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From the Editor

With Jim Mead as Editor and, from Volume 6 onward, David Meltzer as Associate Editor, *Current Research in the Pleistocene* has become one of the foremost publication outlets for Quaternary scientists of the Americas and the Eastern Asian Pacific Rim. It is not hard to understand why this is so. Although other publications occasionally publish short papers in the relevant disciplines, it is clear that *Current Research in the Pleistocene* fills a need. *CRP*, more than any other publication, helps scientists follow Michael Faraday's dictum to "Work, finish, publish." The short contributions for *CRP* are not intended to take the place of the extended monograph, but they are a means of getting the information and ideas out to the research community with a minimum of fuss and bother. The short turnaround time means that the research will be accessible to other scientists worldwide on a timely basis. Finally, packaging 30 or 40 papers on Pleistocene research together insures that a broad audience of interested scholars will be reached.

The last point may be the most important. The unique advantage of *CRP*, for authors and readers alike, is the incredible density of relevant information that is presented in each volume. Looking for relevant articles in many scientific journals is like looking for oases in the desert—they can be few and far between. But each volume of *CRP* is a cornucopia of information directly or indirectly relevant to Quaternary scientists and anyone interested in Ice Age America and the initial discovery of this New World by humans.

I am proud to be taking over as editor of *CRP*, and this volume is my debut. There have been a few changes since the last volume, and I hope the authors and readers will find these changes beneficial. Most of the changes have been behind the scenes and represent an effort to make life easier for the editor.

Rebecca Foster, Assistant Director of the Center for the Study of the First Americans, has been brought on board to serve as Assistant Editor. This means that she does all the real work involved with producing *CRP*. Her efforts at the Center in Corvallis are an invaluable contribution.

In addition, a team of Associate Editors have been assembled to serve not merely as coeditors, but as liaisons and even advocates for the diversity of disciplines represented in the pages of *CRP*. Daniel Fisher of the Museum of Paleontology at the University of Michigan represents geology and paleontology, Linda Shane of the Limnological Research Center at the University of Minnesota represents paleobotany, Gentry Steele of the Department of Anthropology at Texas A & M University represents physical anthropology, and Thomas Stafford of the Institute of Arctic and Alpine Research at the University of Colorado at Boulder represents geochemistry and paleontology. These scholars will review manuscripts submitted pertaining to their various fields of study, and they will help cast the *CRP* net even further out into the ocean of interdisciplinary Pleistocene research. *CRP* is, and has been, dominated by manuscripts from archaeologists. I intend to promote more contributions from the widest possible diversity of related disciplines, and I believe that involving these scholars directly as Associate Editors is the best way to do this.

So far, serving as Editor for *CRP* has been rewarding and a lot of fun. I look forward to working closely with Rebecca, the Associate Editors, and with you the authors and readers. Together we can build on the solid foundation laid by Jim Mead and Dave Meltzer and make *CRP* an even more effective vehicle for disseminating the results of the most current research in the Pleistocene.

H.

Archaeology

Recent Excavations at the Austin Cave Site: A Late Pleistocene through Early Holocene Occupation in North Central Tennessee

Gary Barker and John B. Broster

During the fall and spring of 1991–92 an archaeological survey was conducted along portions of the upper Red River in north-central Tennessee and southcentral Kentucky to document early prehistoric sites along this tributary of the Cumberland River. Through controlled surface reconnaissance, 17 early-Archaic and 4 Paleoindian sites were recorded (Barker 1992).

One site, 40Rb82, was selected for preliminary testing due to the high frequency of Paleoindian material and the possibility that intact deposits might remain at this open habitation site. Three fluted points (Figure 1) and numerous flake tools had been recovered during initial surface collections. Several previously reported sites that provide evidence of Paleoindian activity in the vicinity of 40Rb82 include Savage Cave (Schenian 1988), Adams (Sanders 1990), Boyd, Ledford, and Roeder (Tankersley 1990).

Subsurface integrity of the site and its spatial dimensions were defined on the basis of ten 50-cm² test units placed above the cave and around several adjacent sinks. All fill was screened through ¼-inch mesh. Prehistoric lithic material was observed to subsoil in all units. Kirk Corner-Notch points constituted the majority of diagnostics, followed by a ground and basally thinned side-notch variant. Twelve uniface tools and three fluted preforms were also recovered.

Testing revealed that a majority of 40Rb82 has been severely deflated by erosion and modern farming activities. A small knoll occupying an area of approximately 90 m², situated just to the north of Austin cave, remains the only exception. Initial testing revealed evidence of a deep, naturally stratified midden that warranted further investigation.

Subsequently, four contiguous units, each 1 m^2 , were excavated in this portion of the site. Units were placed on an east-west axis to obtain a maximum profile of deposits. All unit fill was bagged and later screened through $\frac{1}{2}$ -inch and $\frac{1}{2}$ -inch mesh at the Tennessee Division of Archaeology laboratory.

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Figure 1. Fluted projectile points and preforms from 40Rb82.

Three distinct strata were evident in the excavation unit profile. Stratum I consisted of a light brown sandy loam that contained a dense amount of small chunky limestone and blocky fossiliferous chert. The base of this level averaged 40 cm in depth and contained early- and middle-Archaic artifacts, including Kirk, Big Sandy, and a concave stemmed variant of the Stanly point (Justice 1987). Mixed cultural materials in this upper zone are attributed to redeposition by slope wash. This redeposition has resulted in a colluvial cap that has preserved the underlying deposits.

Stratum II extended to 90 cm below surface and consisted of a medium reddish brown loam matrix. Numerous ground and basally thinned side-notch points were recorded in this deposit. Stratum III was composed of a dark brown loam, which attained a maximum depth of 160 cm below surface. Three Clovis preforms (Figure 1), numerous Kirk Corner-Notch points, uniface scrapers, and other flake tools were recovered from this level.

A significant assemblage of floral and faunal remains was present in the excavation unit fill. ¹⁴C samples from hickory nut shell have been prepared and are expected to yield dates for the early-Archaic and possibly Clovis occupation of the site.

A total of two Clovis projectile points, one fluted Greenbriar and 16 Clovis preforms, have been found at 40Rb82. It is apparent that a rather extensive Clovis occupation is represented here, and that further excavations will be necessary to determine if intact Clovis features are present within the deposits. Previous surveys of the region have demonstrated a correlation between caves/ sinkholes and dense concentrations of both Clovis and Cumberland materials.

These areas would have attracted an abundance of game animals and appear to have been a focal point of the early-Paleoindian settlement system. Future excavations at the Austin Cave site may provide clues regarding the type and configuration of Clovis settlement in the mid-south, and could be useful in understanding this very complex human adaptation.

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The Carson-Conn-Short Site (40BN190): An Extensive Clovis Habitation in Benton County, Tennessee

John B. Broster and Mark R. Norton

The Carson-Conn-Short site (40BN190) is located on the edge of Kentucky Lake in Benton County, Tennessee. The site area is a series of partially flooded terrace ridges south of the old Tennessee River channel. The Tennessee Division of Archaeology recorded this site in February of 1992 as part of a Paleoindian site survey project within the Kentucky Lake region (Broster and Norton 1990; Broster et al. 1991).

During the initial survey, some 43 deflated hearths were noted in four distinct areas, and all were associated with fluted points and uniface tools. A limited surface collection included 27 Clovis, 1 Cumberland, 41 bifaces, 78 uniface tools, 35 blades/knives, and 11 blade cores (Figure 1). Three of the exposed areas showed potential for in situ deposits. We thought that testing would be of great importance in understanding Clovis occupation in the area.

An Archaeological Resource Protection Act permit was granted by the United States Department of Interior, Fish and Wildlife Service. Our objectives were to determine if intact Clovis deposits existed, and to obtain faunal and carbon samples from such an occupation. A test unit (1 m²) was excavated in an undisturbed area adjacent to one of the exposed hearths, which had produced one Clovis preform and numerous uniface tools. All three natural levels of the

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Figure 1. Clovis preforms from Site 40BN190.

test pit contained Clovis artifacts. Blade tools, a uniface scraper, channel flakes, and one Clovis point tip were recorded. The limited excavations have demonstrated the existence of an intact Clovis deposit.

The lithic assemblage represented by our excavations and surface collections appear to replicate the tool kit described for Clovis occupations as found across the United States (Collins 1990; Sanders 1990; Stanford 1991; and Young and Collins 1989). In a recent work dedicated to the study of the origins of Clovis, only a passing reference is made to Clovis sites in Tennessee (Bonnichsen and Turnmire 1991). We believe that the study of this site will do much to change this lack of published information. The potential for spatial analysis of features and tools on this site is extremely important for the understanding of Clovis adaptations in the Southeast.

We would like to thank Sarah Bridges, U.S. Department of the Interior, Fish and Wildlife Service; Dennis Stanford, Smithsonian Institution; Vance Haynes, Jr., University of Arizona; Harlan "Kit" Carson, Gary Conn, and Hal Short for their assistance in making this project possible.

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Twelve Thousand Years of Human Occupation at the Eppley Rockshelter

Nigel Brush

The Eppley Rockshelter is located in northern Coshocton County, east-central Ohio. It lies at the head of a small wooded hollow above the valley of Killbuck Creek. The shelter is composed of a large overhang approximately 4.5 m high and a bifurcated tunnel system that emerges directly in front of the sheltered area. The rockshelter faces to the southeast and has a total usable floor space of roughly 84 m².

Excavations were conducted at the Eppley Rockshelter between 1982 and 1984. The midden beneath the shelter had a maximum depth of 110 cm and was underlain by a light yellow sand/clay subsoil. The midden was largely homogeneous and contained little discernible stratigraphy. Twenty-eight 2-m units were excavated in 10-cm levels to sterile subsoil: 15 were located beneath the overhang or within the tunnel system, and 13 were on the midden slope beyond the overhang.

