-game hunting tradition in the Columbia River drainage system (Mehringer 1988a, 1988b; Mehringer and Foit 1990). Later Paleoamerican cultural assemblages, however, show strong evidence for several coexisting traditions (Brauner 1985; Carlson 1990; Rice 1972; Willig and Aikens 1988). This substantial diversity in the West is traced in part to the isolation and environmental disruption brought about by the massive breakup of glacial conditions. Extreme environmental events, including volcanism in the Cascades, recession of the continental ice sheets and the retreat of alpine glaciers in the Northern Rockies and Cascades, catastrophic flooding of the channeled scablands in the Columbia Basin, and extensive deposition of glacial outwash sediments in regional river valleys, presented conditions unique to southern Beringia (Allen et al. 1986; Bretz 1969; Carrara et al. 1986).

Within this setting, post-Clovis human adaptation to environmentally diverse, but geographically more restricted, settings led to the emergence of more diverse Paleoamerican co-traditions. These finds are locally represented in small and specialized assemblages of skillfully made, high-quality cryptocrystalline lithic material. They range in age between 9,000 and 11,000 yrs B.P., known locally as Folsom, Plano, Windust, Hell Gap, and Old Cordilleran. Sites of this age are few in number compared with times as recent as 8,000 yrs B.P. They are preserved in places that escaped the catastrophic events of the late Pleistocene or were buried by the extensive deposition and sedimentation of that time period.

Although scarce, archaeological sites representing a number of different traditions occur along the southern margins of the Laurentide and Cordilleran ice sheets. These cultural patterns appear to be uniquely American and cannot at this time be directly related to cultural patterns found in the northern Beringia Refugium.

References Cited

Allen, J., M. Burns, and S. Sargent 1986 *Cataclysms on the Columbia.* Timber Press, Portland.

Bonnichsen, R., ed. n.d. First Americans Research Project: Regional Perspective and Excavations at Mammoth Meadow with a Focus on Time-Sensitive Artifacts. Report for the Bureau of Land Management, MT-070-076-03.

Brauner, D. 1985 Early Human Occupation in the Uplands of the Southern Plateau: Archaeological Excavations at the Pilcher Creek Site, Union County, Oregon. Department of Anthropology, Oregon State University, USDA Soil Conservation Service.

Bretz, J. H. 1969 The Lake Missoula Floods and the Channeled Scablands. *Journal of Geology* 77:505–543.

Bobrowsky, P. T., N. R. Catto, J. W. Brink, B. E. Spurling, T. H. Gibson, and N. W. Rutter 1990 Archaeological Geology of Sites in Western and Northwestern Canada. In *Archaeological Geology of North America,* Centennial Special Volume 4, edited by N. P Lasca and J. Donahue, pp. 87–122. The Geological Society of America, Boulder.

Buchner, A. P., and L. F. Pettipas 1990 The Early Occupations of the Glacial Lake Agassiz Basin in Manitoba: 11,500 to 7.700 B.P. In *Archaeological Geology of North America,* Centennial Special Volume 4, edited by N. P Lasca and J. Donahue, pp. 51–60. The Geological Society of America, Boulder.

Carrara, P. A., S. K. Short, and R. E. Wilcox 1986 Deglaciation of the Mountainous Region of Northwestern Montana, USA, as indicated by late Pleistocene Ashes. *Arctic and Alpine Research.* 18:317–325.

Carlson, R.L. 1990 Cultural Antecedents. In *Northwest Coast, Handbook of North American Indians,* no. 7:60–69, Smithsonian Institution, Washington DC.

Clayton. L., and S. Moran 1982 Chronology of Late Wisconsin Glaciations in Middle North America. *Quaternary Science Review* 1:55–82.

Davis, L. B., and M. C. Wilson 1985 The Late Pleistocene Lindsay mammoth (24DW501): A Possible Mammoth Association. *Current Research in the Pleistocene* 4:5–6.

Davis, L. B. 1993 Paleo-Indian Archaeology in the High Plains and Rock Mountains of Montana. In *From Kostenski to Clovis: Upper-Paleolithic-Paleo-Indian Adaptations,* edited by O. Soffer and N. D. Praslov, pp. 263–277, Plenum Press, NY.

Fedje, D. 1986 Banff Archaeology, 1983–1985. In *Eastern Slopes Prehistory,* B. Ronagan, ed., pp. 25–62. Archaeological Survey of Alberta Occasional Paper 30. Edmonton.

Frison, G. C. 1991 The Goshen Paleoindian Complex: New Dates for Paleoindian Research. In *Clovis: Origins and Adaptations,* edited by R. Bonnichsen and K. Turnmire, pp. 133–152. Center for the Study of the First Americans, Oregon State University, Corvallis.

Mehringer, P. J., Jr. 1988a Clovis Cache Found: Weapons of Ancient Americans. *National Geographic* 174:500–503.

Mehringer, P. J., Jr. 1988b The Richey-Roberts Clovis Cache, East Wenatchee, Washington. *Northwest Science* 62(5):271–272.

Mehringer, P. J., Jr., and F. Foit, Jr. 1990 Volcanic Ash Dating of the Clovis Cache at East Wenatchee, Washington. *National Geographic Research* 6(4):495–503.

Rice, D. 1972 The Windust Phase in Lower Snake River Region Prehistory. Washington State University, Laboratory of Anthropology, *Report of Investigations* No. 50, Pullman.

Willig, J., and C. M. Aikens 1988 The Clovis-Archaic Interface in Far Western North America. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface,* edited by J. Willig, C. M. Aikens, and J. Fagan, pp 21–41. Nevada State Museum Anthropological Papers 21:1–40.

Wilson, M. C. 1990 Archaeological Geology in Western Canada: Techniques, Approaches and Integrative Themes. In *Archaeological Geology of North America,* Centennial Special Volume 4, edited by N. P Lasca and J. Donahue, pp. 61–86. The Geological Society of America, Boulder.

Coastal Records of Pleistocene Glacial and Sea-Level Events on Chukotka Peninsula, Northeast Siberia: A New Interpretation

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The regional stratigraphic scheme compiled by Russian geologists for Quaternary glacial and marine deposits along the coast of the Chukotka Peninsula in the past has been based on fossil faunal assemblages (mollusks, foraminifera, diatoms), topographic position (height above sea level), position in the stratigraphic sequence, differences in assemblages of detrital minerals, and a small amount of paleomagnetic data (Ivanov, 1986). Since 1991, our research group has collaborated in an effort to erect a new stratigraphic framework for the late-Cenozoic history of the Bering Strait region, based on key depositional sequences preserved on both the Siberian and the Alaskan coasts of the Bering and Chukchi Seas. Our relative-age discriminations, new correlations between sections, and telecorrelations across Bering Strait are based on the amino-acid geochronology of marine mollusks in concert with ^{14}C AMS age estimates on shells and organics and $^{86}Sr/^{87}Sr$ ratios on shells. Field work was conducted at Cape Pinakul' near Bering Strait in 1991, at bluffs near the Nunyamo and Enmelen Rivers on the south coast of the Chukotka Peninsula during 1992, and on St. Lawrence Island, Alaska, from 1992–94. In addition, Ivanov provided shells from the type locality of the middle-Pleistocene Yanrakinot and Mechigmen beds exposed near the village of Yanrakinot.

Our new results differ from previous correlations of marine interglacial and glaciomarine deposits on Chukotka Peninsula and on nearby St. Lawrence Island. Some deposits previously thought to be of early- or middle-Pleistocene age actually record glacial and glaciomarine events associated with the glaciation of the Chukota Peninsula late in isotope stage 5 or early in stage 4. The amino-acid geochronology indicates that fossil assemblages that have been

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used as stratigraphic markers in Chukotka in the past are, in actuality, markers of specific ecological conditions (lagoon, open deep water, etc.).

The 5-km-long bluff southeast of the Nunyamo River exposes a relatively continuous marine bed arched in a broad anticline that locally arches the marine bed to a height of 40 m asl. The marine bed is underlain by glaciofluvial gravels and overlain by coarse beach gravel. The marine bed was previously thought to be correlative with the Mechigmen beds at their type locality, 100 km to the northeast. Amino-acid ratios on mollusks of four genera (*Hiatella, Mya, Astarte, and Macoma*) from the Nunyamo exposure, however, are indistinguishable from ratios on mollusks of the same genera from the type section of the Val'katlen beds of last interglacial age at the mouth of the Enmelen River, 20 km to the southeast. The Val'katlen beds are only 6 m asl; the warping of this marine bed to about 40 m asl in the Nunyamo Bluff suggests deformation by glacial ice approaching the coast from valleys to the east and northwest.

At Cape Pinakul', we studied exposures of the Upper and Lower Pinakul' Suite, previously assumed to be 1 or 2 Ma, as well as adjacent deposits supposed to be correlative with the Yanrakinot Suite. Amino-acid analyses on >50 shells (*Astarte, Macoma, Hiatella, Mya, Portlandia*) indicate that the Upper and Lower Pinakul' Suites are not early Pleistocene in age but are most likely correlative with the last interglacial (isotope stage 5) or possibly a slightly earlier interglacial (stage 7?). Our interpretation is supported by Sr ratios with near-modern values measured on shell material. $^{230}Th/^{234}U$ analyses on concretions from the lower Pinakul' Suite are pending. Evidence of reversely magnetized sediments in this glacially tectonized sequence (Ivanov, 1986) is, in the opinion of the American team, equivocal.

Deposits at Cape Pinakul' previously considered equivalent to the Yanrakinot Suite at the type locality, 60 km to the south, are, in fact, glaciomarine in character. They contain shells with a range of amino-acid ratios that suggests the presence of redeposited material. Possibly these beds include redeposited shells derived from middle-Pleistocene deposits that are no longer exposed. However, additional material from the Yanrakinot type section will be needed to confirm this. What is clear is that the sequence previously recognized as the Pinakul' Suite is younger than either the Yanrakinot or the Mechigmen beds at their type section.

Deformed interglacial deposits correlative with the Anvilian (isotope stage 11) and Pelukian Transgressions (stage 5e) of Alaska indicate that glacial ice originating in Chukotka advanced onto St. Lawrence at least twice—once during the middle-Pleistocene Nome River Glaciation (stage 10) and again during the early-Wisconsinan (Vankarem Glaciation in Siberia) (late stage 5 or stage 4). Owing to aridity throughout central Beringia, late-Wisconsinan (stage 2) glaciers were extremely limited in extent in the Chukotka region as well as in northern and western Alaska.

References Cited

Ivanov, V. F. 1986 *Quaternary deposits of coastal eastern Chukotka* (in Russian): USSR Acad. Sci., Far East Science Center, Vladivostok, 137 pp.

Early Human Occupations in the Southern Part of the "Ice-Free Corridor"

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Recent research in geology, palynology, paleontology and archaeology in Alberta leads to the conclusion that conditions in the "ice-free corridor" were unsatisfactory for occupation by large mammals, including humans, between about 11,500 yr B.P. and 21,500 yr B.P., as suggested by dating of 70 samples of wood and large mammal bones from central Alberta. More than 30 dates have been obtained from preglacial deposits (before the first and only Laurentide advance), which range from off the counter (>43,000) to 21,300 yr B.P., and nearly 40 dates from postglacial deposits after 11,600 to 9,000 yr B.P. (J. A. Burns 1990 and pers. comm. 1994). The hiatus of ten millennia was evidently due to the presence of Laurentide ice and to climatic conditions that were too severe for trees and large mammals.

Pollen cores in west central Alberta (c. 150 km southwest of Edmonton, not far east of the mountains) indicate that the Laurentide ice stagnated and began to melt about 14,000 yr B.P., after which time an unproductive tundra ecosystem developed under cold arid conditions that retarded colonization by trees until birch and poplar pioneered after 12,000 yr B.P., and spruce after 10,800 yr B.P. (Ives et al. 1993; Charles Schweger, pers. comm. 1994). The eastern slopes of the Rockies west of the Laurentide ice mass evidently remained unglaciated except for the major valleys (Bobrowsky and Rutter 1992; Rutter 1980). The Laurentide coalesced with a Cordilleran glacier in the Athabasca valley 150 km west of Edmonton, resulting in capture by the southward-flowing Laurentide ice of erratics from Jasper Park that were deposited in a train extending into northern Montana. Although neither the coalescence nor the erratic train has been directly dated, the fact that the only Laurentide ice farther east and north is clearly dated to the late Wisconsinan supports the hypothesis that, about 21,000 yr B.P., the Laurentide ice advanced rapidly southward, skirting the base of the eastern slopes. The massive Laurentide advance dammed eastward-flowing rivers, creating proglacial lakes, including Glacial Lake Calgary in the Bow River Valley.

Recent discovery and test excavation of an archaeological locality on the contact between Lake Calgary glaciolacustrine deposits, more than 20 m thick, and the underlying Bow Valley till demonstrate that people occupied the valley after the Cordilleran ice had retreated and before the Laurentide ice dammed the river about 21,000 yr B.P. (see Chlachula, this volume). Another locality about 2 km upstream yielded a similar assemblage of percussion-flaked pebble-core and flake artifacts lacking any evidence of bifacial projectile points. The latter assemblage came from beneath the same till on the contact with underlying fluvial gravels. People evidently occupied the Bow Valley in western Calgary before a Cordilleran glacial advance, and reoccupied the top of the till

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after retreat of the Cordilleran ice; but finally were forced to abandon the area when the dammed lake inundated their latest campsite.

Some small mammal species survived on the unglaciated eastern slopes (Burns 1990) while the prairies remained glaciated; however, there is no further evidence for human occupation of Alberta until early postglacial times. Farther up the Bow Valley at Vermilion Lakes near Banff, several localities have been excavated that were deeply buried beneath debris flow fan deposits (Fedje and White 1988). More than 25 dates were obtained on bone and charcoal. Large assemblages of flake tools include evidence for reduction of bifacial cores between 11,000 and 10,200 yr B.P. Although no diagnostic points were recovered, the authors assume that these early occupants made fluted points. Lanceolate and stemmed points similar to Agate Basin and Hell Gap were used between 10,200 and 9,600 yr B.P.

The nearby Eclipse site has yielded projectile points with long stems from a context dated between 9,200 and 10,200 yr B.P. The mean of 9,675 ± 350 (Fedje 1988:38) confirms a date of 9,710 ± 190 yr B. P. (GAK-5097) on bone from the Lindoe buffalo kill site near Medicine Hat in southeastern Alberta, which yielded the same type of point with a parallel-sided lingual stem (Bryan 1980: 98, fig. 34).