A variety of artifacts were recovered from the rockshelter including over 100 flint and stone tools, several hundred pieces of pottery, and several thousand pieces of bone and lithic debitage. Chronologically diagnostic artifacts among these materials represented a variety of periods including Paleoindian and late Paleoindian; early, middle, and late Archaic; and early, middle, and late Woodland (Brush 1990:234–242).

One notable exception to the general mixing within the midden was four "lanceolate points" (Prufer and Baby 1963:20–21), which were recovered from the site. These points were all found at the bottom of the midden zone, either lying directly on the subsoil or partially embedded within the subsoil. Two of the points were found in units on the midden slope beyond the overhang. A third point was found near the back of the overhang, and a fourth was found in the tunnel system. One of the lanceolate points on the midden slope was found in the same unit and stratum as a large side-notched point. Similar associations between late-Paleoindian projectile points and early-Archaic types have also been noted at other sites in eastern North America (Mason 1981:129).

The most important discovery at the Eppley Rockshelter was a large bowlshaped fire hearth that was encountered at a depth of 90 cm and continued

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down to a depth of 110 cm. This hearth was located directly beneath the overhang and in front of the mouth of the bifurcated tunnel system. A basin had been cut into the yellow sandy/clay subsoil and lined with small slabs of sandstone. The soil in the hearth was black and greasy and contained numerous fragments of charcoal. Analysis of the charcoal fragments by Dee Ann Wymer at the Ohio State University resulted in the identification of three types of burned wood: red oak (*Quercus rubra*), hickory (*Carya ovata*), and chestnut (*Castanea dentata*) (pers. comm.).

Two charcoal samples from the hearth were submitted to Dr. Rainer Berger at the UCLA Radioisotope Laboratory in California. The first sample (UCLA-2589C) was from the lower half of the hearth at a depth of 110 cm and yielded a date of 12,185 ± 130 yr B.P. A second sample (UCLA-2589E), taken from the upper half of the hearth at a depth of 100 cm, yielded a date of $9,890 \pm 100$ yr B.P. (Berger 1990). The second sample was submitted to the lab over two years after the first sample had been dated. During this period several improperly stored samples had to be discarded because of the presence of green mold in the plastic sample bags. Although sample UCLA-2589E showed no visible evidence of modern organic contamination, this possibility cannot be excluded. The 12,185 ± 130 yr B.P. date (UCLA-2589C) from the Eppley Rockshelter is comparable with the dates of: (a) $12,800 \pm 870$ yr B.P. (SI-2489) from the top of Lower Stratum IIa at the Meadowcroft Rockshelter in Pennsylvania (Adovasio et al. 1983:175); (b) 12,530 ± 370 yr B.P. (I-4137) from Dutchess Quarry Cave in New York (Snow 1980:135); and (c) 12,250 ± 100 yr B.P. (AA8250) from the Paleo Crossing Site in Ohio (David S. Brose pers. comm.).

No artifacts were found in the hearth, although one end scraper was recovered from the subsoil near the hearth. The only Clovis-like point found at the site was an "Unfluted Fluted Point" (Prufer and Baby 1963:22–23), which was found in an erosion channel beneath the overhang by the owner of the property. This thin, finely made lanceolate point is somewhat similar to the Miller Lanceolate point found at the top of Middle Stratum IIa in the Meadowcroft Rockshelter (Adovasio and Carlisle 1984:136).

In conclusion, the Eppley Rockshelter adds to the growing body of evidence that Native Americans were living in the eastern United States prior to 12,000 yr B.P. The rockshelter contains one of the longest records of repeated human occupation of any excavated site in Ohio. The fire hearth that lies at the bottom of the cultural layers has yielded one of the earliest radiocarbon dates of any archaeological site in the eastern United States and is one of the oldest humanmade structures presently known in North America.

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The Smith Mountain Site: A Buried Paleoindian Occupation in the Southwestern Piedmont of Virginia

William A. Childress

During the past four years salvage work and testing on an eroding floodplain feature of the upper Roanoke River by several members of the Roanoke chapter of the Archeological Society of Virginia has resulted in the identification of a deeply stratified fluted point component apparently underlying a long sequence of early Holocene occupations.

The Smith Mountain site consists of two lithic concentrations exposed at the head and foot of a natural levee paralleling the south bank of the Roanoke River for approximately 300 m as the floodplain begins to widen below the constriction at Smith Mountain Gap. The Appalachian Power Company completed construction of a hydroelectric dam at the gap in 1966 to create an impoundment known as Smith Mountain Lake. A lower impoundment, Leesville Lake, was completed at about the same time to work in tandem with Smith Mountain Lake as a "pump storage" facility for the more efficient production of hydroelectric power. The alternating release and back-pumping of water by this project has resulted in considerable erosion downstream from the dam at Smith Mountain. The Smith Mountain Site is currently on one of the heavily eroded margins of the upper end of Leesville Lake.

The lithic concentration at the foot of the levee (44Pyl52) was first noted in the fall of 1988 during a period of unusually low water. A large bipointed uniface resembling a classic Old World limace was recovered from a possible hearth, which had been exposed on a clay flat at a depth of about 3.3 m below the present surface of the levee. Another concentration was subsequently noted at the head of the levee where a small tributary locally known as Tanker Creek flows into the Roanoke. This site lies within the outer boundary of a much larger Woodland site (44Py7), which had been recorded in 1973. More recent erosion has exposed a deep cobble lens, which appears to form the floor of a heavy concentration of early unifacial forms and early-Archaic projectile points. Ongoing careful examination and semi-controlled collection along the entire

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length of the levee has resulted in the recovery of nearly 500 flaked stone tools and approximately 3,000 pieces of debitage. Virtually the entire range of known Paleoindian tool forms are present, although some occur only in small numbers. Undoubtedly some of these forms are associated with early-Archaic occupations, indicated by corner-notched points of the Kirk-Palmer series. These types erode out of the matrix on somewhat higher levels of the site. A series of auger tests revealed sizable concentrations of chert, jasper, silicified slate and crystal quartz microflakes at a depth of 1.5 to 1.95 m at 44Py7 and at 1.8 to 2.25 m at 44Py152. It is hypothesized that this zone corresponds with the early-Archaic occupations of the site.

Childress (1989) speculated on the possibility of a greater antiquity for the site than was evident from the recognized diagnostic lithics recovered at that time. Since then, a total of three fluted points have been recorded from 44Pyl52 on levels ranging from 2.85 m to 3.2 m below datum; since none were imbedded in the matrix, they could have washed down from higher levels. In addition, Dalton and Hardaway Side Notched projectiles have been recovered there at slightly higher levels. Auger testing of the lower levels has not been implemented, since this part of the site is nearly always below the water table. Charcoal samples have been collected from features on the profile above the hypothesized early-Archaic zone. These may relate to early- or middle-Archaic occupations evidenced by Stanly Stemmed forms that have been recovered imbedded in the profile at 1.0 m at 44Pyl52. No such features have yet been noted for the lower levels. Only a very small part of the lowest levels of the site at 44Pyl52 have been exposed due to the angular nature of the slumping matrix and heavy silting. The extent of the site and possible relationships between the lithic concentrations must be determined by further testing.

There is a noteworthy presence at Smith Mountain of tool forms more familiar in Paleoindian assemblages from other regions. The presence of limaces at 44Pyl52, although somewhat different from the "flake shaver" type documented at Vail (Gramly 1982) and Bull Brook (Grimes and Grimes 1985), is more typical of sites within or near the glaciated regions of the Northeast. Bend break and snap tools are also present, although these forms are better known for the Northeast (Gramly 1982) and in Folsom contexts on the High Plains (Frison and Bradley 1980). None of these forms are well documented for Virginia or the Southeast. A majority of unifacial tools from both concentrations are manufactured on flakes; however, a few appear to be made on true blades. Large core tools-usually of local quartz and quartzite-occur primarily on the lowest levels of 44Pyl52. A sizable concentration of microlithic flake and blade tools occurs at 44Py7. Also present is a highly curated class of tools that are functionally unifacial but have been bifacially worked to create a scraper form that replicates itself on either face by rotating it 180° on the transverse axis. Other atypical tools include dihedral burins, a Hendrix Scraperlike form and a large chert side scraper made on a levallois-like flake that was found on the lowest exposed level of 44Pyl52 at about 3.75 m.

Unlike quarry-related sites in Virginia such as Williamson and Thunderbird, the range of lithic materials present at Smith Mountain is unusually heterogeneous, although cryptocrystalline cherts and flints predominate. Troy cherts and other dark grey (possibly Beekmantown formation) cherts are well represented, as are various jaspers, all of which are available in the Ridge and Valley province to the west. Rhyolite, metasiltstones (silicified slate) and other more exotic materials are present in significant quantities, but no single lithic source dominates the assemblage.

The Smith Mountain site is one of a few known deeply stratified Paleoindian sites in Virginia and the Southeast, but may be representative of the riverine orientation of the early peopling of the Southeast as envisaged by Anderson (1990). Such sites are probably more common in the region than is currently realized, but most may lie buried under thick deposits of Holocene alluvium. This important site deserves more intensive study. Efforts in the immediate future should focus on paleoenvironmental reconstruction including geomorphological testing to ascertain the chronology of the site's alluvial deposits. The funding required for extensive excavations of the early occupation levels below the water table will probably not be forthcoming soon in this time of financial constraints; however, such excavations are possible and should be eventually undertaken. In the meantime, the Smith Mountain site provides a predictive model for locating similar sites in the region. Such sites not only hold great promise for sorting out the complex sequence of cultural succession during this early period in the Southeast, but their lowest levels may be the best place in the eastern United States to isolate traces of pre-Clovis occupations if they exist.

Much credit to Dan Vogt, J. T. Moldenhauer and Jeanette Cole for their work on this site. Also much appreciation is due to L. T. Powell and Mark Haley for their assistance in documenting the first fluted point recorded for the site.

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The Paleoindian Sequence at the Wilson-Leonard Site, Texas

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Excavations at the Wilson-Leonard Site (41WM235) into valley fill 6.5 m thick documented Paleoindian, Archaic and late-Prehistoric remains, in the most complete single-site archaeological sequence in Central Texas. The first excavations (1982–84) were by archaeologists with the Texas State Department of Highways and Public Transportation (now TxDOT); the second excavations were conducted by staff of the Texas Archeological Research Laboratory (TARL) of the University of Texas at Austin and sponsored by TxDOT (1992-93). The TARL excavations were undertaken to obtain geological, ¹⁴C and isotope, archaeomagnetic, phytolith, diatom, and organic residue samples. These new samples are being analyzed now.

The site is on the right bank of Brushy Creek in southern Williamson County in the ecotone between the Edwards Plateau and the Coastal Plain. Three major depositional units are recognized from bottom to top (Units I, II and III). Unit I consists of fluvial deposits. Unit II is poorly sorted colluvium. Unit III is of colluvial and anthropogenic origins. Paleoindian materials were found in Units I and II, while Archaic and late-Prehistoric artifacts were recovered in Unit III.

At the bottom of Unit I fluvial gravels (1.5 m thick) lie directly on bedrock. Toward the valley wall, these gravels interfinger with silts containing colluvial gravel lenses. Prehistoric artifacts occur in the upper portion of these gravels and silts. Flakes, a large biface and the distal portion of a projectile point are among the artifacts recovered. The point tip resembles those of Clovis points.

On the downstream side of the site above the stream gravels, apparently in an ancient channel, the deposits change to dark clayey silts and appear to represent a wet, low-energy depositional environment. A Midland-like projectile point, bison bones, a flake with engravings in its dorsal cortex, and at least two fragmentary preforms considered to be of Folsom technology were recovered from this dark, clayey silt. The clayey silt grades upward into silt altered by pedogenesis, the Leanne Soil (Holliday 1992). From the Leanne Soil, unidentified stemmed projectile points, informally called "Wilson Points," were recovered. These projectile points are large and have expanding stems, thick

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blades with biconvex cross-sections, and light to moderate smoothing of basal, lateral stem, and proximal blade edges. A burned tree stump, dated by radiocarbon, provides an age estimate of 9530 ± 88 yr B.P. (Tx-4828). On the east side of the excavation area a thin, less-organic silt caps the Leanne Soil; it forms, along with the Leanne Soil in other areas, the upper boundary of Unit I. This upper boundary appears to have been eroded, as indicated by the streamward slope of its surface.

A human burial was discovered in 1983 in a shallow pit stratigraphically below the Leanne Soil. Pit fill was similar to Leanne Soil, and the pit probably originated from a surface within that soil. Bulk sediments from the pit fill were dated to 9470 ± 170 yr B.P. (Tx-4787) and 9650 ± 124 yr B.P. (Tx-4793). The human bone, dated directly by the AMS technique, yielded radiocarbon ages of 1270 ± 280 yr B.P. (AA-753), 4650 ± 310 yr B.P. (AA-747), 5440 ± 420 yr B.P. (AA-752), 5860 ± 270 yr B.P. (AA-751), 5940 ± 520 yr B.P. (AA-748), 6700 ± 460 yr B.P. (AA-749) (Stafford et al. 1987). These determinations can be accepted as minimum age estimates only. The interment was of an adult female placed in a flexed position and accompanied by three allocthonous items: a large piece of limestone, a large chopper/grinding stone of metamorphic rock, and a fossil shark tooth.

Unit II is poorly sorted colluvium, with dispersed gravel lenses especially common toward the stream. Plainview, Golondrina and "Texas Angostura" components occur in stratigraphic sequence from bottom to top in Unit II. Hearths occur in the upper portion of Unit II, and charcoal from one of these hearths produced three radiocarbon ages of $8,820 \pm 120$ yr B.P. (Tx-4784a), $8,940 \pm 100$ yr B.P. (Tx-4784b) and $8,860 \pm 150$ yr B.P. (Tx-4784c). Preliminary archaeomagnetic results suggest that the stones in these features were heated and cooled in place.

Unit III is divided into subunits IIIa, IIIb and IIIc. Unit IIIa is a buried soil, the Stiba Soil. Early-Archaic (Gower) and "Texas Angostura" artifacts (which include dart points resembling the Hell Gap and Agate Basin types) were recovered in the lower portion of this buried soil along with abundant burned limestone clasts. These stones appear to represent cooking features similar to burned rock middens common in central Texas in later time periods. Preliminary archaeomagnetic results indicated that some stones in these features were dislocated after last being heated and cooled. It now appears that disturbance occurred during use of the features. It is likely that the "Texas Angostura" material is not in primary context within Unit IIIa, but derived from the upper portion of Unit II and was intermixed with overlying materials when the Unit IIIa hearth pits were dug. Charcoal from a hearth produced an agc estimate of 7470 \pm 230 yr B.P. (Tx-4798). This hearth appears to be in Unit IIIa and provides a rough age estimate for the early-Archaic (Gower) burned-rock midden.

In the upper portion of Unit IIIa, younger early-Archaic components were recovered. Middle-Archaic components were documented in Unit IIIb; late-Archaic and late-Prehistoric components were found in Unit IIIc.

Units I and II together are almost 5 m thick and accumulated in the relatively brief span of about 3,000 years. In contrast, overlying Unit III required over

8,000 years to reach its thickness of about 1.5 m (Holliday 1992). The comparatively rapid deposition rates seen for Units I and II enhance the recovered paleoecological evidence and Paleoindian artifacts with favorable temporal controls; this enhancement is diminished somewhat by turbation of the deposits, by modest yield of organic remains, and by low numbers of artifacts. However, important archeological and paleoecological findings are anticipated for the sequence of Clovis (?), Midland-Folsom, "Wilson," Plainview, and "Texas Angostura" components found in Units I and II.

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Paleoindian Occupation of the Potomac River Valley *Richard J. Dent*

The Catoctin Creek site (44 LD 15), which yielded an assemblage assignable to the eastern North America fluted-point tradition, is located 43 km upstream from Washington, D.C. This site is situated within the Piedmont physiographic province on a small peninsula of land along the Virginia bank of the Potomac River near its confluence with Catoctin Creek. The site itself is on a second terrace formation above the floodplains of both nearby streams and is approximately 73 m above mean sea level. It is the only Paleoindian site known in the Potomac River Valley.

Since the Catoctin Creek site is a surface manifestation, radiocarbon assay is not possible. Based on artifact morphology, the site can reasonably be expected to date to c. 10,600–10,200 yr B.P. (see Meltzer 1988:18). Unfortunately, no features can be associated with the artifact assemblage. It was nevertheless possible to collect a relatively large number of Paleoindian artifacts, including major portions of two fluted bifaces. Unexhausted discoidal and polyhedral cores were also recovered. In addition, the assemblage includes two spokeshaves, nine general bifaces, one backed knife, four apparent gravers, five end-

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scrapers, four combination end/side scrapers, one very large circular unifacial knife, various rough stone tools, hammerstones, and 37 retouched or utilized flakes. A significant number of waste flakes were also recovered along with numerous cobbles thought to represent potential raw material for tool manufacturing. All artifacts, including debitage, were collected with exact provenience.

There is always a question of integrity with such surface manifestations. However, we believe that the placement of all artifacts in the Paleoindian tradition is secure. First, the overt morphologies of all recovered standardized tool forms are classic Paleoindian. Second, the site's second terrace location is unique vis-à-vis known regional settlement patterns; such locations were not favored by later inhabitants. Last, almost all the actual tools and a high proportion of the flakes at this site are of jasper (chert). The predominance of this distinct material, as opposed to other lithic materials employed by subsequent inhabitants in the immediate area, argues for strong contextual integrity.

It is evident that tool manufacturing was taking place on the site. Cores and supplies of lithic raw material support such an assumption. The amount of lithic debris (including many large primary flakes) and the presence of hammerstones is another indication. Recovered bifaces are in the unfinished stages of the reduction sequence. Known jasper quarries have been located near the site, and material is also available in cobble form from nearby stream systems.

Many of the recovered tools appear to be discards or near the end of their usable life. This is another argument for manufacturing activity: old tool kits were abandoned at the site as a new assemblage was produced. The two fluted bifaces recovered were discards, and the scraper collection appears near the end of its usable life span. For example, one end scraper, given its now-minute size, appears to have been rejuvenated many times. A variety of tasks, from hunting to foraging and processing to secondary non-lithic tool manufacture, could have been undertaken with the assemblage recovered from the site.

Another interesting observation about the collection is the presence of what appears to be the thermal alteration of jasper at the site. While the positive identification of heat treating is problematic, some of the tools and a significant portion of the associated manufacturing debris exhibit a deep red color and a waxy surface appearance. Prehistorians typically attribute such conditions to the heat-treating process. This possibly says something about the site inhabitants' attempts to increase either the workability of the raw material and/or trying to increase its potential use life. Since jasper is usually considered an easy and predictable lithic material to work (Goodyear 1979), the latter phenomenon may be the reason for thermal alteration in this instance.

In conclusion, the Catoctin Creek site is the only actual Paleoindian site now known for the Potomac River Valley. Isolated fluted bifaces have, however, been recovered at other locations in the area. While the Catoctin Creek site is not tremendously large and does not contain artifact densities suggestive of repeated occupation, it is a particularly rare local Paleoindian manifestation. Its presence on an upper terrace at the confluence of second- and third-order streams suggests at least one component of local Paleoindian settlement systems.