Elsewhere in the Saskatchewan drainage the search continues for Clovis fluted points, assumed to be associated with the earliest occupation of the region. True Clovis points are very rare and limited to southern Alberta, although stubby triangular fluted points are fairly common in western Alberta, and one has been dated to c. 10,500 yr B.P. at Charlie Lake Cave, near Fort St. John, B. C. (Fladmark et al. 1988). Two more examples were excavated at the Sibbald Creek site 70 km west of Calgary, along with a Scottsbluff and several lanceolate points (Gryba 1983). A date of 9,570 ± 320 yr B.P. (GX-8808) was thought not to be early enough for the fluted points but possibly relevant for the other points. Several sites in southern Alberta and southwestern Saskatchewan have yielded dated evidence of occupations between 9,500 and 10,900 yr B.P. (e.g., Meyer and Liboiren 1990); however, none are directly associated with diagnostic projectile points. A date of 9,380 ± 110 yr B.P. (TO-1097) was obtained from the Fletcher site, an Alberta/Scottsbluff bison kill in south central Alberta. The Heron Eden (+ Scottsbluff) bison-processing site in southwestern Saskatchewan has yielded five dates ranging from 8,150 to 10,210, with an average of 9,080 yr B.P. (Linnamae and Johnson 1993).

To summarize, the working hypothesis remains undemonstrated that the first people who occupied southern Alberta after the Laurentide ice had melted used fluted points. Points with lingual stems, Agate Basin, Hell Gap, and Scottsbluff/Eden shouldered varieties were used to hunt bison between about 9,000 and 10,200 yr B.P., and unfluted points of various shapes and materials may have been used earlier as well. The search for early sites should not be limited to fluted points; and it is especially important that deeply buried Pleistocene geological contexts be examined carefully.

References Cited

Bobrowsky, P. T, and N. W. Rutter 1992 The Quaternary Geological History of the Canadian Rocky Mountains. *Géographie physique et Quaternaire* 46:5–15.

Bryan, A. L. 1980 The Stemmed Point Tradition: An Early Technological Tradition in Western North America. In: *Anthropological Papers in Memory of Earl H. Swanson, Jr.*, edited by L. B. Harten, C. N. Warren, and D. R. Tuohy, pp. 77–107. Special Publication of the Idaho State Museum of Natural History, Pocatello.

Burns, J. A. 1990 Palaeontological Perspectives of the Ice-Free Corridor. In *Megafauna and Man: Discovery of America's Heartland.*, edited by L. D. Agenbroad, J. I. Mead, and L. W. Nelson, pp. 61–66. Scientific Papers, Volume 1. The Mammoth Site of Hot Springs, South Dakota, Inc. and Northern Arizona University, Hot Springs, SD and Flagstaff, AZ.

Fedje, D. W. 1988 *The Norquay and Eclipse Sites*: Trans-Canada Highway Twinning Mitigation in Banff National Park. Environment Canada. Parks Service. Western Region. Archaeological Research Services. Microfiche Report Series 395. Calgary.

Fedje, D. W., and J. M. White 1988 *Vermilion Lakes Archaeology and Palaeoecology*: Trans-Canada Highway Mitigation in Banff National Park. Environment Canada. Parks Service. Western Region. Archaeological Research Services. Microfiche Report Series 463. Calgary.

Fladmark, K. R., J. C. Driver, and D. Alexander 1988 The Paleoindian Component at Charlie Lake Cave (HbRf 39), British Columbia. *American Antiquity* 33(1):1–10.

Gryba, E. M. 1983 Sibbald Creek: 11,000 Years of Human Use of the Alberta Foothills. Archaeological Survey of Alberta, Occasional Paper 33. Edmonton.

Ives, J. W., A. B. Beaudoin, and M. P. R. Magne 1993 Evaluating the Role of a Western Corridor in the Peopling of the Americas. Paper prepared for publication in *Routes into the New World*, edited by R. E. Ackerman, WSU Press, Pullman.

Linnamae, U., and E. A. Johnson 1993 An Analysis of the Lithic Collection from the Heron Eden Site: A Cody Complex Manifestation in Saskatchewan. Paper presented at the 51st Plains Anthropological Conference in Saskatoon, Saskatchewan.

Meyer, D., and H. Liboiron 1990 A Palaeo-Indian Drill From the Niska Site in Southern Saskatchewan. *Plains Anthropologist* 35(129):299–302.

Rutter, N. W. 1980 Late Pleistocene History of the Western Canadian Ice-Free Corridor. *Canadian Journal of Anthropology* 1(1):1–8.

Early Cultural Traditions in British Columbia West of the Rocky Mountains

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The limited evidence for settlement in British Columbia (B.C.) west of the Rocky Mountains before 8,000 yr B.P. is of two kinds: data from excavated sites, and surface finds of early types of artifacts. These data, such as they are, do show spatial patterning that permits recognition of the probable presence of five cultural traditions: the Fluted Point Tradition; the intermontane Stemmed Point Tradition; the Plano Tradition; the Pebble Tool or Foliate Biface Tradition; and the Microblade Tradition.

The Fluted Point Tradition is the least represented. Evidence is limited to five bifaces from the Kamloops-Kelowna-Princeton region in south central interior B.C. (Rousseau 1993, Fig. 3). These bifaces are from poorly docu-

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mented collections, are not fluted, and can at best be considered derivatives of fluted types. They are similar to late fluted points east of the Rockies in northeastern B.C. and Alberta (Fladmark et al. 1988; Gryba 1985). Just south of the B.C. border in Washington State at the East Wenatchee site (Mehringer and Foit 1990) true Clovis fluted points are found.

The Plano Tradition is known only from casual finds of projectile points. Alberta, Scottsbluff, Agate Basin, Eden, Lusk, and Hell Gap types have been noted in local collections from south central B.C., particularly the Shuswap Lakes region (Grabert 1974, Rousseau 1993), and there is one Scottsbluff point in the Sewell Collection from the Vanderhoof locality in central interior B.C. (Laboratory of Archaeology , University of B.C. collections). It remains to be seen whether these points reached this area from the Plains prehistorically or through the activities of modern collectors. Other large lanceolate flaked-stone points reminiscent of Paleoindian types are present, but are not necessarily indicative of early time placement since such points are found in later assemblages up to at least 2,000 yr B.P. (cf. MacDonald 1983, Fig. 6:17d), where they may have functioned as daggers or status symbols in later cultures.

The intermontane Stemmed Point Tradition (Carlson 1983), extending from the headwaters of the Columbia River in southeast B.C. through the Columbia drainage and south through the Great Basin, dates between about 10,500 and 8,000 yr B.P. The long-stemmed points and chipped crescents are quite distinctive. No crescents have been found, but similar undated points are reported from the Fraser-Thompson region of central interior B.C. (Rousseau 1993, Fig. 4). The Gore Creek skeleton from this region, ^{14}C-dated to just over 8,000 yr B.P., lacks associated cultural materials but is the remains of a hunter (Cybulski et al. 1981), and could belong to this tradition. In the Kutenai region of southeast B.C., the Goatfell complex (Choquette 1987) belongs to this tradition.

The Pebble Tool Tradition (Carlson 1983, 1990) is found on the coast from the Queen Charlotte Islands south into Washington State. It is defined on the basis of early assemblages in which unifacial pebble tools and/or simple leaf-shaped (Cascade) bifaces co-occur, and fluted and stemmed points are absent. Assemblages at Namu, Milliken, Bear Cove, and Glenrose sites are well dated between 9,700 and 8,000 yr B.P. Assemblages of pebble tools without bifaces, grouped as the Pasika Complex and once thought to predate those with bifaces (Borden 1969), have been shown to postdate assemblages in which bifaces occur (Haley 1987). Recent work in the Queen Charlotte Islands (Fedje 1993, Josenhans et al. 1993) has demonstrated the presence of an early (ca. 9,600–9,200 yr B.P.) biface tradition at Matheson Inlet, which is probably related.

The Microblade Tradition centers on the northern B.C. coast and southeast Alaska. In the earliest assemblages at Namu and at coastal sites to the south that predate 8,500–8,000 yr B.P.—Bear Cove, Milliken, and Glenrose—biface technology is emphasized and microblade technology is absent. These assemblages are placed in the Pebble Tool Tradition. In sites to the north of Namu—Hidden Falls, Ground Hog Bay and most Queen Charlotte Island sites—there are few or no bifaces, microblade technology is present, and these assemblages are grouped with the Microblade Tradition. In the south central interior two small assemblages with microblades (13 in total) dated at 7,700 and 8,400 yr B.P. from the Landels site lack bifaces (Rousseau 1993:154). In younger periods microblade technology is found in many parts of the southern coast and interior up to at least 1,500 yr B.P. The most parsimonious explanation of microblade distribution is that it accompanied an expansion of people from further north into northern B.C. and from there spread south to already resident peoples.

The Fluted Point, Stemmed Point, and Plano traditions are clearly interior hunting traditions that reached B.C. from the continental interior, and are only marginally represented there. The Pebble Tool and Microblade traditions are probably coastwise derivatives of pre-Denali and Denali Beringian traditions.

References Cited

Borden, C. E. 1969 Early Population Movements from Asia into Western North America. *Syesis* 2(1-2):1–13. Victoria, B.C.

Carlson, R. L. 1983 The Far West. In *Early Man in the New World*, edited by R. Shutler Jr., pp. 73–96. Sage Publications, Beverly Hills.

Carlson, R. L. 1990 Cultural Antecedents. In *Handbook of North American Indians 7 Northwest Coast*, edited by W. Suttles, pp. 60–69. Smithsonian, Washington D.C.

Choquette, W. 1987 Typological Visibility and the Stemmed Point Tradition. Paper presented at the 20th annual meeting of the Canadian Archaeological Association, Calgary, Alberta.

Cybulski, J. S., D. E. Howes, J. C. Haggerty, and M. Eldridge 1981 An Early Human Skeleton from South-central British Columbia: Dating and Bioarchaeological inference. *Canadian Journal of Archaeology* 5:49–60.

Fedje, D. 1993 Sea-Levels and Prehistory in Gwaii Haanas. Unpublished M.A. Thesis in Archaeology, University of Calgary, Calgary.

Fladmark, K., J. C. Driver, and D. Alexander 1988 The Paleoindian Component at Charlie Lake Cave (HbRf 39), British Columbia. *American Antiquity* 53(2):371–384.

Grabert, G. 1974 Okanogan Archaeology: 1966–67, *Syesis* 7, Supplement 2. Provincial Museum of British Columbia, Victoria, 82 pp.

Gryba, E. 1985 Evidence of the Fluted Point Tradition in Alberta. In *Contributions to Plains Prehistory: The 1984 Victoria Symposium*, edited by D. Burley, Archaeological Survey of Alberta Paper Occasional Paper 26, pp. 22–38, Edmonton.

Haley, S. 1987 The Pasika Complex Cobble Reduction Strategies on the Northwest Coast. Unpublished Ph.D. Dissertation in Archaeology. Simon Fraser University, Burnaby.

Josenhans, H. W., J. V. Barrie, K. W. Conway, R. T. Patterson, R. W. Mathewes, and G. J. Woodsworth 1993 Surficial geology of the Queen Charlotte Basin: evidence of submerged proglacial lakes at 170 m on the continental shelf of western Canada. Current Research, Part A, *Geological Survey of Canada Paper* 93-1A:119–127.

Mehringer, P. J., and F. F. Foit 1990 Volcanic Ash Dating of the Clovis Cache at East Wenatchee, Washington. *National Geographic Research* 6(4):495–503.

MacDonald, G. F. 1983 Prehistoric Art of the Northern Northwest Coast. PP. 99-12 In *Indian Art Traditions of the Northwest Coast*, edited by R. L. Carlson, pp. 99–121. Archaeology Press, Simon Fraser University, Burnaby.

Rousseau, M. K. 1993 Early Prehistoric Occupation of South Central British Columbia: A Review of the Evidence and Recommendations for future research. Pp. 140–183 In Changing Times: British Columbia Archeology in the 1980s, edited by K. Fladmark, pp. 140–143. *BC Studies* 99.

A ca. 17,500-year Magnetic Susceptibility Record from North Killeak Lake, Bering Land Bridge National Preserve, Western Alaska

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The Cape Espenberg–Devil Mountain (CEDM) region of the Bering Land Bridge National Preserve (BELA), occupying the northernmost extension of Seward Peninsula, is located between 66°10′–66°40′ N and 163°50′–165°15′ W. It is part of the Chukchi Sea coastal plain, and less than half of the region lies 35 m above sea level. The highest-relief land form in the area, Devil Mountain, reaches an elevation of only 135 m.

Thermokarst lakes, formed by localized thawing of ice-rich permafrost, are the dominant feature found on the landscape. Poor stratigraphic exposures and the reworking of old organic material, however, do not allow accurate paleoenvironmental interpretations to be made from sediments deposited within thermokarst lakes. In contrast to the thermokarst lakes, the CEDM region also contains five stable lake basins created by magma-induced explosive steam eruptions (maars) during the late Pleistocene (Forbes 1978; Hopkins 1988). These bedrock basins are more stable than the expanding thermokarst lake basins and contain longer, continuous sediment records.

During the spring of 1993, eight sediment cores were recovered from one of the five maar lakes found within the CEDM region (North Killeak Lake). The goals of the coring project were to characterize sedimentation and productivity changes that have taken place within the lake during the last 20,000 years and to further relate these changes to regional environmental changes. The coring project is only one of several current projects investigating the landscape evolution of the Bering Land Bridge National Preserve funded by the National Park Service.

As shown in Figure 1, two AMS radiocarbon-age estimates at depths of 5.70 and 5.80 m in the longest core recovered indicate the record from North Killeak Lake extends beyond the last ca. 17,500 years. Over this time, three periods of high magnetic susceptibility are recorded at core depths of 0.50–1.50 m, 2.50–5.00 m, and 6.50–6.80 m. In general, magnetic-susceptibility measurements of the sediments vary as a function of mineralogy, grain size, and sedimentation rate. As can be seen by the inverse correlation between the susceptibility and LOI values in Figure 1, the variation in magnetic susceptibility within the North Killeak Lake sediments results in part from organic matter diluting the concentration of magnetic materials in the core.