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Squatec (ClEe-9), A Late Pleistocene/Early Holocene Site In Southeastern Québec, Canada

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Location

The Squatec site (ClEe-9) was discovered in 1991 during an archaeological survey conducted in the Témiscouata region of southeastern Québec. This fieldwork was part of a theoretical research in spatial archaeology dealing with the general prehistory of a study zone approximately 7,500 km² in area, and strategically located in the center of an important topological network (see Figure 1). The Témiscouata region is about 50 km inland from the south shore of the St. Lawrence River and is contiguous with the northern borders of the state of Maine and the province of New Brunswick.

The area is located within the so-called Notre-Dame Mountain ridge, characterized by hills and dales that are organized in a true geometric pattern, where the hills enclose longitudinal valleys. Inside the depressions is a relief characterized by rises and inclines that give easy access to the interfluve summits from where the view is often spectacular.

The Squatec site lies within a major natural trend linking the south shore of the estuarine section of the St. Lawrence River near Rimouski to an interior central place coinciding with the Lake Témiscouata basin (Figure 1). The site is thought to be part of a glacial delta that formed between 11,500 and 10,500 yr B.P., following the regional geochronological sequence known today.

Context

This previously undisturbed site was first evaluated by test-pitting for possible artifacts from different stratigraphic horizons. A total of 14 small test pits yielded a collection composed mainly of debitage and resharpening flakes, which are thought to be derived almost exclusively from a local chert of which an outcrop used during prehistoric times is only 17 km away (Morin 1988). Geological maps show that other chert exposures occur even closer to the site. A biface fragment and a scraper have been collected, but unfortunately no

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diagnostic tools have been found during this limited sampling work. A probable mineralized mammalian bone fragment was also unearthed, but its small size prevents proper species identification.

The composition of the glacial delta is a deeply stratified and sorted sand and gravel, capped by an organic forest soil (a podzol), which colors the upper 30 to 40 cm of sediments. Artifacts were encountered in three different horizons varying in depth from 5 cm to 1 m. The stratigraphic sequence of the sediments sampled was recorded, and the samples collected were submitted to a morphoscopic analysis at 30X enlargement. In two of the test pits, the following sequence (from the oldest or bottom to the youngest or top) was recorded:

1. From a depth of 60 cm and lower, the deposit is of fluvioglacial origin and

is part of a glacial delta. The inclination of the foreset beds suggests that the meltwater flowed towards the north and fed glacial lake Des Aigles. The deepest artifacts were found in the topset bed of this formation.

- 2. The second major stratigraphic unit in which artifacts were found is a beach deposit of then glacial lake Madawaska at its northern limit. This lake emptied at about 10,000 yr B.P. (Kite 1983).
- 3. The third unit is about 15 cm thick. The observed trend in the flattening of the sand particles is less marked here than in the preceding unit, but their dullness still indicates water deposition. This unit may be associated with the drainage of the drift-controlled Des Aigles glacial lake, upstream from the site, that probably occurred shortly after the emptying of Madawaska glacial lake.
- 4. Finally, at the level of the present podzol, a layer of silty sand 10 cm thick indicates colluvium deposition.

Implications

From these findings at the Squatec site, we conclude the following:

- 1. Following the chronology of the late-glacial period in this area, we propose that the oldest human occupation of the site dates back to the Paleoindian period. It occurred in an environment characterized by tundra vegetation (Richard et al. 1992) where local ice sheets were still receding (sometime between 11,500 and 10,500 yr B.P.). A Paleoindian presence in a periglacial context has also been interpreted for some of the Munsungun-Chase sites in northern Maine (Bonnichsen 1991:316). If our interpretation is correct, Squatec would be the first early-Paleoindian site recognized in Québec and it would be the most northerly site of this age in the Northeast (48 degrees of latitude).
- 2. Stratigraphic context suggests that at least two occupations of probable Paleoindian age followed in a relatively short period of time after the oldest occupation of this site. These occurred on a beach of glacial lake Madawaska or drift-dammed Des Aigles lake. The important sand accumulation over the artifacts points to a small-scale regression-transgression dynamics of these lakes during this time period. This association raises interesting questions about the role of these large interior bodies of water in the control of local space, transportation and resource use.
- 3. The location of the Squatec site on a major trend that offers direct communication to the south shore of the St. Lawrence River points to a possible presence of early Paleoindians on the coast of the Goldthwait post-glacial sea. This hypothesis will have to be tested by problem-oriented surveys conducted on the raised late-Pleistocene landforms associated with this body of water.

Fieldwork in the Témiscouata region and on the Squatec site in particular should be pursued in the near future in order to gather additional data concerning spatial relationships at the local and regional levels, artifact content, stratigraphic relationships, and chronology and organization of living space. This research will also offer an interesting opportunity for interplay between the earth sciences and archaeology.

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Evidence for a Terminal Pleistocene Human Occupation of Daisy Cave, San Miguel Island, California

Jon Erlandson

Daisy Cave (CA-SMI-261) is a stratified shell midden located on San Miguel Island, 40 km off the California coast (Figure 1). San Miguel is the westernmost of the Northern Channel Islands, separated from the mainland throughout the Quaternary. The island is rich in sea mammals, fish, and shellfish, but poor in terrestrial foods, so Daisy Cave's occupants probably relied on marine foods throughout prehistory. The first people to colonize the islands, in fact, must have had seaworthy boats to cross the often hazardous Santa Barbara Channel.

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Figure 1. Location and structure of Daisy Cave.

In 1967–68, a team led by C. Rozaire (1978) first systematically excavated Daisy Cave. Rozaire's work produced diverse assemblages of artifacts and faunal remains, including the bones of several extinct species (Guthrie 1980; Walker 1980). The antiquity of Daisy Cave's cultural deposits was not thought to exceed about 3,500 years, however, until 1985–86, when P. Snethkamp and D. Guthrie obtained ¹⁴C dates that bracketed the earliest clear evidence for human occupation between about 8,460 ± 100 (Beta-15621) and 8,900 ± 120 (Beta-



15623) yr B.P. Subsequent studies have shown that the base of this early-Holocene deposit is about 9,700 cal B.P. (Stuiver and Reimer 1993). In this midden (Stratum E/F), dated to about 9,360 \pm 90 (Beta-49948) yr B.P., plant remains are preserved, including cordage and other woven items.

Here, I focus on an earlier stratum at Daisy Cave, one that may place humans on the Channel Islands 11,500 years ago. In 1986, Snethkamp, Guthrie, and D. Morris removed two columns from the walls of Rozaire's trenches, to use as samples to identify the contents of various strata at the site. Below the 9,700-year level, several paleosols contain small amounts of marine shell, burned and unburned bone, and charcoal. One of these (Stratum G) contained an abalone (*Haliotis rufescens*) shell dated to $10,700 \pm 90$ (Beta-14460) yr B.P. Snethkamp (1987) believed this shell was deposited by humans, but no artifacts or other clear signs of cultural occupation were found with it.

I have suggested that natural mechanisms could account for the shells and burned bones in the lower levels of the cave (Erlandson 1993). The bones of several carrion-eating birds (seagulls, ravens, eagles, and condors) have been found at Daisy Cave, and such birds may have transported shellfish to the site. Barn owls roost in the cave, and regurgitated owl pellets may have been a major source of rodent and small-bird remains (Guthrie 1980). Cormorants also nest in the cave (one nest contained thousands of fishbones), and after El Niño conditions in the summer of 1992, cormorant carcasses littered the site. Finally, wildfires have been an active part of the San Miguel Island landscape for millennia (Johnson 1972), and charcoal or burned bones are not unequivocal cultural indicators.

Since 1991, I have studied the 1985–86 collections from Daisy Cave. Two lines of evidence now suggest that humans may have occupied CA-SMI-261 as much as 11,500 years ago. One of these is a second ¹⁴C date on black turban (*Tegula funebralis*) shells from Stratum G, submitted to check the red abalone date. The turban shells were dated to $10,600 \pm 70$ (Beta-52360) yr B.P., confirming the terminal-Pleistocene age of Stratum G. After calibration (Stuiver and Reimer 1993) the calendar age of the two shell dates averages $11,550 \pm 200$ years. An 1,800-year gap between the base of the early-Holocene midden and the shells in Stratum G also suggests that the latter were not derived from above.

Demonstrating that these 11,500-year-old shells were left by humans, however, requires that artifacts be found with them in Stratum G. I first searched the fine screen fractions for microdebitage or other artifacts. In the 1/16-inch fraction, one tiny piece of angular Monterey chert debris was found, hinting at a possible cultural association. This minute sample inspired little confidence, however, as the possibility of stratigraphic mixing could not be ruled out.

We returned to Daisy Cave in 1992, partly to answer questions about its Pleistocene occupation. Two test pits, each 50 x 100 cm wide, were dug. In both, small amounts of marine shell, fish bone, and chipped stone were recovered in Stratum G. In Unit E7, the overlying midden rested directly on Stratum G and the downward movement of cultural material by trampling or other processes could not be precluded. In Unit D6, the contact between the early-Holocene and terminal-Pleistocene strata was clear—the two were separated by a nearly continuous pavement of black abalone shells, a stratum of lighter-colored sediments, and rock fall from the cave walls. Here, an area measuring 50 x 50 cm of Stratum G sediments produced flakes and angular chunks of Monterey chert and siliceous shale. At least two Monterey chert flakes have well-defined bulbs of percussion and other flake attributes. Artifacts made from these same materials dominate the chipped stone assemblages from overlying midden layers, but neither rock type seems to occur naturally in the cave. Finally, within the exposures examined, no mechanism is apparent that can account for the movement of chipped stone artifacts (but not marine shell) downward from overlying strata.

New ¹⁴C dates, analysis of column sample microconstituents, and new excavations all seem to support Snethkamp's (1987) claim that Daisy Cave was occupied by humans during the terminal Pleistocene. Given the limited sample recovered from 11,500-year-old layers, however, caution still is warranted. In 1993, I hope to resolve questions about the antiquity of the site occupation and the nature of the adaptations of some of the earliest maritime peoples yet documented in the New World.

My 1992 research at Daisy Cave was done under ARPA Permit WR-1979-92-CA-2, with support from Channel Islands National Park, Southwest Parks and Monuments Association, and the University of Oregon. D. Morris and R. Kelley (NPS) provided logistical support, and E. Forgeng, R. Dugger, S. Cooper, and D. Morris worked in the field. My work builds on that of C. Rozaire, P. Snethkamp, and D. Guthrie. Figure 1 was adapted from an original by S. Hammersmith.

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A Record of Paleoindian Occupation in North-Central Wisconsin

Matthew G. Hill

For nearly 20 years, avocational archaeologist Gary Steele of Black River Falls, Wisconsin, collected prehistoric artifacts from the cultivated fields adjacent to Silver Mound (47JA21), the source of Hixton silicified sandstone (HSS), sometimes incorrectly referred to as Hixton quartzite (Porter 1961). This

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localized outcrop of Upper Cambrian silicified sandstone is found within the northernmost extension of Wisconsin's Driftless area (Martin 1965) in Jackson County near the modern-day town of Hixton. Unfortunately, some localities at Silver Mound were damaged, if not destroyed, during highway and railroad construction earlier in this century. Additionally, in early Historic times, Euroamericans expanded prehistoric quarry pits in search of silver, hence the name Silver Mound. However, the site still contains hundreds of pristine quarry pits. The fields bordering the mound, particularly to the southeast, are littered with lithic debitage and artifacts spanning thousands of years.

The extensive and well-provenienced Steele Collection documents c. 12,000 years of prehistory in north-central Wisconsin from early-Paleoindian times through the late-Prehistoric period. Of particular interest are 69 Paleoindian projectile points collected at the Silver Mound locale. Well-known Paleoindian point types such as Clovis, Plainview, Agate Basin, Hell Gap, and Cody Complex specimens have been identified. The points were manufactured from local and non-local lithic materials, and provide insight into Paleoindian mobility and settlement strategies as well as point production and maintenance.

HSS possessed the necessary physical and aesthetic qualities to make it a favored lithic material among Paleoindians throughout the Wisconsin and the Midwest. HSS Clovis points have been recovered in Kentucky, Ohio, Indiana, and Illinois (Tankersley 1988). Later-Paleoindian points have been recovered in Ontario (Julig et al. 1987), Michigan (Buckmaster and Paquette 1988), and Iowa (Morrow 1984).

Thirteen Clovis points have been identified in the Steele collection. Ten specimens are HSS; of the remainder, one is manufactured from Moline chert, one from Galena chert, and the last is an unidentified chert. The short, blunt, asymmetrical morphology of Galena, Moline, and several HSS specimens suggests they were discarded as exhausted tools, with one HSS specimen having been worked into an endscraper. Additionally, three HSS Clovis preforms were broken during various manufacturing stages. An overshot flute broke one specimen during the first fluting attempt. Another specimen was successfully fluted on one face; however, flute detachment on the other face failed when a misdirected blow crushed the platform and the preform snapped. The third specimen broke during platform preparation; fluting of either face was not attempted.

Twelve Plainview points are also represented. Seven are HSS, while the remaining specimens are of Burlington (n = 2), Galena, local, and unidentified cherts. Except for one HSS broken in manufacture, all the specimens have been heavily resharpened, with one point worked into a drill/reamer-like tool.

Thirty-five Agate Basin points make up most of the Paleoindian projectile points in the Steele collection. All are HSS except for specimens manufactured from obsidian, local (n = 2) and Galena chert, and an unidentified quartzite. Specimens broken in manufacture or discarded as exhausted tools are represented.

Three Hell Gap points have been identified. Two of these specimens were manufactured from unidentified lithic materials, while the third specimen is Knife River chalcedony. These specimens were resharpened extensively and subsequently discarded after they were no longer effective tools.

The collection also contains six Cody Complex related points. Three specimens are HSS, and one each are from Burlington chert, Knife River chalcedony, and an unidentified lithic material, possibly novaculite. The Knife River chalcedony specimen appears to be the basal portion of a Cody knife.

Procurement of HSS, manufacture of projectile points, subsequent discard, and retooling were important activities at the Silver Mound locality. Specimens broken or discarded in nearly every stage of production and use, from early bifacial reduction sequences to tool exhaustion, are present in the Steele collection. As a result, the "life-cycle" of HSS Paleoindian projectile points can be documented in detail. Exhausted HSS specimens recovered at Silver Mound imply a return to the site, while other heavily resharpened points suggest visits to other lithic sources (e.g., Moline chert of northwestern Illinois) during systematic movement. Further analysis of the Steele collection and investigation at quarry and habitation sites throughout the Midwest should reveal a more detailed understanding of Paleoindian adaptation and mobility in the Eastern United States.

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New World Grasslands Hunter-Gatherers in the Late Pleistocene and Early Holocene *Eileen Johnson and Gustavo G. Politis*

The North American Great Plains and South American Argentinean Pampas are extensive grasslands ecosystems analogous to each other in temporal, climatic, environmental, and geomorphic development. The core of the Pampas has remained a grasslands since at least the late Pleistocene (Salemme and Miotti, 1987), similar to the situation with the Southern Plains (albeit the character of the grasslands and the faunal communities of both regions changed throughout this period) (Johnson, 1986; Lundelius et al., 1983). For the Pampas, the regional primary depositional units are aeolian and lacustrine. Loess units are a regional phenomenon laid down in extensive blanket sheets, similar to the extensive loess deposits of the Northern Great Plains. Different geological and faunistic evidence recognized at several localities indicates a possible regional dry period in the middle Holocene (Fidalgo et al. 1986; Fidalgo and Tonni 1981) analogous to the Altithermal on the Plains (Holliday 1989).

Research over the past 15 years (Crivelli Montero et al. 1987; Fidalgo et al. 1986; Flegenheimer 1987, 1990; Madrid y Salemme 1991; Politis 1984, 1989; Politis and Olmo 1986; Politis and Tonni 1982; Politis et al. 1991; Silveira 1991) now indicates an analogous cultural development, particularly striking between the Southern Plains and the Pampas. In a broad perspective, huntergatherers were exploiting the grasslands herd herbivores of both regions at least as early as 11,000 to 11,500 yr B.P. using a lithic tool kit consisting of a stylized weapon (projectile point) and a variety of percussion-flake tools. This pattern continues into the middle Holocene, with a concomitant, analogous change to a greater focus on a particular herd herbivore (bison in the Great Plains and guanaco on the Pampas) during the early Holocene after widespread faunal extinctions. Smaller game animals supplement the subsistence base in both regions (Fidalgo et al. 1986; Johnson 1987; Politis 1984; Salemme 1987). Furthermore, in the Pampas, fishtail projectile points (Flegenheimer 1987, 1990) appear to be equivalent to and synchronous with North American fluted points.

Much of the ancient-peoples research on the Pampas has focused on fewer than a dozen sites. La Olla (Politis and Lozano 1988, ms.) and Paso Otero 1 (Politis et al. 1991) appear to be early- to middle-Holocene potential kill/ processing sites, the former a potential seal-processing and the latter a potential guanaco-kill site. At Paso Otero 1 (Politis et al. 1991), testing has revealed three separate bone piles from at least 20 adult and subadult guanaco. The bone piles represent a mixture of different individuals. La Moderna (Palanca et al. 1972;

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Politis 1984, 1985) is a glyptodon (*Doedicurus clavicaudatus*) kill-site located on the banks of a late-Pleistocene to early-Holocene marsh. The partial remains of one glyptodon have been recovered in association with close to 2,000 lithic flakes and debris (Politis and Olmo 1986). Arroyo Seco (Fidalgo et al. 1986; Politis 1984) is a geologically stratified, multicomponent, early- through late-Holocene site. It is located on a loess ridge adjacent to a shallow, marshy pond similar to a playa on the Southern Plains. Numerous occupation levels representing camping activities have been uncovered within lacustrine deposits. The lithics are produced primarily from regionally available quartzite, and a variety of unifacially flaked flake tools similar to the amorphous flaked tools on the Plains are the common tool type (Fidalgo et al. 1986). To date, 28 human burials have been uncovered from different levels dating from 9,000 to 5,000 years ago.

Despite the coastal setting of La Olla, these sites are comparable to the Paleoindian sites on the U.S. Plains. Furthermore, La Moderna and Arroyo Seco are directly comparable to the Paleoindian occupations at Lubbock Lake, including the topographic settings and lithic tool kits (Johnson 1987). Amorphous flake tools are the standard, if not the hallmark, of Plains Paleoindian butchering tools (e.g., Frison 1978; Johnson 1987; Wheat 1972, 1979). Bone piling is typical at bison kill-sites (Frison 1978; Johnson 1987; Wheat 1972); secondary processing areas (Johnson 1987; Wheat 1979) and camping sites (Ferring, in press; Wheat 1979) also have been excavated. More specifically, a late-Pleistocene secondary processing area at Lubbock Lake (Johnson 1987) contains the remains of the giant armadillo (Holmesina septentrionalis), an extinct pampathere. This pampathere is a relative of the South American glyptodont, and its homeland is Argentina and Brazil (Edmund 1985). The Lubbock Lake Paleoindian bison kills are at the marshy edges of shallow ponds and marshes. The tool kits consist of fracture-based utilitarian bone tools and amorphous flake tools, both expedient technologies (Johnson 1985, 1987).