The decrease in susceptibility and increase in organics from 5.00–6.80 m are particularly significant. These changes most likely record the biological recovery of the lake from the cold, dry Duvanny Yar period of Hopkins (1982). The

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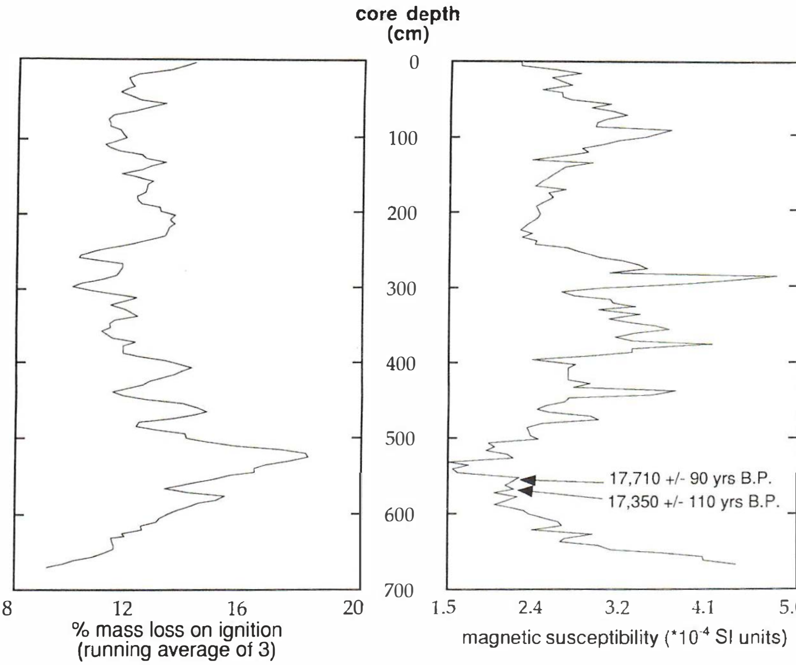

Figure 1. Organic content (LOI) and magnetic-susceptibility records for North Killeak Lake, BELA. The sampling interval is 5 cm.

early age of the recovery, however, suggests that the variations may be documenting only the increase of aquatic productivity within the lake and not the recovery of the local landscape. Future analysis of grain-size variations within the core will help determine if the susceptibility decrease also occurs when grain size decreases. If so, the susceptibility decrease may in fact reflect a change in regional vegetation and/or wind intensity commonly associated with glacial-to-interglacial transitions. In addition, future analysis of the pollen record from these cores will also clarify the relationship between regional vegetation and lake productivity.

References Cited

Forbes, R. B. 1978 The Origin and Geological Setting of the Maars Near Cape Espenberg, Alaska. Unpublished Report in Files of the National Park Service, Alaska Regional Office. 34p.

Hopkins, D. M. 1982 Aspects of the Paleogeography of Beringia During the Late-Pleistocene. In *Paleoecology of Beringia*. D. M. Hopkins, J. V. Matthews Jr., C. E. Schweger, and S. B. Young, eds. New York. pp. 3–28.

Hopkins, D. M. 1988 The Espenberg Maars: A Record of Explosive Volcanic Activity in the Devil Mountain-Cape Espenberg Area, Seward Peninsula, Alaska. In *The Bering Land Bridge National Preserve: An Archeological Survey*. J. Schaaf, ed. United States Park Service. pp. 188–247.

Early Paleolithic in the Minusinsk Basin, Upper Yenisei River Region, Southern Siberia

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Systematic geological and archaeological investigations since the late 1980s in the northern Minusinsk Basin, southern Siberia, have produced evidence of very early human occupation of this part of Siberia dating at least to the late middle Pleistocene. The main study area, referred to as the Kurtak Archaeological Region, is located in the upper Yenisei River valley (91° W longitude and 55° N latitude) in a tectonic depression of the eastern part of the Altai-Sayan Mountain System. The present climate is dry and strongly continental with mean annual temperature -0.5 °C, and maximum temperature deviations of -56°C and +37°C. Parkland steppe covers the interior basin, which is surrounded by southern taiga.

Research was initiated after progressive erosion of unconsolidated, largely aeolian slope deposits by water-table fluctuation of the Krasnoyarsk reservoir that flooded the valley to about 60 m above the original river level. The 10- to 40-m-high sections along the lake shore exposed a nearly complete late-Quaternary geological record containing a series of early- to late-Paleolithic stone industries and a rich middle- and upper-Pleistocene fauna (Derevianko, Drozdov and Chekha 1992; Drozdov *et al.* 1990). Until the ponding of the Yenisei, the oldest archaeological finds known in the region dated to about 30,000 yr B.P.

Most of the early-Paleolithic record comes from the 60- to 65-m terrace. The lower terraces of the Yenisei River are now under the lake. The high terraces (70–90 m, 110–130 m, 150–170 m), dating from the early Pleistocene to Pliocene, are preserved mostly as relics. In addition to several middle- and upper-Paleolithic cultural horizons recorded within the late-Pleistocene loess deposits, several sites have been recognized with older lithic industries largely redeposited by past as well as present hydrologic processes. After the first finds of an archaic lithic industry at the Berezhekovo Site in 1987, four other major locations with early-Paleolithic stone tool occurrences include the Kamennyj Log, Sukhoj Log, Verkhnyj Kamen and Razlog sites. At all sites, most of the artifactually modified cobbles made on local clastics have been found on the surface of the eroded 60- to 65-m-high terrace relict exposed by wave undercutting of the slope overburden. Artifacts have been washed from their original geological context onto the present beach, together with fossil fauna and later Paleolithic stone tools derived from loess deposits above the terrace. Ongoing wave action has caused sorting of the flaked lithics and other clastic materials. This phenomenon is particularly apparent at the Kamennyj Log Site, extending 2–4 km south of Berezhekovo, with large flaked cobbles concentrated in the

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southern part of the site, and most of the small-sized artifacts and lithic fragments dispersed in the northern part. At the Sukhoj Log and Verkhnyj Kamen Sites, most of the coarse pebbly alluvium has been washed away, and the macrolithic industry is found directly on the Carboniferous sandstone bedrock that forms prominent ramparts elevated 1 to 7 m above the lake. A more complex situation is found at the Razlog Site. An abundant lithic industry is distributed with large mammal bones among cobble gravels on the shore at the foot of an eroding 20-m-high alluvial fan capped by 10–15 m of late-Pleistocene aeolian and colluvial sediments. Except for artifacts from the eroded 60-m terrace, most of the modified lithics have been introduced from the slope

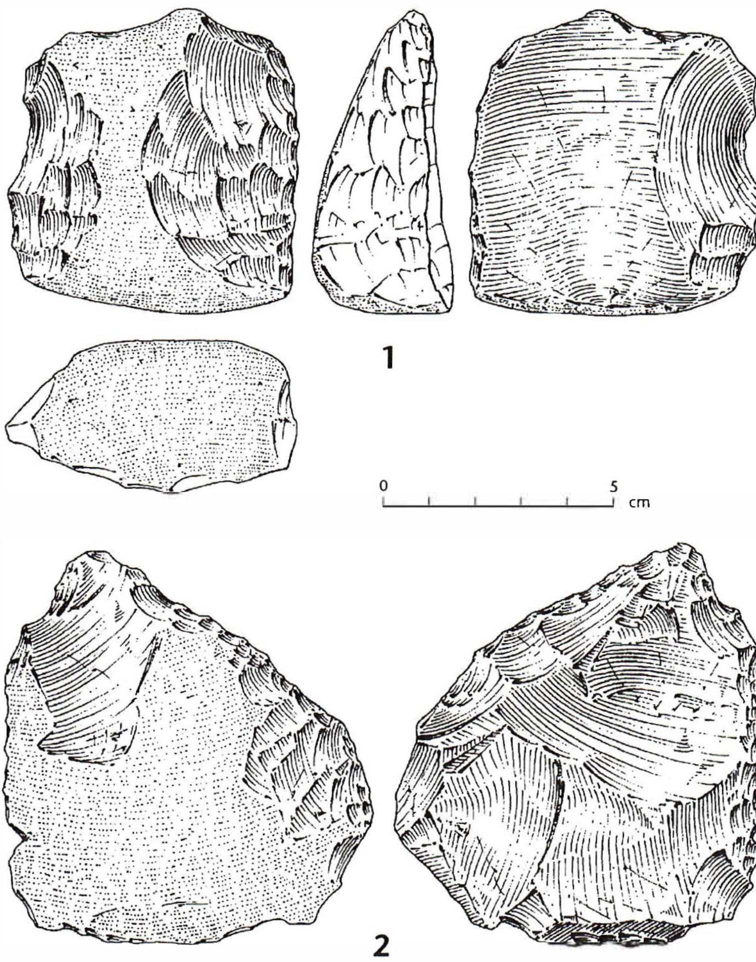

Figure 1. Berezhekovo Site. Early Palaeolithic (late middle Pleistocene) stone industry: 1–2, retouched quartzite flakes.

alluvium, including weathered gravels derived from the highest (130–150 m) terraces. A large-scale excavation has been carried out at the Berezhekovo Site (Derevianko, Drozdov and Chekha 1992; Drozdov et al. 1990).

At all sites, large clastic raw materials (mostly quartzite, less vein quartz and basalt), collected from the fluvial/alluvial gravels, were used for stone-tool production. At least two early-Paleolithic industries can be recognized on the basis of degree of corrosion. The first (older) series, constitutng part of the collections from the alluvial fan at the Razlog Site, is characterized by weathered, stained and heavily rolled quartzite tools with a uniform dark-brown or cinnamon patina covering both the unmodified as well as the flaked faces of particular specimens. The second (younger) series, including most of the stone artifacts from other sites, is distinguished by a lesser degree of abrasion and white unpatinated flake scars on cobbles with yellowish cortex. No apparent technological and typological differences exist between the two rudimentarily modified "pebble industries," produced by hard-hammer, direct-percussion technique. Unifacial choppers and simple cobble cores are the most frequent artifact forms. A specific type with a protruding laterally flaked distal edge is often encountered in the archaic assemblage at Razlog. More elaborate flaking, present on some bifacial choppers, is rare. Most flakes exhibit limited unifacial or alternate retouch, although a few better-produced side scrapers occur (Figure 1).

Chronology of the early-Paleolithic record is based on chronostratigraphy of the industry-incorporating, largely alluvial, deposits. A (late) middle-Pleistocene age for the less-weathered early-Paleolithic collections is supported by their stratigraphic position beneath a complex of paleosols, including well-developed chernozemic soils from the last two interglacial periods, and the associated fauna derived from the high river terraces. Greater antiquity is assumed for the archaic-series lithic industry from the Razlog Site. Overall, the cultural evidence from the Minusinsk Basin shows that parts of southern Siberia in the main river valleys, including the upper Angara River Basin (Medvedev, Savel'ev and Svinin 1990), were occupied at several stages during the middle Pleistocene.

References Cited

Derevianko, A. P., N. I. Drozdov, and V. P. Chekha 1992 *Arkheologia, geologia i paleogeografia paleoliticheskikh pamiatnikov yuga sredneji Sibiri (Severo-Minusinskaya Vpadina, Kuznetskij Alatau i Vostochnyj Sayan)*. Excursion Guide of the International Conference "Palaeoecology and Settlement of Early Man in North Asia and America." Russian Academy of Sciences, Siberian Branch, Krasnoyarsk.

Drozdov, N. I., V. P. Chekha, S. I. Laukhin, V. G. Kol'tsova, E. V. Akimova, A. V. Yermolaev, V. P. Leont'ev, V. A. Vasil'ev, A. F. Yamskikh, G. A. Demidenko, E. V. Artem'ev, A. A. Vikulov, A. A., Bokarev, I. V. Foronova, and S. D. Sidoras 1990 *Khronostratigrafia paleolititcheskikh pamiatnikov sredneji Sibiri. Basein reki Yenisei.* Excursion Guide of the International Conference of the XIIth INQUA Congress "Chronostratigraphy of Palaeolithic of North, Central, Eastern Asia and America." Russian Academy of Sciences, Siberian Branch, Novosibirsk.

Medvedev, G. I., N. A. Savel'ev, and V. V. Svinin 1990 Stratigrafia, paleogeografia i arkheologia yuga sredneji Sibiri. Excursion Guide of the International Conference "Chronostratigraphy of Palaeolithic of North, Central, Eastern Asia and America." Russian Academy of Sciences, Siberian Branch, Novosibirsk. AN SSSR, Siberian Branch, Irkutsk.

Window on the Bering Land Bridge: A 17,000-year-old Paleosurface on the Seward Peninsula, Alaska

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Alaska, the Yukon, eastern Siberia, and the former Bering Land Bridge are commonly referred to as a single continental entity, Beringia. This area has repeatedly served as the gateway for species interchange between the Old World and the New. The paleoenvironment of Beringia during the late Pleistocene is of particular interest because humans probably spread to the New World during this period. There is a great deal of controversy over the composition of the Beringian environment during this period (Cwynar and Ritchie 1980; Guthrie 1990; Hopkins et al. 1982).

Views of the Beringian environment during the last cold cycle are derived mainly from vertebrate remains and pollen from lake-sediment cores; plant macrofossils dating from this time are scarce (Hopkins et al. 1982). In the early 1970s, Hopkins discovered an ancient vegetated land surface preserved beneath a tephra covering about 2,500 km^2 of the northern coastal plain of the Seward Peninsula. The area lies within the boundaries of the Bering Land Bridge National Park and Preserve. The tephra and the buried vegetated surface are underlain and overlain by thick, frozen windblown silt and sand. After the tephra fall, the permafrost table rose above the level of the vegetated surface, preventing bacterial decay. Plant remains from the buried surface date to approximately 17,000 radiocarbon yr B.P.

Exposures of the buried vegetated surface are found in walls of stream valleys and deep thermokarst lake basins that dissect the remains of the late-Pleistocene landscape. During the summer of 1993, we exposed the paleosurface at six sites within a few km of the mouth of the Kitluk River. At each site, several square meters of the surface was excavated and sampled and the morphology of the surface was carefully mapped. The buried surface consists largely of hummocks about 30 cm across separated by depressions about 5–10 cm deep. The hummocks were created either by frost heaving or by repeated wetting-drying cycles.

Samples were cleaned and sorted. Some were screen-washed, but many intact blocks were cleaned by soaking them in the water and gently brushing the dirt from the paleosurface with a paintbrush. Leaf fragments, woody stems, moss clumps, graminoid clumps, and two complete graminoid stems were recovered in this fashion. The most abundant graminoid remains are caespitose (tufted).

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Seeds found at three of our six sites are tentatively identified as *Trichophorum caespitosa,* a sedge found in moist places and on calcareous substrates. We also found leaves tentatively identified as *Salix phlebophylla,* a prostrate arctic willow. D. F. Murray aided in the identifications.

The remains of a rodent nest found at the "Ulu Lake" site (informal name) were examined by R. D. Guthrie. The material included a lower jaw of *Microtus miurus* (singing vole), which is commonly found today in mountain meadows. It is a subnivean nester that dries vegetation during the summer for use during the winter. The preservation of a subnivean rodent nest suggests that the tephra fell during late winter or early spring before nest materials became dispersed. Granular ice that may be firn and small masses of clear ice with horizontal upper surfaces that may be frozen puddles support this interpretation.

Our results seem to indicate that the vegetation that characterized the study area 17,000 yr B.P. was mesic and of low stature. The vegetation is consistent with Anderson's (1985; 1988) interpretation of pollen evidence from sites in northwestern Alaska. The hummocky ground surface provided micro habitats that increased the local variability of the vegetation. In 17,000 yr B.P., the northwestern section of the Seward Peninsula was a reasonably hospitable place for small mammals and prostrate, woody shrubs.

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References Cited

Anderson, P. 1985 Late Quaternary Vegetational Change in the Kotzebue Sound Are, Northwestern Alaska. *Quaternary Research* 24:3, pp. 307–321.

Anderson, P. 1988 Late Quaternary Pollen Records from the Kobuk and Noatak River Drainages, Northwestern Alaska. *Quaternary Research* 29:3, pp. 263–276.

Cwynar, L. C., and J. C. Ritchie 1980 Arctic Steppe-Tundra: A Yukon Perspective. *Science* 208:1375–78.

Guthrie, R. D. 1990 *Frozen Fauna of the Mammoth Steppe.* University of Chicago Press: Chicago.

Hopkins, D. M., J. V. Matthews, Jr., C. E. Schweger, and S. B. Young 1982 *Paleoecology of Beringia.* Academic Press: New York.

Lithic Refits at Walker Road: Continuing Studies into the Nenana Complex of Central Alaska

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Recent lithic-refit analysis has produced new insights into the Nenana Complex artifact assemblage from the Walker Road site. Walker Road site is located in the Nenana Valley of central Alaska and is situated on a strath terrace incised into

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early-Wisconsinan glacial outwash of the Nenana River (Powers and Hoffecker 1989). The site encompasses a southerly panoramic view of the river floodplain and central portion of the Alaska Range. The Nenana Complex tool assemblage at Walker Road consists of scrapers, perforators, cobble tools, retouched flakes and blades, wedges, and bifacially and bimarginally worked points or knives that date to before 11,000 yr B.P. (Goebel et al. 1991, Hoffecker et al. 1993).

Three spatially discrete activity areas are identified at Walker Road (Goebel et al. 1991; Powers et al. 1990). Horizontal distribution of artifacts shows two concentrations associated with well-defined hearths. One hearth (Area A) is located near an eroding terrace edge. An elliptical pattern of artifacts is loosely concentrated around this feature. The other hearth (Area B) is surrounded by a 3-m radius of lithic tools and debris that form a distinct circular pattern around the hearth. The third concentration (Area C) is a dense cluster of lithic debitage covering a small area near the terrace edge. Areas A, B, and C are located within an area 12 m square.

Refit-analysis objectives were to reconstruct lithic-reduction sequences and to study refit intra-site and inter-site relationships among the distinct artifact concentrations. The majority of refits occur on two distinct variable-grade cherts and various occurrences of black siltstone. Although no complete cobble reconstructions are possible with existing lithic material, partial reassemblies demonstrate that three asymmetrical, variable-grade cobbles weighed at least 1000 g prior to reduction.

Forty-five tan chert artifacts conjoin to a core, ten of which were utilized as flake tools. Cobble reconstruction indicates that flakes were removed from the core as the cobble was rotated while using the cortex margin as the striking platform. The core itself was used as a scraper. All tan chert in the assemblage comes from Area B, except for one primary flake located 10 m away in Area A.

Refits of black siltstone raw material are ascribed to three separate core reductions. Twenty-one flakes refit directly to one of three cores. Large flakes struck from the core took advantage of a naturally flat cortex as a platform. No refit secondary flakes exhibit wear or retouch and there are no primary cortical reduction flakes. This series of refit flakes demonstrates the knapper's intention to produce a core tool (convergent plane).

Another black siltstone core tool has similar characteristics as the above described sequence except for the final manufacturing step. The planar face of the core was created by a single cleaving blow. The flake resulting from the cleaving blow has a linear retouched, beveled scraper edge. Also, a small set of refitted black siltstone flakes represents the end of a reduction sequence from a third fist-sized core. The sequence consists of three irregular flakes, which conjoin to an exhausted prismatic blade core. Although black siltstone artifacts were found around both hearths, refits were made in Area B only.

No core was recovered for 35 refit green chert artifacts. Primary flakes were removed from the hypothetical core until a suitable platform enabled a series of flake removals (blade blanks). One refit includes an end scraper made on a blade. Natural banding in the green chert material indicates that several blades were struck from the same hypothetical core at a 90-degree angle from the above described blade series. One of three blade blanks struck from this angle exhibits retouch along the distal end, suggesting its use as a scraper and later use as a notched tool when the scraper end snapped off. Refit green chert artifacts are found in areas A, B, and are exclusive to Area C.

Intra-area refitting suggests that the two largest artifact concentrations, areas A and B, are locations of specialized hearth-related activities including primary and secondary lithic reduction, while Area C is interpreted as a related but peripheral secondary reduction area or lithic refuse dump. Inter-area refitting of tool fragments and debitage demonstrates links between areas A, B, and C, suggesting their contemporaneity and possible successional seasonal occupations. The refit analysis suggests that the primary technological strategy involved selection of locally available variable-grade raw materials for expedient on-site production and use of flake and blade uniface tools.

References Cited

Goebel, T., W. R. Powers, and N. H. Bigelow 1991 The Nenana Complex of Alaska and Clovis Origins. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp. 49–79. Center for the Study of the First Americans, Oregon State University, Corvallis.

Hoffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–53.

Powers, W. R., and J. F. Hoffecker 1989 Late Pleistocene Settlement in the Nenana Valley, Central Alaska. *American Antiquity* 54:263–287.

Powers, W. R., F. E. Goebel, and N. H. Bigelow 1990 Late Pleistocene Occupation at Walker Road: New Data on the Central Alaskan Nenana Complex. *Current Research in the Pleistocene* 7:40–43.

Buried Soils on Seward Peninsula: A Window into the Paleoenvironment of the Bering Land Bridge

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Currently the paleoenvironment of the late-Pleistocene Bering Land Bridge (and on a larger scale, of Beringia) is still virtually unknown and remains a source of controversy. The existing data appear contradictory. Palynologists, such as Ritchie, Cwynar, and Colinvaux (as cited in Guthrie 1990: 226), argue in favor of a Polar Desert, or sparse, dry tundra, environment. Vertebrate paleoecologist Guthrie (1990) believes that aridity played a key role. According to his hypothesis the dry, cold climate caused the vegetation to shift to a steppe

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tundra with a dominance of grass. It is also possible that the environment was similar to the tundra of modern Seward Peninsula, N.W. Alaska.

Further information about the paleoenvironment of the Bering Land Bridge can be retrieved through the study of paleosols dating from the last glacial maximum occurring on the northern Seward Peninsula. About 17,000 years ago, tephra ejected from a volcanic eruption covered a large area surrounding the craters (today's Devil Mountain Lakes). The soils that were buried froze shortly after the eruption and have been frozen ever since. During the 1993 field season, we located and excavated these well-preserved soils at 11 different sites. The morphological properties of two profiles are discussed here.

Both profiles developed in loess, and all horizons contain carbonates and fine roots. They are distorted and have dominantly platy structure. Profile 1 shows three sequences of A and Bw horizons, and a secondary blocky structure is present at 70 cm. Profile 2 has a Bw, BC, Bg sequence. The profile is 45 cm thick and underlain by massive ice.

The distorted horizons indicate cryoturbation. The multi-sequence in Profile 1 suggests local environmental or regional climatic changes that resulted in alternate processes of syngenesis (Bw horizon) and epigenesis (A horizon). Fine platy structure is typical for active layers, and its continuous distribution throughout the profile shows that all horizons have been part of the active layer at different times (another indication for the input of loess over a long period). Blocky structure at about 70 cm is caused by ice-net formation immediately above the permafrost table (Ping et al. 1993:63). Therefore the depth of this active layer was approximately 70 cm at the time of the burial.

Profile 2 is underlain by massive ice, which most likely caused water to be perched immediately above it. This resulted in reducing conditions, as indicated by the dark-gray color of the Bg horizon. Fine platy structure again is typical for the active layer. The top of the massive ice probably indicates the top of the permafrost table. Therefore the depth of the active layer at this site would have been 45 cm.

In short, the properties of the paleosols studied to date indicate that 1) Little organic matter accumulated, 2) Depths of active layers range from 40–70 cm, compared with 30–40 cm in modern soils in the area, 3) Platy and blocky structure and evidence of cryoturbation are present, 4) Fine roots occur throughout the profile; larger roots appear occasionally, 5) Soil development is weak (organic matter accumulation in A horizon, oxidation in Bw horizon, and reduction in Bg horizon), and 6) Carbonates are present throughout the profile.

These properties suggest the following:

- The small amount of organic matter accumulated could be attributed to 1) very sparse vegetation, 2) rapid mineralization of organics, or 3) constant loess accretion that resulted in a lack of time for organic accumulation.
- A vegetation type that provided little soil insulation could have been responsible for the relatively deep active layers. Warmer summers and/or more precipitation during the summer might be other explanations.
- The dominance of fine roots can probably be accredited to the presence

of grasses or other herbs in the ancient vegetation. Presence of roots throughout the profile also suggests continuous loess deposition.

- Weak soil development can most likely be attributed to the arctic environment, presence of carbonates, and syngenetic soil-forming conditions.

In summary, the paleosols show little evidence for tundra or polar desert environments, whereas most properties support a steppe tundra environment for the late-Pleistocene Bering Land Bridge on northern Seward Peninsula. We point out that these conclusions are tentative and further research needs to be done.

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References Cited

Guthrie, R. D. 1990 *Frozen Fauna of the Mammoth Steppe.* University of Chicago Press, Chicago.

Ping, C. L., S. Gubin, G. G. Mazhitova, and Y. L. Shur 1993 Soil Characteristics of the Upper Edoma Formation, N.E. Russia. In *23rd Annual Arctic Workshop Program and Abstracts.*, p. 63. The Ohio State University, Columbus, OH.

Human Presence in Heilongjiang, China, along the Late Pleistocene Periphery of Beringia

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Although it is common to think of upper-Pleistocene hominid expansion into cold and open landscapes from a European perspective, China has an ancient hominid history, extending a million or more years into the past. Archaic and anatomically modern humans in China had similar opportunities to move northward; some researchers even see northern China as the locale in which the gene pool for Amerindian populations was organized 20,000 or more years ago. Heilongjiang, China's northernmost province, has a key geographic situation in this regard, ultimately communicating with greater Beringia via the Amur drainage (and the Sea of Okhotsk continental shelf) as well as the Mongolian steppes (within reach of the headwaters of major rivers flowing northward into Siberia and the Lake Baikal region).

Heilongjiang had a rich upper-Pleistocene fauna, certain to have been attractive to early human populations. The province has dozens of find-spots

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for mammoth, as well as many other extinct species. Collaborative work between the Provincial Museum of Alberta and the Archaeological Institute of Heilongjiang suggests that this fauna was well represented in the interval from 45,000 to 20,000 yr B.P., as indicated by a new series of 16 conventional and AMS radiocarbon dates from animal-bone and wood remains at seven paleontological and archaeological sites. Hints of human activities associated with these faunal assemblages have been evident for several decades at localities like Huang Shan in Harbin. Two sites excavated in the 1980s, however, have the greatest current potential to illuminate Pleistocene human presence in this region (Yu 1988; Yu and You 1988).

Abundant mammoth, woolly rhinoceros, horse and bison remains have been recovered from anaerobic deposits about 8 m beneath the surface at Xue Tian, near the Jilin border. Mammoth bones from an organic-rich surface (or possibly, a series of surfaces) yielded dates of 38,800 ± 3,500 yr B.P. (AECV-1405C), 39,600 ± 3,000 yr B.P. (AECV-1407C) and 40,200 ± 3,500 yr B.P. (AECV-1406C) These are situated beneath pine and fir wood fragments AMS dated, in stratigraphic order, at 35,010 ± 370 yr B.P. (TO-2607) and 37,840 ± 420 (TO-2608). Excavations in 1993 revealed a beveled bone projectile point, three ivory flake tools, one bone specimen with polished facets, fragments of orange rhyolite identical to a flake from 1986 excavations at the site, and at least one bone with cut-like alterations.

The chronostratigraphic context is less clear at Yanjiagang, just outside of Harbin. Twenty-five large and small mammal species (including mammoth, woolly rhinoceros, bison, giant elk, tiger, wolf, and hyena) recovered from predominantly fine-grained sediments have yielded five radiocarbon dates ranging from >41,300 yr B.P. (AECV-1404C) to 26,560 ± 670 (AECV-1402C) yr B.P. Despite instances of extraordinary bone preservation, the Yanjiagang assemblage has been heavily ravaged by carnivores of all sizes. There are enigmatic traces of human presence, however, among them a chert core fragment, a few chert and rhyolite flakes, and an apparently sawn antler. Yanjiagang has also produced two semicircular bone and earth structures (roughly 3.5 m in diameter) that may be of human origin (You et al. 1986).

Heilongjiang was undoubtedly occupied in the interval between 21,000 and 13,000 years ago, but there is currently no evidence of human presence then. After 13,000 years ago, terminal Paleolithic and Neolithic sites are better known. Several (e.g., Ang Angxi, Wufu, Tenjiangang) are concentrated in the Qiqihar region, and west to the Inner Mongolian Border (e.g., the Jingcing site near Longjiang). There is also the site of Shibazhan, Huma County, just to the south of the Amur River. Lower levels at some of these sites have dates in the range of 12,000 to 7,500 years of age. Assemblages are marked by well-developed microcore industries, bone tools such as harpoons, and faunal remains that include small mammals, fish and mollusks.