The overall and specific similarities are quite striking. While the Great Plains Paleoindian models may not be applicable to areas of South America forested during the late Pleistocene and early Holocene, these grasslands-based models appear useful as a starting point in evaluating the growing pampean database. After the extinction of the late-Pleistocene fauna, the basic hunter-gatherer way of life continued to follow a pattern of adaptation where the bison or the guanaco play a major role.

Some differences are apparent in the archaeological knowledge of both regions. Basically, in the Pampas, only a few early human sites have been excavated intensively; radiocarbon ages remain scarce; and taphonomic analyses are lacking. Extinct megamammals may have been of secondary importance in the diet, as guanaco appears to dominate the record from the earliest occupations. The late-Pleistocene Plains Paleoindian diet also is a varied one including a wide array of both megamammals and smaller game. For the Great Plains, only a few Paleoindian camp sites are known and human skeletal remains are exceedingly rare.

While the databases are not totally compatible, the numerous striking similarities indicate a broad area of overlap that provides a significant oppor-

tunity for comparative research. On the Pampas and Great Plains, peoples through time and within the same geologic time period were hunter-gatherers living in a grasslands ecosystem exploiting a grasslands biota under similar climatic regimes. The apparent commonalty provides the mechanism for exploring decision-making and the pursuit of different options under similar circumstances, subsistence and settlement patterns, and response to climatic and environmental changes. The pampean database also facilitates an assessment of the Great Plains Paleoindian models and the delineation of shared characteristics of grasslands-oriented hunter-gatherers.

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The Takamori Site: A Possible >300,000-Year-Old Site in Japan

Toshiaki Kamata, Shin'ichi Fujimura, Hiroshi Kajiwara, and Akihiro Yamada

The Takamori site could be the oldest site yet excavated in Japan, with an age estimated to be well over 300,000 years. Takamori is located in the town of Tsukidate in northern Miyagi Prefecture, about 60 km north of the city of Sendai. It is not far from the famous early Paleolithic sites of Babadan A and Zazaragi. The site is situated on low, rolling hills at an elevation of 80–90 m. This locality is in the northern part of the Sendai Plain, a large coastal plain on the Pacific Ocean side of northeastern Japan.

The site was discovered in 1988 and excavated for two weeks in November of that year (Sekki Bunka Danwakai 1991), for three weeks in May 1991 (Kato and Yamada 1991), and again for about seven weeks in August and September 1992 (Abe and Yamada 1992). These excavations unearthed 356 m² at Location A, recovering 41 artifacts, and 312 m² at Location 0, about 200 m away, recovering three more artifacts there. These artifacts consist of several flakes, retouched flakes, small bifacially worked tools, cores, bipolar cores and scrapers, as well as one notch, an ax, a spatula-like tool, a drill and a pointed pebble tool (Figure 1). Most artifacts are made of jasper or chalcedony, but a few are of shale, silicified tuff and silicified wood. Only two pieces could be refitted (across a distance of 5 m); most pieces are from different original cores or nodules of stone. The artifacts at Location A were found in four spatially separated clusters.

These materials compare closely to those belonging to the oldest phase of the Japanese early Paleolithic as it is presently recognized. The major known components in this phase are Babadan A Strata 20, 31a (originally called 32a) and 34a (originally called 33a) (Sekki Bunka Danwakai 1986, 1988, 1989), Nakamine C Stratum VII (Fujinuma et al. 1985) and Aobayama B Stratum 11d (Sudo et al. 1987). These components date between 120,000 and 200,000 years ago. Stratigraphically, the Takamori lithics clearly date much older than any of these assemblages.

A 10-meter cutting at Location D, in the vicinity of the excavated locations, revealed a long sequence of tephra layers (Soda 1992). Sixteen of these have been named the Takamori Tephras 1 to 16 (Tm-1 to Tm-16), from oldest to youngest. Below these are three Kuranosawa Tephras (Ks-1 to Ks-3). The artifacts were found 10–20 cm below the deepest Takamori Tephra (Tm-1) and just above the youngest Kuranosawa Tephra (Ks-3). This whole Takamori sequence is separated from the oldest key tephra—Shimoyamasato Tephra

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Figure 1. Artifacts from the Takamori site, Location A, Miyagi Prefecture, Japan.

(Sm)—in the standard sequence for northern Miyagi by numerous other tephras, pyroclastic-flow deposits and pumice layers.

In the standard geological sequence, the Sm tephra is overlain by three Nakazato Pumice layers (N_1P to N_3P), the youngest of which (N_3P) is dated about 290,000 yr B.P. Above this is the Magasaka Ash (MgA), dated 210,000–220,000 yr B.P., and above this are numerous other key strata, many of which also have radiometric dates. These dates are mostly consistent with the stratigraphic sequence, providing a fairly sound basis for dating artifacts found in sites with these deposits. The relatively great depth of the Takamori lithics below the oldest dated key layer suggests an age parallel to the human occupation at the Zhoukoudian Cave in North China.

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The Paleoindian Occupation of Little Pin Oak Creek, Fayette County, Texas

Floyd B. Largent, Jr. and Joseph B. Wilson

The first Americans had occupied Texas by approximately 11,500 yr B.P., as evidenced by the Paleoindian cultural remains found at archaeological sites scattered throughout the state. This report deals with archaeological investigations undertaken at one such locality, a multicomponent site located in northwest Fayette County, Texas (Figure 1).

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The Little Pin Oak Creek Site (41FY53) is quite extensive, measuring roughly 500 m (EW) by 160 m (NS); it is characterized as a Paleoindian campsite with Clovis, Plainview, and Angostura remains overlain by early-Archaic, late-Archaic, and late-Prehistoric components. The site is located on the floodplain of Little Pin Oak Creek, a first-order tributary of the Colorado River, and is dominated by three stream terraces, which have undergone extensive periods of deposition and erosion during the past 12,000 or more years.

Three separate areas of the site were excavated between 1977 and 1990, each producing evidence of Paleoindian occupation (Largent 1991; Wilson 1980). These excavations produced a single perversely fractured Clovis point; three Plainview points; three Angostura points; a polyhedral Clovis blade core; three Paleoindian thumbnail scrapers; and a number of prismatic blades and thin bifaces which probably have a Paleoindian origin. Most artifacts were recovered on or near the interface between a thin (40–200 cm) layer of sand overlying an undulatory, weathered clay paleosol. The presence of Paleoindian artifacts on the surface of the paleosol indicates that its upper surface dates to at least 11,500 yr B.P.

While later cultural groups are also represented at Little Pin Oak Creek, the Paleoindian finds make the site particularly noteworthy; Paleoindian remains are somewhat rare for this region of Texas (Largent et al. 1991; Meltzer 1986). Because of its nature, the Little Pin Oak Creek Site is a valuable addition to the Central Texas archaeological data base. Particularly valuable is the Paleoindian evidence, which contributes to a further understanding of the Paleoindian occupation of Central Texas, and of North America in general.

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Early Holocene Archaeology and Paleoecology of the Manning Site (33CT476) in Southern Ohio

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The Manning site (33Ct476) is situated on a high flood terrace or terrace remnant of the Ohio River in Clermont County, Ohio. Archaeological investigations were undertaken here as a part of the William H. Zimmer Generating Station cultural resource management project (Roper and Lepper 1991). Deep testing at this site revealed a stratified series of late-Paleoindian through early-Archaic occupations.

The earliest documented occupation at the site occurs nearly 2 m below the surface. It consists of a large, shallow, elongate basin containing highly oxidized red (2.5 YR 4/8) sediment and scattered charcoal (Feature 11). No diagnostic artifacts were found in association with this feature. In fact, only a single microflake was recovered from this irregularly shaped burned area. Feature 11 is reliably dated by two radiocarbon dates, one of $9,840 \pm 200$ yr B.P. (Beta-23046) on soil humates, and another of $9,890 \pm 200$ yr B.P. (Beta-27477) on charcoal.

In Feature 11, *Fraxinus* (ash) is the most abundant charcoal type, with cf. *Juglans* (walnut) and conifer also present. The recovery of *Fraxinus* charcoal from Feature 11 establishes the presence of ash on the middle Ohio River floodplain by approximately 9,800 yr B.P.

The second occupation occurs 40 cm above Feature 11. It consists of a large, shallow, ovoid basin (Feature 1) surrounded by a scatter of stone tools and debitage to a radius of about 3 m. The artifact assemblage associated with Feature 1 includes two conjoining fragments of a small lanceolate preform, a variety of unifacial tools including one endscraper, and a pitted stone. Radio-carbon dates for this feature range from $10,240 \pm 110$ yr B.P. (Beta-17774) to $9,010 \pm 120$ yr B.P. (Beta-23047), although both these dates are on soil humates. A third date of $9,720 \pm 290$ yr B.P. (Beta-27476), run on small *Picea* (spruce)

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charcoal fragments given extended counting, provides the most reliable age estimate for this occupation and is consistent with the stratigraphic position of Feature 1 relative to Feature 11. It also positively dates the presence of *Picea* in the middle Ohio Valley to $9,720 \pm 290$ yr B.P.

In Feature 1, Juglans, Juniperus (juniper), and Picea charcoal all are relatively abundant. Carya (hickory), Populus (poplar), and Juglandaceae also are present. The diversity of species represented in the charcoal record of this feature suggests that the surrounding local environment was a mixed conifer-deciduous forest.

Juglandaceae (cf. Carya), Carya and Juglans nigra (Black walnut) nutshell remains were recovered from Feature 1. Since Juglandaceae most probably represents Carya and not Juglans nigra nutshell, Carya appears to be the most abundantly collected and processed nut at this site. The presence of nutshell remains in Feature 1 indicates that it was likely used in the fall between September and November, when hickory nuts were most readily available.

A third occupation occurs 10 to 25 cm above the level of Feature 1. This extensive occupation is defined by a 10- to12-cm-thick band of dark, organicrich sediment. The spatial limits of this cultural level were not determined, but it was visible across the entire profile of a 14-m test trench. No radiocarbon dates were obtained for this occupation, but two early-Archaic Kirk Corner Notched projectile points were recovered along with numerous lithic artifacts. No charcoal samples large enough for identification were recovered from this level.

In conclusion, the paleoethnobotanical record from the Manning site indicates that the cultural sequence here spans the transition from a mixed conifer-deciduous forest to a full deciduous forest. The presence of *Picea* macrofossils at the relatively late date of 9,720 yr B.P. is surprising and indicates that this transition may not have been either as abrupt or as simple as the pollen record has suggested (e.g., Ogden 1967; Shane 1987). The evidence for nut exploitation (*Carya* spp. and *Juglans* spp.) by late-Paleoindian groups in the middle Ohio Valley corroborates Brose's (1975) findings at several sites in the Lake Erie drainage and offers support for the view that eastern Paleoindian and Archaic subsistence strategies were broadly similar (Meltzer and Smith 1986).

The William H. Zimmer Generating Station project was undertaken for American Electric Power Service Corporation by Gilbert/Commonwealth Inc. (G/C); Commonwealth Cultural Resources Group was subcontractor to G/C during the report phase. Donna C. Roper was the principal investigator throughout the project.

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The Tomizawa Site: A Small Late Paleolithic Encampment on an Alluvial Plain in Northeastern Japan

Akio Ota and Hirohiko Saino

The Tomizawa site is unusual among Paleolithic sites in Japan: only three brief occupations occurred during a short period when grassland or open woodland covered an area that was otherwise an alluvial plain of sand and silt (Ota and Saino 1988, 1991a, 1991b; Sendai-shi Kyoiku Iinkai 1989). Eleven radiocarbon dates place the development of this woodland between 19,000 and 23,000 yr B.P.; tree-ring measurements suggest the trees endured for more than 300 years. The site now is on the floodplain between the Natori and Hirose rivers, not far from the Pacific coast, on the southern edge of the city of Sendai in Miyagi Prefecture in northeastern Japan. The present elevation of the Paleolithic layers is 6–7 m, but at the time of occupation this would have been the inland edge of a wide coastal plain (Ota and Yonekura 1987:71).

The total excavation at the Tomizawa site covers 82 ha. Of this area, $1,100 \text{ m}^2$ of Pleistocene deposits was excavated in 1988. Peat was discovered in Strata 25 to 27 at a depth of about 3 m. Over 100 trees were preserved in this peat, together with many other kinds of plant macrofossils, pollen, insects and deer feces, and more than 100 Paleolithic artifacts.

Despite the proximity to the rivers, most of the alluvium comes from small streams draining the hills just west of the site, rather than from flooding by the rivers. For a brief period around the time of the glacial maximum the site was dry enough to support a grassland and open woodland. The climate was more continental than today, and the temperature was 7°C lower, or near boreal conditions.

The only significant human occupation of the site occurred in Stratum 27, before the woodland had developed. At that time the site was covered with sedges (*Cyperaceae*), heaths (*Ericaceae*), parsleys (*Umbelliferae*) and thistles (*Compositae*). There were no tall trees, and much of the site was still damp. The

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humans utilized the slightly higher and drier parts of the site, near the edges of the present excavation. They left behind 103 stone artifacts, a small pit, and evidence of a fire, stone-tool manufacturing, hide scraping and meat cutting. Many of the lithics are of the same black shale, and some of these cores and flakes can be refitted.

As conditions on the site improved in Stratum 26, a marshy woodland dominated by Sakhalin spruce (*Picea glehnii*) developed. Dahurian Larch (*Larix gmelinii*) and fir (*Abies sp.*) were also present, as were Korean pine (*Pinus koraiensis*), hemlock (*Tsuga*), birch (*Betula*), hazelnut (*Corylus*), alder (*Alnus*), willow (*Salix*), sedge (*Carex*), reeds (*Phragmites communis*) and sasa-grass (*Sasa* sp. of the bamboo family). The evidence for human occupation is poor—one knife-like stone tool and a possible graver. These say very little about the human activities here beyond the obvious fact that humans did pass through.

This open woodland survived into Stratum 25, but parsleys and sedges began to increase in the damper low parts of the site. By the end of this sedimentary phase, the trees had died out and sandy and silty alluvial conditions had returned. Humans left behind ten knife-shaped stone tools during this final phase of the woodland. Use-wear analysis suggests these were projectile points. The deer feces seem to be associated with this stratum, too. These feces were found in 21 different spots around the excavated area. Analysis of their contents suggests that the deer were wintering here. The size of the feces indicates a large deer, perhaps the moose (*Alces alces*) or Yabe's elk (*Sinomegaceros yabei*). It could be that the humans came here to hunt these animals. The site shows no signs of further human activity until well after the end of the Pleistocene.

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Excavated Paleoindian Contexts at the Bostrom Site, St. Clair County, Illinois

Kenneth B. Tankersley, Juliet E. Morrow, and Larry Kinsella

The authors systematically excavated an unplowed area of the Bostrom site, St. Clair County, Illinois, during the spring and summer of 1992. The excavation was located on a relatively narrow upland spur bordered by a low-order side valley and Silver Creek. The crest of this spur displays an uninterrupted soil profile (Tankersley et al. 1993). The 1992 excavations exposed four features, a concentration of anthropogenic sandstone, and an assemblage of Paleoindian artifacts (Figure 1).

The features included two shallow hearths, a bathtub-shaped depression, and a circular concentration of sandstone. Both hearth features contained ashy clay, minute fragments of carbon, and heat-altered sandstone. One of the features was approximately 3 cm deep and 40 by 50 cm in diameter, and the other was 6 cm deep and 67 by 81 cm in diameter. The bathtub-shaped depression was 28 cm deep and 92 by 97 cm in diameter, and contained heat-altered sandstone, a fluted-biface fragment, and powdered apatite (calcium phosphate, identified by X-ray diffractometry). The apatite is likely decomposed bone, the collagen and calcium carbonate having been leached. Unfortunately, it is impossible to determine whether or not the apatite originated from human or animal bone.

A circular concentration of sandstone, approximately 1 m in diameter, occurred immediately south of the bathtub-shaped feature. A channel flake was located near the center of the sandstone circle.

Heat-altered anthropogenic sandstone and Paleoindian artifacts were concentrated in the area of the features. The Ogles Creek bed, located approximately 0.5 km to the north, is the closest source of sandstone. The artifact assemblage includes three fluted-biface fragments, a channel flake, four side scrapers, and a spurred end scraper. The fluted-biface fragments are manufactured from Burlington chert (n = 2) and Kaolin chert (n = 1). The latter artifact is an early stage preform recycled into an end scraper. The channel flake is manufactured from Attica chert. Of the four side scrapers, two are manufactured from Burlington chert, one from heat-altered Kaolin chert, and one from Cobden/Dongola chert. One of the Burlington-chert side scraper is manufactured from a large bifacial thinning flake. The spurred end scraper is manufactured from Cobden/Dongola chert.

The lithic assemblage is comparable to Paleoindian artifacts recovered from the plow zone of the site (Koldehoff 1983; Tankersley et al. 1993). More than half of the assemblage (64%) is composed of nonlocal lithic materials. The presence of features and the composition of the artifact assemblage suggest the site was used for tool-maintenance activities and temporary habitation.

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Figure 1. The distribution of Paleoindian artifacts and features exposed during the 1992 excavations.

The 1992 excavation was made possible through funds from the Illinois State Museum, Washington University, and the Lithic Casting Lab. Volunteer assistance was provided by the Illinois Association for the Advancement of Archaeology.

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Paleoindian Survey in Northern California

Michael Wendorf

Stratified deposits in Napa River tributaries, late-Pleistocene lake shorelines, and several sites that could date to the Paleoindian period in Northern California have been surveyed. The following sites were surveyed and have ¹⁴C dates, obsidian hydration readings, and/or Paleoindian artifacts that indicate

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an age of approximately 11,000 yr B.P.: Borax Lake (LAK-36), Mostin (LAK-380/381), parts of Anderson Marsh (near LAK-510), the Hultman site (NAP-131), and NAP-15. Of these sites, only Borax Lake has a widely accepted Paleoindian component. Most of the artifacts collected in this survey are now in the Hearst Museum collections at the University of California, Berkeley.

The first site examined in this survey was Borax Lake (LAK-36), where obsidian Clovis fluted points and crescents have hydration readings that range from 8 to 10 microns (Meighan and Haynes 1970). In this survey, an obsidian Clovis fluted point and a basalt end scraper were found on the surface. The Clovis point is fluted on one face and is missing the base and tip portions.

The Mostin site (LAK-380 and LAK-381), just west of Borax Lake near Kelseyville, has been exposed by erosion in Kelsey Creek. Excavations at LAK-



Figure 1. Basally thinned projectile points and preforms collected at the Hultman Site (Napa-131), near St. Helena, California. A, B, and C are projectile point fragments with concave bases and basal thinning. D, E, and F are bifacial preforms that resemble Paleoindian preforms broken during the fluting process. D resembles a concave hinge fracture with a channel flake remnant, E resembles a preform snapped by a hinged channel flake, and F resembles a preform fluted on one face (see Tunnell 1977). Mean obsidian hydration rims: A: 4.9 microns; B: not measured; C: not measured (burned); D: 4.5 microns; E: 3.6 microns; and F: 3.6 microns. These hydration rims indicate that this industry is somewhere between 1900 and 3600 years old.