References Cited

Yu H. 1988 A preliminary study of the Paleolithic cultural site at Xue Tian in Wuchang, Heilongjiang Province (in Chinese). *Acta Anthropologica Sinica* 7(3):255–262.

Yu H., and Y. You 1988 A study of structures and taphonomic processes at the Yanjiagang site in Harbin, China (in Chinese). *Archaeology and Cultural Relics* 4:8–15.

You Y., Q. Xu, Y. Li, and C. Ho 1986 Seasonality and site structure of Late Paleolithic sites in northeastern China. *Current Research in the Pleistocene* 3:97–102.

Terminal Pleistocene Occupation of the Kheta Site, Upper Kolyma Region, Northeastern Russia

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Sites that date to the Pleistocene or early Holocene are rare in western Beringia. With the exception of the Ushki sites in the Kamchatka Peninsula (Dikov 1979) and the Berelekh site on a tributary of the lower Indigirka River, no sites east of the Verkoyansk Range can be dated reliably to this time (Hoffecker et al. 1993; Michael 1984; Powers 1973). The lack of early sites underscores the significance of new finds. Here we report on the discovery of the Kheta site in the Upper Kolyma region, Magadan Oblast, northeastern Russia. Preliminary excavations in 1991 and 1992 revealed a multicomponent site. Of special interest is a lower component that is likely terminal Pleistocene in age.

The site, at an elevation of 800 m, is on a terrace ca. 15 m above the confluence of the Right and Left Kheta Rivers. A stratigraphic cross section of the terrace deposits reveals an inset terrace relationship. The basal unit is bedrock shale. Gravel on the bedrock surface indicates that the terrace was scoured prior to the deposition of sands, an event that occurred during the Kargin (middle Wisconsin equivalent) warming epoch (Glushkova 1984). At 12 m from the terrace edge 30–40 cm of clean alluvial sand overlays the bedrock and gravel. No artifacts were found here. Toward the terrace edge is an aeolian re-worked sand overlain by an early-Holocene tephra, the Elikchan tephra dating to ca. 8,300 yr B.P. (Beget et al. 1991). The aeolian sand has a high organic content providing evidence of a buried soil beneath the tephra. The aeolian sand is likely a terminal-Pleistocene deposit (O. Yu. Glushkova, pers. comm.). Artifacts were found beneath the aeolian sand and lodged within the gravel and bedrock schist.

Finds include a microblade core, microblades, a ski-spall, four bifaces/biface fragments, two scrapers, one burin, two pendants, and lithic debitage. The assemblage is typologically similar to material from the upper Paleolithic "Diuktai culture" in the Aldan valley (Mochanov 1977) and the material from Ushki Level VII in Kamchatka (Dikov 1979). The microblade core can be described as wedge-shaped (Figure 1A). It was manufactured from a biface that was struck longitudinally (removing a flake called a "ski-spall") to form a platform. Microblades

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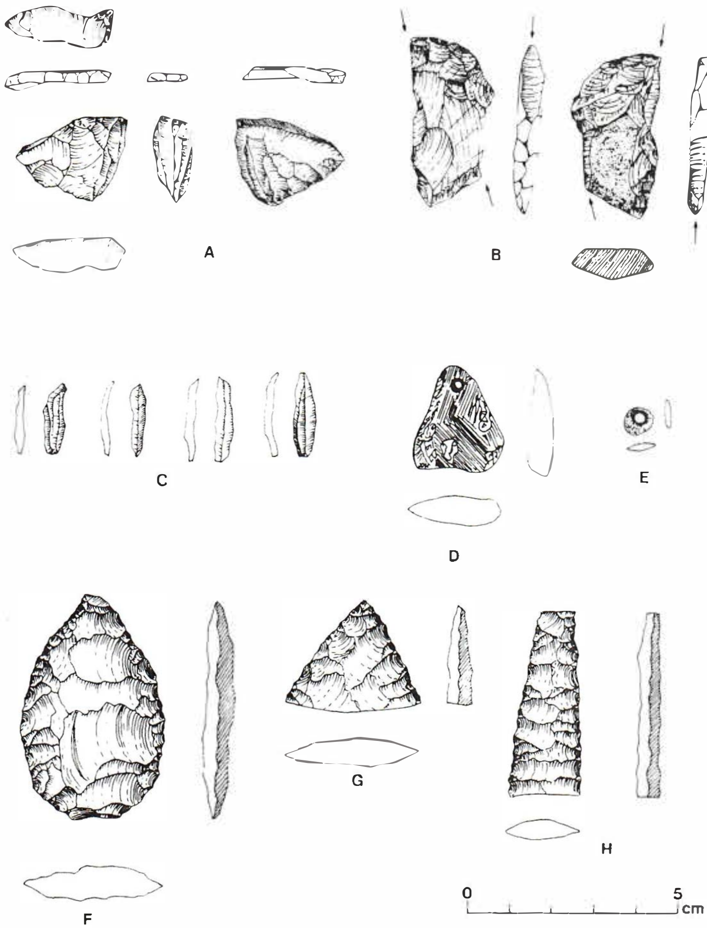

Figure 1. Select artifacts form the Kheta site. A: microblade core and ski spall; B: burin; C: microblades; D, E: pendants; F, G, H: biface/biface fragments.

were removed from one end of the biface. One of the blades exhibits retouch on the distal end that converges to form a point (perforator).

Of the four bifaces/biface fragments, three appear to represent finished forms (Figure 1F, G, H). The fourth may be a preform for a microblade core. The two scrapers were made on flakes that have a trapezoidal cross section (possibly blades) and exhibit steep unifacial retouch on the distal margins. The burin was manufactured from a biface and exhibits traces of burin blows on the opposing ends (Figure 1B). Finally, two pendants were found (Figure 1D, E). Each has a biconically drilled hole. There is no serious argument that the earliest peoples in eastern Beringia came from Asia, nor that they traveled across the Bering Land Bridge. However, recent colonization models of eastern Beringia that attempt to identify the prehistoric "cultures" responsible for specific migration episodes (for example, Diuktai culture and American Paleoarctic tradition [Dixon 1993; Hoffecker et al. 1992]) are premature. The early prehistory of western Beringia is virtually unknown. Before any real understanding of the relationship between the early peoples of western and eastern Beringia is possible, the culture history of western Beringia must be known empirically. We are conducting additional research at the Kheta site that will provide important data about terminal-Pleistocene occupation of the Upper Kolyma region.

References Cited

Beget, J. E., D. M. Hopkins, A. V. Lozhkin, P. M. Anderson, and W. R. Eisner 1991 The Newly Discovered Elikchan Tephra on the Mainland of Soviet Asia. *Geological Society of America Abstracts with Programs, 1991*, A62.

Dikov, N. N. 1979 *Drevnie Kul'tury Severo-Vostochnoi Azii (Ancient Cultures of Northeast Asia).* Nauka, Moscow.

Dixon, E. J. 1993 *Quest for the Origins of the First Americans.* University of New Mexico Press, Albuquerque.

Glushkova, O. Yu. 1984 Morfoloiya i Paleogeografiya Pozdnepleistotsenovykh Oledenenii Severo-Vostoka SSSR (Morphology and Paleogeography of the Late Pleistocene Glaciations of East Asia, USSR). In *Pleistotsenovie Oledeneniya Vostoka Azii*, pp. 28–42. Magadan.

Hoffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–53.

Michael, H. N. 1984 Absolute Chronologies of Late Pleistocene and Early Holocene Cultures of Northeastern Asia. *Arctic Anthropology* 21(2):1–68.

Mochanov, Y. A. 1977 *Drevneishie Etapy Zaseleniya Chelovekom Severo-Vostocnoi Azii (Most Ancient Stages of Human Settlement in Northeast Asia).* Nauka, Novosibirsk.

Powers, W. R. 1973 Paleolithic Man in Northeast Asia. *Arctic Anthropology* 10(2):1–106.

Paleolithic of the Russian Far East: A Geoarchaeological Aspect of the Problem

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Edited and translated by Andrzej Weber

The Paleolithic of the Russian Far East has been reported from a total of about 100 sites. Some of these collections (e.g., Ushki, Ust'-Ul'ma, Ustinovka, and Osinovka) have been used to correlate the North Asian Paleolithic with North American archaeological sequences. Unfortunately, the quality of the Far East record can be criticized because geoarchaeological data were not collected, and

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stratigraphy and planigraphy were poorly controlled on most sites excavated prior to the 1980s. Despite these deficiencies, some interesting patterns emerge. For example, microblade industries were used during the late Paleolithic, and the southern version differed slightly from the technique used farther north. Other regional similarities and difference also existed; however, the meaning of these patterns remains unclear.

Primor'e (Maritime province)

About 50 Paleolithic sites are known from this area, and some were extensively excavated (e. g., Ustinovka 4–800 m²). Published interpretations of these materials are often contradictory. According to the Novosibirsk group, archaeological evidence from Primor'e includes occupations from the early Paleolithic (Osinovka lower horizon), early upper Paleolithic (Ustinovka 1 lower horizon), and late and final Paleolithic, mainly on the basis of typology (Derevianko 1985:111–112; Okladnikov 1959:26–37; Okladnikov and Derevianko 1973:63–81; Vasil'evski and Gladyshev 1989:3–18). The Far East group believes, mainly on the basis of geoarchaeology, that there is no firm evidence for early dating of these deposits (D'iakov 1986a, 1986b; Lynsha 1989, 1992). For example, at Gorbatka 3, two levels were identified with ice wedges: an upper horizon with small pseudomorphs up to 20 cm long, and a lower level where the wedges were up to 60 cm long and 1.2 m wide at the top. The lower horizon can be synchronized with the last glacial climatic minimum (Partisansk—11,500 yr B.P.), and the upper with the early-Holocene climatic minimum (9,000–8,000 yr B.P.). Sheet erosion was another natural agent responsible for artifact redeposition. Since the geological contexts of the Primor'e Paleolithic sites are, in most cases, very similar, cryoturbation and sheet erosion are suggested to be responsible for the lack of original living floors with features, and for having redeposited the artifacts, which are found only in secondary contexts entrapped between levels with ice wedges. Chronological position of these disturbed assemblages can be narrowed down to the period between large and small ice-wedge formation, i.e., some time between 11,000 and 8,000 yr B.P.

Cis-Amur

Early fieldwork in this region involved such sites as Kumary Cave, the Osipovka group of sites, Philimoshki, Gatsya, and Bogorodskoe. Chronology of these collections was estimated purely by typology (surface collections from Kumary, Philimoshki, and Bogorodskoe, Derevianko 1983:82–82; Okladnikov and Derevianko 1973:83–84), or it is questionable because of the possibility of later intrusions (Gatsya).

During the last ten years, fieldwork in the Zeia River valley produced new materials. The Paleolithic assemblage at Novoribachii was dated to 20,000–15,000 yr B.P. on the basis of its archaic appearance and stratigraphic position. The sites of Barkanskaia sopka 1 & 2 have similar stratigraphies consisting of two cultural horizons (Derevianko, Volkov and Grebenshikov 1987). Lithics of the upper level are similar to the Neolithic Gromatukhinskaia culture of the Zeia River. The tool kit of the lower level resembled the Novoribachii material. Both cultural levels were intersected by small ice wedges (20–25 cm).

At the Ust'-Ul'ma group of sites (Ust'-Ul'ma 1, 2, and 3) the lithic material, also trapped between two levels of ice wedges, was typologically divided into four horizons: 24,000–20,000 yr B.P., 20,000–18,000 yr B.P., 17,000–13,000 yr B.P., and 12,000–10,500 yr B.P. This chronology was based on the assumption that the lower and upper ice-wedge horizons date to the Gydan'sk and Noril'sk stages of the Sartan stadial (Zenin 1992).

The evidence for the chronology of the Cis-Amur Paleolithic is inconclusive. Geoarchaeological data are rare and stratigraphy is unclear; chronology is often based on typology, even of surface collections; and chronology based on ice-wedge horizons is probably pushed too far back (small ice wedges were still forming in the early Holocene).

Okhotsk Sea Coast

The Paleolithic record from this region is limited to three sites: Siberditsk, Kongo, and Durchak. The most important appears to be the Siberditsk site on the Detrin river (800 m^2 excavated by Dikov). Bifacial projectile points and small wedge-shaped cores recovered from a living floor had features dated by radiocarbon to 8,000 yr B.P. (Dikov 1977). Paleolithic deposits at Kongo were found on two levels (Dikov 1977). The lower horizon, with conical microcores, has a radiocarbon date of about 9,000 yr B.P. The upper horizon, radiocarbon-dated to about 8,000 yr B.P., yielded bifacially retouched arrowheads, and small blades. At the Durchak B site, artifacts were found in two layers, but cryoturbation mixed them (Vorobei 1992). Pollen data suggest that the cultural horizons were formed at the Pleistocene/Holocene boundary. Again, despite quite reliable radiocarbon dating of the Siberditsk and Kongo deposits, insufficient data exist for a synthesis.

Kamchatka

The Kamchatka Paleolithic is known mainly from the complex of Ushki 1, 2, 3, and 5 sites (a total of about 2200 m^2 excavated, Dikov 1977, 1979; Dikov et al. 1977). Ushki is unique because rich lithic material was found on original living floors dated by radiocarbon and separated by layers of volcanic ash. In this complex Dikov identified three Paleolithic strata: Layer V with wedge-shaped cores, bifacial projectile points, and microblades; Layer VI characterized by wedge-shaped cores on bifaces, conical microcores, microblades, small leaf-shaped projectile points, and bifacial tools; controversial small stemmed projectile points came from the lowest Layer VII.

Unfortunately, several issues of substantial relevance remain unclear. First, despite several publications, the spatial relationships between separate segments of the Ushki group of sites require clarification (are they separate sites or just distinct excavation units within one site?). Second, even though layers of volcanic ash should provide excellent stratigraphic control, the strata identified as Paleolithic do not correlate well with each other. Two other questions relate to the lowest Paleolithic level (VII). The two radiocarbon dates indicate an age of 13,000–14,000 yr B.P., which appears to be too old when compared with a cluster of dates around 10,500 yr B.P. from layer VI (Okladnikov and Vasil'evskii 1976). The charcoal samples for layer VII were collected from a burial pit that cut through underlying strata containing charcoal but no artifacts. Thus older material possibly intruded into the filling of the burial pit. Finally, small stemmed projectile points from Layer VII are unknown elsewhere in Siberia until the early Holocene (Mochanov and Fedoseeva 1982).

Sakhalin

The Paleolithic of this region seems to be the least known of all regions reviewed in this paper. Only two lithic sites have been excavated, that is, Sokol II (Golubev and Lavrov 1988) and Imchin I (Vasil'evskii 1973), plus a surface collection from Takoe (Golubev and Lavrov 1988). At Sokol II, cultural remains were discovered on two levels yielding obsidian-hydration dates ranging from 16,000 to 11,000 yr B.P. Wedge-shaped cores, unifacial and bifacial preforms, points, blades, and microblades typologically correspond with late-Shirataki (15,000–12,500 yr B.P.) and Togeshita (12,500–11,000 yr B.P.) assemblages. Geoarchaeological evidence is lacking, and the role of natural agents in site formation processes is unknown.

In summary, the Paleolithic evidence from the Russian Far East can be characterized by a general paucity of geoarchaeological data and rare evidence for pollen and fauna, despite good preservation on some sites. Relative chronology is questionable on most sites because of dubious stratigraphy and destruction of primary contexts by cryoturbation and sheet-erosion. Inconclusive evidence is present for sites earlier than late Paleolithic.

References Cited

D'iakov, V. I. 1986a Kamennyi vek Primor'ia: problemy i sostoianie izuchennosti [The Stone Age of the Primor'e: Issues and the state of research]. In *XXVII s'ezd KPSS i problemy razvitiia Dal'nego Vostoka SSSR i zarubezhnykh gosudarstv*, pp. 18–21. Vladivostok.

D'iakov, V. I. 1986b Nekotorye aspekty kul'turogeneza na iuge Dal'nego Vostoka [Some aspects of the origin of culture in south Far East]. In *Istoria i kul'tura Vostochnoi i Iugo- Vostochnoi Azii*, pp. 3–12. Moscow: Nauka.

Derevianko, A. P. 1983 *Paleolit Dal'nego Vostoka i Korei* [The Paleolithic of the Far East and Korea]. Novosibirsk: Nauka.

Derevianko, A. P. 1985 Paleolit Tikhookeanskogo basseina [The Paleolithic of the Pacific Ocean Basin]. In *Problemy Tikhoekeanskoi arkheologii*, pp. 42–125. Vladivostok: Izdatel'stvo Dal'nevostochnogo universiteta.

Derevianko, A. P., P. V. Volkov, and A. V. Grevenshikov 1987 Paleoliticheskie kompleksy Barkasnoi sopki na r. Seleme [Paleolithic complexes of the Barkasnaia sopka on the Selema River]. In *Drevnosti Sibiri i Dal'nego Vostoka*, pp. 73–82. Novosibirsk: Nauka.

Dikov, N. N. 1977 *Arkheologicheskie pamiatniki Kamchatki, Chukotki i Verkhnei Kolymy. Aziia na styke s Amerikoi v drevnosti* [Archaeological Sites of Kamchatka, Chukotka and the Upper Kolyma River. Contacts Between Asia and America in the Past]. Moscow: Nauka.

Dikov, N. N. 1979 *Drevnie kul'tury Severo-Vostochnoi Azii* [Early Cultures of the Northeast Asia]. Moscow: Nauka.

Dikov, N. N., E. E. Titov, T. D. Davidovich, and A. V. Lozhkin 1977 Kompleksnoe issledovanie mnogosloinoi paleoliticheskoi stoianki Uskhi V na Kamchatke [A complex investigations of the multilayered Paleolithic site Ushki V on Kamchatka]. In *Trudy Magadanskogo otdeleniia Geograficheskogo obshchestva SSSR:* Vladivostok.

Golubev, V. A., and E. L. Lavrov 1988 *Sakhalin v epokhu kamnia* [Sakhalin During the Stone Age]. Novosibirsk: Nauka.

Lynsha, V. A. 1989 Problemy vozrasta Ustinovskoi kul'tury v svete noveishikh issledovanii mezolita v Iugo-Zapadnom Primor'e [The age question of the Ustinovka culture in the light of recent investigations of the Mesolithic of the south-west Primor'e]. In *Problemy izucheniia pamiatnikov kamennogo veka i paleometalla Dal'nego Vostoka i Sibiri,* pp. 3–7. Vladivostok: Dal'nevostochnoe otdelenie AN SSSR.

Lynsha, V. A. 1992 Otkrytie paleolita na severe Primor'ia [Discovery of the Paleolithic in the northern Primor'e]. In *Paleoecologiia i rasselenie drevnego cheloveka v Severnoi Azii i Amerike,* edited by A. P. Derevianko, N. I. Drozdov, E. V. Akimova, and V. P. Chekha, pp. 168–171. Krasnoiarsk: Zodiak.

Mochanov, I. A., and S. A. Fedoseeva 1982 Mnogosloinaia stoianka Ushki na Kamchatke i ee mesto v drevnei istorii Severo- Vostochnoi Azii [The multilayered site Ushki on Kamchatka and its place in the early history of Northeast Asia]. In *Tezisy dokladov k regional'noi konferentsii.* Irkutsk: IGU.

Okladnikov, A. P. 1959 *Dalekoe proshloe Primor'ia* [Early Past of the Primor'e]. Vladivostok: Primorskoe knizhnoe izdatel'stvo.

Okladnikov, A. P., and A. P. Derevianko 1973 *Dalekoe proshloe Primor'ia i Priamur'ia* [Early past of the Primor'e and Priamur'e]. Vladivostok: Dal'nevostochnoe knizhnoe izdalel'stvo.

Okladnikov, A. P., and R. S. Vasil'evskii 1976 *Po Alaske i Aleutskim ostrovam* [Across Alaska and the Aleutian Islands]. Novosibirsk: Nauka.

Vasil'evskii, R. S., and S. A. Gladyshev 1989 *Verkhnii paleolit Iuzhnogo Primor'ia* [The Upper Paleolithic of the south Primor'e]. Novosibirsk: Nauka.

Vorobei, I. E. 1992 Durchak B—novaia dokeramicheskaia stoianka v Severnom Priokhot'e [Durchak B—a new preceramic site in north Okhotsk area]. In *Paleoekologiia i rasselenie drevnego cheloveka v Severnoi Azii i Amerike,* edited by A. P. Derevianko, N. I. Drozdov, E. V. Akimova, and V. P. Chekha. Krasnoiarsk: Zodiak.

Zenin, V. N. 1992 Vozrast i etapy razvitiia kamennoi industrii pamiatnikov Ust'-Ul'ma 1–3 v Priamur'e [Chronology and development of the stone industry of the Ust'-Ul'ma 1–3 sites in Priamur'e]. In *Paleoecologiia i rasselenie drevnego cheloveka v Severnoi Azii i Amerike,* edited by A. P. Derevianko, N. I. Drozdov, E. V. Akimova, and V. P. Chekha, pp. 99–102. Krasnoiarsk: Zodiak.

Early Cultures of the Mackenzie Drainage to Keewatin Barrenlands Area of Northern Canada

Raymond J. Le Blanc

Evidence for early (ca. 8,000 yr B.P. and older) human occupation is scanty in the vast area east of the Rocky Mountains, including portions of northern Alberta, adjacent British Columbia, and the districts of Mackenzie and Keewatin in the Northwest Territories. Sporadic archaeological research since the 1950s by university, government and, since the early 1980s, private-sector researchers, has revealed a few dated, well-known sites, and many more that are undated. Early components in the eastern Keewatin area are best represented by the Grant Lake (Wright 1976, 1981) and Migod sites (Gordon 1976), which are located west of Baker Lake. Here there is evidence for early post-glacial

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migration into the region by Northern Plano-tradition peoples, approximately 8,000 years ago. This interpretation is based mainly on the presence of a fairly large sample of Agate Basin-type projectile points that are similar to specimens from the type site in Wyoming. Other sites with similar projectile points suggest a distribution of these caribou-hunting peoples from northern Saskatchewan to Schultz Lake, northwest of Baker Lake (Gordon 1981).

In the District of Mackenzie, the earliest occupation is suggested by a single fluted-point base, described as Clovis-like, from an undated site (JgSd-3) in the southern Mackenzie Mountains area (Hanks 1992). The point is a surface find, and although evidence of quarrying activity was also found at the site, the relationship of the fluted point to the remainder of the assemblage is unclear. Later in time and more well defined are several Acasta Complex sites, located in the region from the Great Slave to Great Bear lakes (Noble 1971, 1981). The complex is described as having Agate Basin-type points in association with a range of side-notched, lanceolate Acasta points, and bulbous stemmed Kamut varieties. Although Noble considers Acasta part of the Northern Plano Tradition, others dispute this because of the dates, which are later than the Keewatin District sites, and because of the presence of non-Agate Basin forms (Gordon 1981).

On the eastern flank of the Rockies, the Charlie Lake Cave site in northeastern British Columbia has produced a single small or "stubby," basally thinned projectile point from the deepest component (Component I) at the site (Fladmark et al. 1988). The point was associated with ten other artifacts, including a perforated schist bead, a retouched flake, a keeled core tool, and six pieces of debitage, as well as a range of fauna including small mammals (e.g., hares and ground squirrels), birds, bison and fish. Several radiocarbon dates place the fluted-point occupation at approximately 10,500 yr B.P. Finds of similar fluted points in northeastern British Columbia (e.g., Wilson 1989) and adjacent Alberta indicate a more widespread fluted-point presence in the region, although none are dated. A recently excavated component on a high ridge known as Saskatoon Mountain, located west of Grande Prairie in northwestern Alberta, has produced a date on pit-fill of 9,380 ± 360 B.P. (AECV-1474C; Beaudoin and Wright 1992). According to a reconstruction of the local glacial and post-glacial topographic history (Liverman 1991), the site would have been on an island during the first major stage of glacial Lake Peace. No diagnostic artifacts were found in the small assemblage, although there were concentrations of bifacial thinning and trimming flakes that suggest production or recycling of bifacial tools. The date may relate to the fluted-point presence of the region, or could pertain to later Cody Complex material, which has also been found in the area.

References Cited

Beaudoin, A. B., and M. Wright 1992 Links between Culture and Environment: an Example from Archaeological and Palaeoenvironmental Research in the Grande Prairie Region, Northwestern Alberta, 1987–1991. Paper read at the Proceedings of the 24th Annual Chacmool Conference, The University of Calgary. Calgary.

Fladmark, K. R., J. C. Driver, and D. Alexander 1988 The Paleoindian Component at Charlie Lake Cave (HbRf 39), British Columbia. *American Antiquity* 53(2):371–384.

Gordon, B. C. 1976 Migod—8,000 Years of Barrenland Prehistory. National Museum of Man, Mercury Series, Archaeological Survey of Canada, Paper No. 51. Ottawa.

Gordon, B. C. 1981 Man-environment Relationships in Barrenland Prehistory. *Musk-ox* 28:1–19.

Hanks, C. C. 1992 A Pass to the South: Anatomy of a Traditional Route Across the T'logotsho Plateau—Mackenzie Mountains, N.W.T., Canada. Unpublished mss. in possession of the author.

Liverman, D. G. E. 1991 Sedimentology and History of a Late Wisconsinan Glacial Lake, Grande Prairie, Alberta, Canada. *Boreas* 20:241–257.

Noble, W. C. 1971 Archaeological Surveys and Sequences in Central District of Mackenzie, N.W.T. *Arctic Anthropology* Vol. 8(1):102–135.

Noble, W. C. 1981 Prehistory of the Great Slave Lake and Great Bear Lake Region. In Subarctic, edited by J. Helm, pp. 97–106. *Handbook of North American Indians*, Vol. 6. Smithsonian.

Wilson, I. 1989 The Pink Mountain Site (HhRf-1): an Early Prehistoric Campsite in Northeastern B.C. *Canadian Journal of Archaeology* Vol. 13:51–67.

Wright, J. V. 1976 *The Grant lake Site, Keewatin District, N.W.T.* National Museum of Man Mercury Series, Archaeological Survey of Canada, paper No. 47. Ottawa.

Wright, J. V. 1981 Prehistory of the Canadian Shield. In Subarctic, edited by J. Helm, pp. 86–96. *Handbook of North American Indians*, Vol. 6, Smithsonian Institution, Washington.

Active Layer Depths during Full Glacial Conditions for Fairbanks, Alaska

Lawrence J. Plug

Debate persists on the nature of the Beringian landscape during the last glacial period (Colinvaux 1986; Cwynar and Ritchie 1980; Guthrie 1990). In this paper I outline one factor important to any Beringian ecological model—active-layer depth—and simulate possible responses to full glacial climates. My purpose is to test the feasibility of one aspect of the steppe-tundra ecological model and to provide a background for understanding proxy data on active layer depths (e.g., Hoefle, this volume). The preliminary model used here is a component in ongoing research on geomorphic responses to past and present climate change.

Active-layer depth equals the maximum extent of summer thaw in permafrost regions. Ground water quickly saturates shallow active layers, commonly maintaining water-tables near the surface because permafrost impedes drainage. In semi-arid interior Alaska today, shallow active layers and low evapotranspiration rates produce waterlogged soils supporting mesic boreal forest and wetland species. The short-grass species of the steppe-tundra paleoecological model require well-drained soils and hence deeper active layers, but deeper-than-present thaw penetration during the cool summers of full-glacial climates (Kutzbach and Guetter 1986) is seemingly paradoxical.

The model uses the modified Berggren equation for the problem of phase change in a homogenous material (Lunardini 1988), solved analytically, and

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numerical solutions of the Neumann equation for the coefficient (see McRobert 1975). The influence of climate, snow cover and vegetation on soil temperatures is complex (Lachenbruch et al. 1988); model results are heuristic and are not precise values. Comparisons between simulations (Figure 1) illustrate relative magnitudes of soil and climate factors on thaw depth.

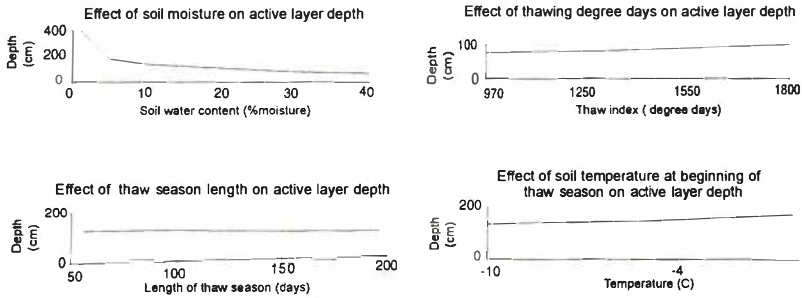

Figure 1. Response of active-layer depth to climate variables. Individual charts illustrate changes in active-layer depth with a change in a single input parameter. The standard or full model uses values of 1700 degree (C) days, thaw-season length of 120 days, soil moisture of 15%, and soil temperature at the beginning of the thaw season of -6° C.

Active-layer depths respond most strongly to soil-moisture content, because latent heat is much greater than sensible heat in any phase change involving measurable water content (Williams and Smith, 1988). Summer temperatures (measured in degree days) are less important, and thaw indexes ranging from 970 to 1800 degree days produce minor 14-cm changes in thaw depth. Shortening the thaw season but holding the thaw index constant has little effect. As sensible heat is insignificant in soil-water mixtures, extreme winter temperatures during the full glacial (e.g., Barnosky et al. 1987) would not have caused significantly shallower active layers.

Given the thermal conductivity of loess (Kersten 1949), modern Fairbanks climate, and soil-moisture levels of 35%, modeled active layers for the Fairbanks area are ca. 0.95 m, comparable to actual values. Using an estimate of 18 ka for summer temperature (Barnosky et al. 1987; Kutzbach and Guetter 1986), the thaw index for interior Alaska was ca. 1150° C days and thaw-season length 150 days. I estimated initial soil temperatures to be 6° C lower than present due to severe winter conditions and less snow cover. At soil-moisture levels of 15–20%, lower due to increased continentality and clearer summer skies in interior Alaska (Kutzbach and Guetter 1986), modeled active layers are deeper (ca. 1.38 m). Deeper active layers may have improved drainage under already arid conditions, leading to dry soils favoring xeric-adapted tundra vegetation capable of supporting mammoth, bison and other now-extinct or range-excluded fauna.

References Cited

Barnosky, C. W., P. M. Anderson, and P. J. Bartlein 1987 The Northwestern U.S. during

Deglaciation; Vegetational History and Paleoclimatic Implications. In *North America and Adjacent Oceans during the Last Deglaciation,* edited by W. F. Ruddiman and H. E. Wright Jr., Geological Society of America, Boulder Colorado.

Colinvaux, P. A. 1986 Plain Thinking on Bering Land Bridge Vegetation and Mammoth Populations. *Quarterly Review of Archaeology* 7:8–9.

Cwynar, L. C., and J. C. Ritchie 1980 Arctic Steppe-Tundra: A Yukon Perspective. *Science* 208:1375–78.

Guthrie, R. D. 1990 *Frozen Fauna of the Mammoth Steppe: The Story of Blue Babe.* University of Chicago Press, Chicago.

Kersten, M. S. 1949 *Thermal Properties of Soils.* Bulletin No. 28, University of Minnesota Experimental Station, Minneapolis.

Kutzbach, J. E., and P. J. Guetter 1986 The Influence of Changing Orbital Parameters and Surface Boundary Conditions on Climate Simulations for the Past 18,000 Years. *Journal of Atmospheric Sciences* 43:1726–1759.

Lachenbruch, A. H., T. T. Cladouhous, and R. W. Saltus 1988 Permafrost Temperature and the Changing Climate. *Proceedings of the Fifth International Conference on Permafrost,* edited by Kaare Senneset, vol 3:9–17. Trodheim.

Lunardini, V. J. 1988 *Heat Conduction with Freezing or Thawing.* Monograph 88-1. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover.

McRoberts, E. C. 1975 Field Observations of Thawing in Soils. *Canadian Geotechnical Journal* 12:126–130.

Williams, P. J., and M. W. Smith 1989 *The Frozen Earth: Fundamentals of Geocryology.* Cambridge University Press, Oxford.

The Putu Site: Pleistocene or Holocene?

R. E. Reanier

Fluted projectile points have been found in northern Alaska since the 1940s (Solecki 1951; Thompson 1948), but most have come from surface sites and are undated (Clark 1984, 1991). The Putu site, which overlooks the Sagavanirktok Valley on the north flank of the Brooks Range, was the first in Alaska to produce radiocarbon dates said to be in association with fluted points (Alexander 1974, 1987). However, a number of investigators have viewed these results with caution, apparently because of unresolved questions about the spatial association between the radiocarbon dates and artifacts from the site (Gal 1976; Hoffecker et al. 1993). The confirmation of a late-Pleistocene Paleoindian presence at the Mesa site 200 km to the west (Reanier and Kunz, this volume) has led to renewed interest in the Putu site chronology. Because of the importance of accurate dates from this key site, and because of persistent questions about the provenience of radiocarbon-dated samples, I have examined the field notes and other records in order to elucidate additional details about the sample provenience and radiocarbon record.

The last sample submitted by Alexander from the Putu site was run by the Smithsonian Radiation Biology Laboratory in late 1975. This date is the cornerstone upon which arguments for the antiquity of Putu have been based

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(Alexander 1987; Dumond 1980; Haynes 1982; Morlan 1977; Morlan and Cinq-Mars 1982). The date, 11,470 ± 500 yr B.P. (SI-2382), was reported by Alexander to have come from Feature 9, a hearth about 30 cm (12 in) below the surface in excavation unit 25-30S; 15-20W (Alexander 1987:36). From the excavation records it was not possible to identify which sample had produced the 11,470 ± 500 yr B.P. date, because all three samples taken from Feature 9 can been accounted for in other dates. This apparent discrepancy led to examination of the archived records from the Smithsonian laboratory for the SI-2382 sample. According to these records, sample SI-2382 was identified as having come from Feature 3, rather than Feature 9 as was indicated in the 1987 monograph (Smithsonian Archives accession 87-035, record unit 387, box #6, Sample Runs Notebook #1-2534). Corroborating the archival records is a handwritten note found with the excavation records entitled "Putu charcoal for Smithsonian," which lists the Feature 3 sample. In the 1987 monograph Feature 3 is described as the same type of hearth as Feature 1, which was a shallow surface hearth found directly beneath the tundra root mat (Zone I) (Alexander 1987:11). The excavator's notes, however, clearly indicate that Feature 3 was not near the surface, but within the culturally sterile gravel (Zone III) at a depth of about 46–48 cm (18–19 in) below the surface (Wilson 1973:6). In test excavations at Putu in 1993 I observed organic-rich smears within this gray, gravelly unit (Zone III) that appeared to be the remains of surface vegetation buried by deposition of Zone II material. Possibly the 11,470 yr B.P. date reflects the beginning of deposition of Zone II sediment prior to site occupation.

But what of Feature 9, the hearth originally said to be the source of the date of 11,470 yr B.P.? The importance of Feature 9 lies in its proximity not to the fluted points, but to the base of a heavily edge-ground lanceolate projectile point technologically similar to those from the Mesa site. This projectile point (Alexander 1987:Fig. 8h and Fig. 9i) was recovered 5 cm from the mapped edge of Feature 9 (Seymour 1973). Records indicate that two samples from the feature were combined by Alexander with a number of other unrelated samples to produce sufficient carbon for dating. The resultant dates, 5,700 ± 190 yr B.P. (GaK-4941) and 6,090 ± 430 yr B.P. (GaK-4939), have no analytical value because there is no reason to presume all samples were contemporaneous. A third sample from Feature 9 was archived. In order to resolve the age of the hearth this sample was recently submitted for AMS dating. It yielded an age of 8,810 ± 60 yr B.P. (Beta-69901, CAMS-11038), demonstrating that Feature 9 is considerably younger than previously thought, and in fact has an age in line with the original radiocarbon determination from the site of 8,450 ± 130 yr B.P. (WSU-1318) made on a sample taken in 1970 (Alexander 1974).

This revised chronology from the Putu site has important implications for the interpretation of northern Paleoindian materials. First, the 11,470 ± 500 yr B.P. date is probably a maximum limiting age for deposition of Zone II and is not a cultural date at all. Putu is no longer a candidate for a late-Pleistocene occupation of the Brooks Range based upon its radiocarbon dates. Second, Feature 9 has now been shown to be younger than formerly thought on the basis of the newly run AMS date of 8,810 ± 60 yr B.P. from the feature. Third, the two mid-Holocene dates from the site should be ignored. They were produced from combined samples and cannot arguably be said to date individual cultural events. Fourth, the fluted points from Putu, which for so long had been held out as the sole example of dated northern fluted points, can no longer be considered so. Because of the lack of demonstrable spatial association between the fluted points and any of the radiocarbon dates, they must be considered essentially undated by radiocarbon. I emphasize that this result does not prove they are not ancient, but simply shows that radiocarbon evidence for their antiquity is lacking at the present time. Fifth, the association of edge-ground lanceolate projectile points with the Feature 9 hearth now seems certain, and I must conclude we now have evidence from Putu that these forms, so similar to those from the Mesa site, persisted in the Brooks Range until at least 8,800 yr B.P.

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References Cited

Alexander, H. L. 1974 The Association of Aurignacoid Elements with Fluted Point Complexes in North America. In: *International Conference on the Prehistory and Paleoecology of Western North American Arctic and Subarctic.* Edited by S. Raymond and P. Schlederman. pp. 21–31. University of Calgary Archaeological Association, Calgary, Alberta.

Alexander, H. L. 1987 *Putu: A Fluted Point Site in Alaska.* Publication No. 17, Department of Archaeology, Simon Fraser University, Burnaby, British Columbia.

Clark, D. W. 1984 Northern Fluted Points: Paleo-Eskimo, Paleo-Arctic, or Paleo-Indian. *Canadian Journal of Anthropology* 4:65–81.

Clark, D. W. 1991 The Northern (Alaska-Yukon) Fluted Points. In: *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp. 35–47. Center for the Study of the First Americans, Corvallis, Oregon.

Dumond, D. E. 1980 The Archeology of Alaska and the Peopling of America. *Science* 209:984–991.

Gal, R. 1976 Paleo-Indians of the Brooks Range: A Tradition of Uncontrolled Comparison. Paper presented at the Society for American Archaeology annual meeting, St. Louis, Missouri.

Haynes, C. V. 1982 Were Clovis Progenitors in Beringia? In: *Paleoecology of Beringia*, edited by D. M. Hopkins, J. V. Matthews, C. E. Schweger, and S. B. Young, pp. 383–398. Academic Press, New York.

Hoffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–53.

Kunz, M. L., and R. E. Reanier 1994 Paleoindians in Beringia: Evidence from Arctic Alaska. *Science* 263:660–662.

Morlan, R. E. 1977 Fluted Point Makers and the Extinction of the Arctic-Steppe Biome in Eastern Beringia. *Canadian Journal of Archaeology* 1:95–108.

Morlan, R. E., and J. Cinq-Mars 1982 Ancient Beringians: Human Occupation in the Late Pleistocene of Alaska and the Yukon Territory. In: *Paleoecology of Beringia*, edited by D. M. Hopkins, J. V. Matthews, C. E. Schweger, and S. B. Young, pp. 353–381. Academic Press, New York.

Seymour, B. 1973 Unpublished field notes on file with the Bureau of Land Management, Fairbanks, Alaska.

Solecki, R. S. 1951 Notes on Two Archaeological Discoveries in Northern Alaska, 1950. *American Antiquity* 17:55–57.

Thompson, R. M. 1948 Notes on the Archaeology of the Utukok River, Northwestern Alaska. *American Antiquity* 14:62–65.

Wilson, P. 1973 Unpublished field notes on file with the Bureau of Land Management, Fairbanks, Alaska.

The Prehistory of Northern Alaska at the Pleistocene/Holocene Boundary

R. E. Reanier and M. L. Kunz

Until recently, the American Paleo-Arctic tradition was the only recognized cultural unit for the early Holocene in northern Alaska. Defined by Douglas Anderson from the Akmak and Kobuk complexes at the Onion Portage site on the Kobuk River (Anderson 1968, 1988), and from Trail Creek Caves on the Seward Peninsula (Larsen 1968), the American Paleo-Arctic tradition spans the period from ca. 8,000 to ca. 9,700 yr B.P. It is characterized by wedge-shaped microblade cores, microblades, and burins (Anderson 1968). The Akmak complex has large core bifaces and bifacial blade cores (Anderson 1970). Also present are blades and tools, like end scrapers, made on blades. Bifacial tools such as knives are present, but the tradition lacks bifacial projectile points. This tradition has clear antecedents in the Siberian Diuktai tradition (Dumond 1987; Mochanov 1977), and was expanded both in space and time by Dumond to become the Paleo-arctic tradition which, according to Dumond (1980, 1987), encompasses the Siberian materials as well as those from the Denali complex of central Alaska (West 1981) and materials like those from Anangula in the Aleutian Islands. In northern Alaska the Paleo-arctic tradition has served as an organizing device for many undated surface finds and has played a prominent role in most regional archaeological surveys (Davis et al. 1981; Hall and Gal 1982; Kunz 1991).

Fluted projectile points have been found in northern Alaska since the 1940s (Humphrey 1966, 1970; Solecki 1951; Thompson 1948). Most have been surface finds from undated contexts, and controversy quickly arose as to whether these points were contemporaneous with Paleoindian fluted points from midcontinental North America, or were much younger (Clark 1984, 1991; Dumond 1980; Gal 1976; Giddings 1963). Some specialists hypothesized a Paleoindian presence in the north (Clark 1984, 1991; Morlan 1977), while others believed these forms were mid-Holocene in age (Davis et al. 1981; Gal 1976) or included the fluted-point finds in the Paleo-arctic tradition (Dumond 1987).

Secure dating evidence for a Northern Paleoindian tradition recently has

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come from the Mesa site, situated in the arctic foothills north of the Brooks Range (Kunz and Reanier 1994a). The Mesa site sits atop a prominent bedrock hill with a commanding view of the surrounding terrain. Here, AMS radiocarbon dates on charcoal from 12 shallow hearths range between 9,900 ± 70 yr B.P. (Beta-57429, CAMS-4146) and 11,660 ± 80 yr B.P. (Beta-55286, CAMS- 3572). Eleven of the hearths cluster near 10,000 yr B.P. in age, and one has replicate dates of 11,190 ± 70 yr B.P. (Beta-57430, CAMS-4147) and 11,660 ± 80 yr B.P., placing it a millennium earlier than the others (Kunz and Reanier 1994b). Associated with these hearths are nonfluted lanceolate projectile points with heavy proximal edge and base grinding that are technologically similar to Hell Gap and Agate Basin projectile points from midcontinental North America. The points are typically basally concave and heavily resharpened. Other typical Paleoindian tools include spurred gravers, end scrapers, and bifaces.

The Putu site 200 km to the east provides the only other reported radiocarbon date on Paleoindian materials from the region (Alexander 1987). The Putu site is similarly situated near the top of a prominent hill overlooking the Sagavanirktok River valley. The date, 11,470 ± 500 yr B.P. (SI-2382), was reported to have come from a hearth about 30 cm below the surface (Alexander 1987:36), but has recently been shown to have come from within a deeper, culturally sterile unit (Reanier and Kunz 1994). The hearth, evidently associated with the base of a nonfluted lanceolate projectile point technologically similar to those from the Mesa site, recently has been re-dated to 8810 ± 60 yr B.P. (Beta-66901, CAMS-11038). At least two bases of fluted projectile points with multiple flutes were recovered from the Putu site, but were not in direct association with any of the radiocarbon dates: one was found on the surface, and another came from less than 10 cm below the surface. Apart from obsidian-hydration dates that place them in the range of 10,000 to 14,000 yr B.P., fluted points remain poorly dated in the north (Reanier and Kunz 1994).

In the 1930s nonfluted lanceolate projectile points were the first implements to suggest a connection between Alaska and the newly discovered Paleoindian materials of the American southwest (Hibben 1943; de Laguna 1937; Rainey 1939). Confirmation of a Northern Paleoindian tradition in northern Alaska containing these forms implies possible contemporaneity with the Paleo-arctic tradition (Holmes et al. 1994) and with the Nenana complex of interior Alaska (Hoffecker et al. 1993), and raises new questions about eastern Beringian cultural complexity at the close of the Pleistocene. However, the intriguing northern fluted points, which have been at the center of the northern Paleoindian debate for more than four decades, remain controversial, since none have been directly dated by radiocarbon.

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References Cited

Alexander, H. L. 1987 *Putu: A Fluted Point Site in Alaska.* Publication No. 17, Department of Archaeology, Simon Fraser University, Burnaby, British Columbia.

Anderson, D. D. 1968 A Stone Age Campsite at the Gateway to America. *Scientific American* 218(6):24–33.

Anderson, D. D. 1970 Akmak: An Early Archeological Assemblage from Onion Portage, Northwest Alaska. *Acta Arctica* 16.

Anderson, D. D. 1988 Onion Portage: The Archaeology of a Stratified Site from the Kobuk River, Northwest Alaska. *Anthropological Papers of the University of Alaska* 22(1–2).

Clark, D. W. 1984 Northern Fluted Points: Paleo-Eskimo, Paleo-Arctic, or Paleo-Indian. *Canadian Journal of Anthropology* 4:65–81.

Clark, D. W. 1991 The Northern (Alaska-Yukon) Fluted Points. In: *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp. 35–47. Center for the Study of the First Americans, Corvallis, Oregon.

Davis, C. W., D. C. Linck, K. M. Schoenberg, and H. M. Shields 1981 *Slogging, Humping, and Mucking through the NPR-A: An Archeological Interlude.* Occasional Paper No. 25, Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska, Fairbanks.

Dumond, D. E. 1980 The Archeology of Alaska and the Peopling of America. *Science* 209:984–991.

Dumond, D. E. 1987 *The Eskimos and Aleuts.* revised ed., Thames and Hudson, London.

Gal, R. 1976 Paleo-Indians of the Brooks Range: A Tradition of Uncontrolled Comparison. Paper presented at the Society for American Archaeology annual meeting, St. Louis, Missouri.

Giddings, J. L. 1963 Some Arctic Spear Points and Their Counterparts. *Anthropological Papers of the University of Alaska* 10(2):1–12.

Hall, E. S., Jr., and R. Gal 1988 The U.S. Geological Survey-Bureau of Land Management Cultural Resources Program in the National Petroleum Reserve in Alaska, 1977–1981. In: *Geology and Exploration of the National Petroleum Reserve in Alaska, 1974–1982,* U.S. Geological Survey Professional Paper 1399, edited by G. Gryc, pp. 859–897. U.S Government Printing Office, Washington, D.C.

Hibben, F. C. 1943 Evidences of Early Man in Alaska. *American Antiquity* 8:254–263.

Hoffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–53.

Holmes, C. E., R. Vanderhoek, and T. Dilley 1994 Old Microblades in the Tanana Valley: The View from Swan Point. Paper presented at the 21st annual meeting of the Alaska Anthropological Association, Juneau, March 31–April 2, 1994.

Humphrey, R. L. 1966 The Prehistory of the Utukok River Region Arctic Alaska: Early Fluted Point Tradition with Old World Relationships. *Current Anthropology* 7:586–588.

Humphrey, R. L. 1970 *The Prehistory of the Arctic Slope of Alaska: Pleistocene Cultural Relations between Eurasia and North America.* Unpublished Ph.D. dissertation, University of New Mexico, Albuquerque.

Kunz, M. L. 1991 *Cultural Resource Survey and Inventory: Gates of the Arctic National Park and Preserve, Alaska.* National Park Service Research/Resources Management Report AR-18, National Park Service, Anchorage.

Kunz, M. L., and R. E. Reanier 1994a Paleoindians in Beringia: Evidence from Arctic Alaska. *Science* 263:660–662.

Kunz, M. L., and R. E. Reanier 1994b The Mesa Site and The Mesa Project: New Temporal/Typological Associations within the Paleoindian Tradition. Paper presented at the 21st annual meeting of the Alaska Anthropological Association, Juneau, March 31–April 2, 1994.

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Larsen, H. E. 1968 Trail Creek: Final Report on the Excavation of Two Caves on Seward Peninsula, Alaska. *Acta Arctica* 15.

Mochanov, Yu. A. 1977 Drevneischie etapy zaseleniya chelovekom Severo-Vostochnoi Azii. [The Earliest Stages of the Settlement of Northeast Asia by Man]. Nauka, Novosibirsk.

Morlan, R. E. 1977 Fluted Point Makers and the Extinction of the Arctic-Steppe Biome in Eastern Beringia. *Canadian Journal of Archaeology* 1:95–108.

Rainey, F. 1939 Archaeology in Central Alaska. *Anthropological Papers of the American Museum of Natural History* 36(4):351–389.

Reanier, R. E., and M. L. Kunz 1994 The Paleoindian Period in Northern Alaska. Paper presented at the 21st annual meeting of the Alaska Anthropological Association, Juneau, March 31–April 2, 1994.

Solecki, R. S. 1951 Notes on Two Archaeological Discoveries in Northern Alaska, 1950. *American Antiquity* 17:55–57.

Thompson, R. M. 1948 Notes on the Archaeology of the Utukok River, Northwestern Alaska. *American Antiquity* 14:62–65.

West, F. H. 1981 *The Archaeology of Beringia*. Columbia University Press, New York.

Subsistence Diversity and Hunter-Gatherer Strategies in late Pleistocene/early Holocene Beringia: Evidence from the Broken Mammoth Site, Big Delta, Alaska

David R. Yesner

Recent discoveries of late-Pleistocene archaeological sites in the Tanana Valley of east-central Alaska have led to revisions in understanding of the subsistence base and hunting strategies of the earliest occupants of eastern Beringia. The Broken Mammoth, Swan Point, and Mead sites are blufftop sites containing evidence, in the form of artifacts, features, and food debris, of late-Pleistocene/early-Holocene occupation dating between ca. 9,300 and 11,800 yr B.P. These dates are associated with two major paleosols, best dated at the Broken Mammoth site to ca. 9,300 to 10,500 and 11,000 to 11,800 yr B.P., respectively. The paleosols, which resulted from a combination of soil-forming episodes and anthropogenic debris, are embedded in a highly calcareous loess matrix. Calcigenic precipitation within the loess matrix, a result of an extremely dry episode during the mid Holocene (7,500 to 9,000 yr B.P.), resulted in excellent preservation of organic materials in the early (late-Pleistocene/early-Holocene) horizons at the Broken Mammoth site. These materials include bone tools and faunal remains. Features preserved within the paleosols include large hearths, associated toss zones, and possible tent rings.

Technological inventories at the Broken Mammoth site include a bifacial and unifacial tool industry including basally thinned projectile points, knives, scrapers, and amorphous cores, utilizing predominantly local source materials such as quartz ventifacts and river cobbles, but also cherts and obsidian. No microblade tools have been recovered from early contexts at this site. Bone tools recovered at the site during the 1992 field season included an eyed needle and a bone toggle, both of which reflect clothing-preparation activities. The

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eyed needle, one of the few known from Paleoindian contexts in North America, is associated with a date of ca. 10,500 yr B.P. During the 1993 field season, three mammoth-ivory tools were uncovered from the same layer, although the tools themselves produced a date of ca. 15,800 yr B.P. These tools appear to represent three sections of a composite atlatl and dart system, with a handle, shaft, and bone point (Figure 1). They show similarities to spear industries known from the upper Paleolithic of northern Eurasia, and some linkage with those known from Paleoindian sites.

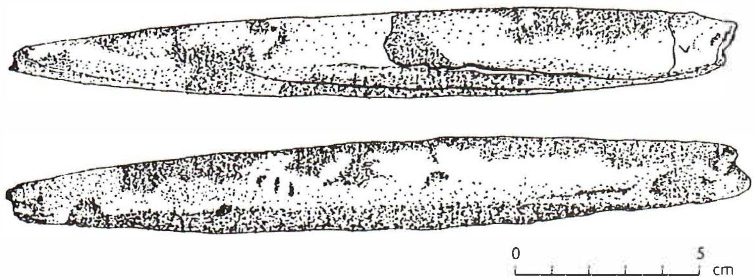

Figure 1. Mammoth ivory point, Broken Mammoth site, east-central Alaska.

Faunal assemblages from the Broken Mammoth site show the use of a wide diversity of animal species, but with a focus on bison (*Bison priscus*), wapiti (*Cervus elaphus*), and caribou (*Rangifer tarandus*). These species were probably abundant in the mosaic savanna parkland surrounding the site during the so-called "Birch Period" (c. 9,000 to 14,000 yr B.P.). Nearly 85% of large mammal remains were smashed up for marrow extraction, bone grease rendering, boiling, or tool production, and may be related to large cobble industries found at the site. Fore limbs, hind limbs, axial vertebrate elements and meat-bearing units are equally well represented, suggesting retrieval of whole animals to the site and reduced selectivity for body parts. However, the woolly mammoth (*Mammuthus primigenius*) is represented at all three sites solely by tusk material, which may have been scavenged from the tundra for use in ivory-tool manufacture.

A variety of small game, particularly hare and ground squirrel, were exploited at the Broken Mammoth site. Some carnivores are represented at the site, particularly Arctic fox (*Alopex lagopus*) and dire wolf (*Canus dirus*). In addition, a wide variety of bird species were taken, particularly by the earliest inhabitants of the site during the period from ca. 11,800 to 11,000 yr B.P. The latter included primarily waterfowl, particularly the tundra swan (*Cygnus columbianus*), dabbling ducks (*Anser* sp.), and geese (*Anser* sp. and *Branta* sp.). The widespread use of these species suggests that the North Pacific flyway had become re-established within 1,000 years after the drowning of the Beringian land mass. Fish were also utilized by at least 10,500 years ago, and are represented by salmonid vertebrae and scales.

The blufftop locations of the Broken Mammoth, Swan Point, and Mead sites suggest that these were primarily hunting locales, located in areas that allowed scanning for game. Bison, elk, caribou, and perhaps mammoth populations in such a savanna parkland environment would have probably been characterized by short seasonal migrations for which scanning strategies would have been important. Differences in faunal assemblages associated with the two early components at the Broken Mammoth are most likely the result of differences in seasonal use: the waterfowl remains in the lowest paleosol (11,800 to 11,000 yr B.P.) may indicate spring utilization, while a juvenile bison mandible from the horizon dated 10,000 yr B.P. indicates fall utilization of the site. Campsites occupied during other times of year were probably located in the floodplain of the Tanana River and are now eroded or buried under alluvial deposits. However, the presence of hide sewing gear at the Broken Mammoth site (at least in the horizon dated 10,000 yr B.P.) suggests more than ephemeral site use. Shifts in settlement patterns during late-Pleistocene/early-Holocene times may be related to increasing environmental aridity, vegetational change, extinction of some species, and local changes in the course and volume of the Tanana River.

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FORM AND STYLE

The following are some preferred abbreviations, words and spellings: Paleoindian (or Paleoamerican), archaeology, ca. (circa), yr B.P. (years before present), early-, mid-, late- (i.e., early-Holocene), ^{14}C (radiocarbon 14; ^{16}C, etc.), in situ, et al., pers. comm., CRM (cultural resource management), and AMS or TAMS (accelerator mass spectrometer technique of radiocarbon dating). Metric units should be used and abbreviated throughout: mm, cm, m, km, ha, m², etc.

Numbers should be written out when they start a sentence and when they are numbers one through nine (exception: ". . . researchers recovered 20 choppers, 10 burins, and 2 knives"). Numbers greater than nine should be written as numerals. All numbers greater than 999, including radiocarbon ages, should use a comma (22,000 ± 1,210 yr B.P.; 1,000 years ago; 12,000 mollusks).

Radiocarbon dates should be expressed in ^{14}C years before present (yr B.P.) and should include the standard error and the laboratory number, i.e. 11,000 ± 250 yr B.P. (A-1026).

All underlined and italicized words will be italicized in final form. Use of Latin or common names is acceptable, but include the name not used in parentheses following first usage (e.g., ". . . recovered the dung of the Shasta ground sloth (*Nothrotheriops shastensis).*" If technical jargon or abbreviations are used, provide an explanation in parentheses or use a more common term.

References cited in the text must adhere to the style guide printed in *American Antiquity,* 48 (2):429–442; this facilitates the editing for style used in *CRP.* Citations used in the text are as follows: ". . . according to Martin (1974a, 1974b)," ". . . as has been previously stated (Martin 1974; Thompson 1938)." Crosscheck all references with the original work—this is where most problems occur. *CRP* editors are not responsible for reference errors.

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