381 by Kaufman (1980) yielded charcoal that was ¹⁴C dated at 11,250 \pm 250 yr B.P. (UCLA-2165), and bone collagen from human burials was ¹⁴C dated at more than 10,000 yr B.P. However, maximum obsidian-hydration readings of 7.4 microns on Borax Lake obsidian would place the Mostin site later than the Clovis fluted points at Borax Lake. Fredrickson and White (1988) noted that the bone-collagen dates at the Mostin site could have been skewed by ancient carbonates; they suggest an age of 3,500 to 6,300 yr B.P., placing the site in the lower Archaic. In this survey, charcoal collected from a hearth exposed in the lowest layer at LAK-380 (the downstream locality) was ¹⁴C dated at 8,400 \pm 190 yr B.P. (SMU-2435). This date supports an Archaic age for the Mostin site, but suggests that the site could be older than 6,300 years.

Just to the south of Borax Lake, much of Anderson Marsh also was surveyed. Previous excavations at LAK-510, a stratified site in Anderson Marsh, produced obsidian artifacts with hydration readings that ranged from 10.2 to 8.4 microns (White 1984), well within the range of the Clovis fluted points from Borax Lake. In this survey, a chopper, an obsidian core, and charcoal were collected from deeply buried sediments (c. 3 m) exposed in Cache Creek, which flows through Anderson Marsh near LAK-510. Further analysis showed that these deposits and the associated charcoal and artifacts were redeposited, possibly from sites further upstream. The charcoal has not yet been ¹⁴C dated. No Paleoindian artifacts or sites were found in surveys along the late-Pleistocene shoreline around Anderson Marsh.

The Hultman site (NAP-131), in the Napa Valley near St. Helena, California, is in a vineyard between Glass Mountain and the Napa River. This site was excavated by C. Meighan in the 1950s and H. Kinsey in the 1960s. Though Meighan (1953) reported finding a fluted-point fragment at NAP-131, no Paleoindian artifacts were found in the Kinsey excavations. Obsidian-hydration measurements of several artifacts from NAP-131 (Clark 1964) and further analysis by Fredrickson (1973) placed the site within the latest of the three periods at the Borax Lake site, suggesting an age between 3,000 and 5,000 yrB.P.

In this survey, shouldered points, a crescent, and fluted projectile points and preforms that resemble Paleoindian preforms (Tunnell 1977) were found on the surface of the Hultman site (Figure 1). However, four of these fluted artifacts had obsidian-hydration readings that ranged from 3.6 to 4.9 microns, indicating an age between 1,900 and 3,600 yr B.P. The Hultman-site fluted points and preforms, including the fluted point found by Meighan, are evidently not Clovis artifacts but may instead be part of a much more recent concave-base industry that has been found in the North Coast Ranges (White et al. 1982) and often resembles Clovis. These more recent fluted projectile points differ from Clovis fluted points in the lack of basal grinding and in the relatively shallow basal thinning flakes.

However, eleven obsidian flakes, collected from deeply buried sediments (c. 4 m) exposed on the north side of Glass Mountain near the Hultman site, had hydration readings that ranged from 6.4 to 8.5 microns, with an average of 7.4 microns. Because Napa Valley obsidian hydrates at a slower rate than Borax lake obsidian (Fredrickson 1989), hydration readings of 6.0 to 8.3 microns on Napa Valley obsidian could be comparable to the 8- to 10-micron readings on

Borax Lake Clovis fluted points. The Hultman site (NAP-131) and Glass Mountain, then, may have been visited by Paleoindians about 11,000 years ago, but these may not have been Clovis groups.

NAP-15, which is also in the Napa Valley south of the Hultman site, was examined in this survey. Previous excavations at NAP-15 produced several Napa Valley obsidian artifacts with hydration rims in excess of 8 microns (Stradford and Schwaderer 1982: Table 28), suggesting that the site could have a Paleoindian component. Unfortunately, this site is now largely covered by Highway 29 and several buildings.

With the exception of the new locality near the Hultman site (NAP-131), no additional Paleoindian sites have been located in surveys of Napa River tributaries.

The author wishes to thank Clem Meighan, Dave Fredrickson, and Tom Origer for reading the hydration rims on artifacts collected in this survey. Jack Meyer, of Sonoma State University, kindly helped interpret the stratigraphy in Cache Creek, near Anderson Marsh. Thanks are due Herb Haas of Southern Methodist University for special handling of the Mostin-site charcoal sample. Special thanks to Nancy Wendorf for the illustrations in Figure 1. The author also wishes to thank the Mostins of Lakeport, California, and the Sorensens of St. Helena, California, for allowing access to their property during this survey.

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Physical Anthropology

Geoarchaeology of the Midland (Paleoindian) Site and the Age of the Midland Skull

Vance T. Holliday and David J. Meltzer

The Midland site is in a small (<5 km²) dune field that overlaps Monahans Draw at the southern edge of the Llano Estacado. Human remains were discovered there in June 1953 by Keith Glasscock on the floor of the draw (Locality 1). Archaeological excavations were conducted at Locality 1 in 1953–1954, in 1955 by Fred Wendorf, and in 1954 by E.H. Sellards. Surveys in adjacent dunes and blowouts (Localities 2–5) yielded Folsom fluted points, and morphologically similar but unfluted projectile points, initially identified as "unfluted Folsoms" (Wendorf et al. 1955:49). Three of these, including one that became the Midland point–type specimen, were found in Locality 1 on the surface of the same "Gray Sand" that yielded the skeletal remains (Wendorf et al. 1955:48).

Initial age estimates of the human remains hinged on the interpretation of the site stratigraphy: the "Gray Sand," where the skull and artifacts were found; an underlying "White Sand," which contained the bones of extinct Pleistocene fauna; and an overlying "Red Sand." The White and Gray Sands are found only in Locality 1. The Red Sand covers the entire site and served as "a chronological reference point" (Wendorf et al. 1955:65). In Localities 2-5, Folsom points were found atop the Red Sand (Wendorf et al. 1955:69; Wendorf and Krieger 1959:67). In Locality 1, the newly named Midland points, the skeletal material, and the burned bones of Capromeryx came from the Gray Sand below the Red Sand. Therefore, Wendorf and Krieger (1959:71) inferred that the Locality 1 material predated Folsom. Attempts to date the site using ¹⁴C and the newly devised U-series method provided ambiguous results, but the "more plausible" scenario (Wendorf and Krieger 1959:78), based on ¹⁴C, dated the skull to between c. 13,400 yr B.P. and c. 10,000 yr B.P. The U-series results combined with other ¹⁴C ages offered tantalizing evidence that the skull was even older, however, perhaps as much as 20,000 yr B.P. As a result, the site generally was accorded an age "more than 10,000, and possibly as much as 20,000 years old" (Jennings 1989:66).

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Many questions still linger about the precise age of the Midland material. To address these in light of 35 years of regional Quaternary research, we conducted geoarchaeological investigations beginning in 1989. In brief annual visits since then, we examined 43 cores, auger holes, and exposures in and around Localities 1 and 3.

Our work confirmed the original stratigraphic sequence, with several major modifications: 1) A calcrete forms the bedrock under the sediment in both Localities 1 and 3 and also forms the valley wall of the draw. 2) In Locality 3 there are two Red Sand layers (lower and upper). In Locality 1 the White and Gray Sands are inset against the lower Red Sand and covered by the upper Red Sand. 3) The Folsom occupation in Locality 3 is associated with the buried surface atop the lower Red Sand, and therefore the Folsom finds cannot be used to provide an age estimate for the Gray Sand and associated human remains. Wendorf (1975:267) independently reached this conclusion. 4) The stratigraphy along the draw-axis is essentially identical to that observed in other reaches of the draw and in other draws (Holliday 1993) and also is easily correlated with the draw-margin facies in Locality 1. Of particular note, the Gray Sand is a valleymargin facies of a highly calcareous sandy loam ("marl") ubiquitous throughout most of the draws of the Llano Estacado (e.g., Stratum 3 at Lubbock Lake and Mustang Springs) (Holliday 1993). The marl is not dated in Monahans Draw, but over 30 radiocarbon determinations from other localities throughout the Llano Estacado show it is time-transgressive, rarely dates to >10,000 yr B.P., and is <10,000 yr B.P. on the southern Llano Estacado.

Wendorf and Kreiger (1959:67) used similarities in fluorine content and degree of fossilization in the bone from the White and Gray Sands, including the human remains, to argue that all the bone was "essentially contemporaneous" and "that the human fossil was unquestionably contemporaneous with the Pleistocene fauna from this site." Fluorine content and fossilization are post-depositional characteristics of the bone, however, and are dependent on local environmental conditions such as groundwater chemistry and history. Similarity in fluorine content therefore does not necessarily indicate contemporaneity; the Natchez pelvis provides a striking example of this point (Cotter 1991).

The fragments of teeth and bone of the *Capromeryx* in the Gray Sand and Red Sand could have been redeposited from stratum 1 (as suggested by Wendorf et al. 1955 and Wendorf and Krieger 1959) or sloughed off the valley walls. If the *Capromeryx* specimen from the Gray Sand was in primary context, it provides a general chronological clue: *Capromeryx* was found at Lubbock Lake in stratum 2 deposits dated between 11,000 and 8,500 yr B.P. (Johnson 1987).

McKinney (1992) presented new U-series analyses on the human bone from Midland and offered an age of 11,600 \pm 800 yr B.P. This calculation is problematic because it is based on a simple arithmetic average of three ages determined on three different pieces of bone. McKinney also applied a ²³⁴U/²³⁸U ratio determined on one sample to the other two. Because each fragment may have a unique weathering history, the ²³⁴U/²³⁸U ratio can vary among samples.

We can offer no definitive conclusion on the age of the human remains from the Midland site. Based on our field work and an examination of data from all other investigations, we find no compelling evidence that the human remains from the Midland site are older than Folsom age. Stratigraphic correlations of the Gray Sand/marl with radiocarbon-dated sections elsewhere further suggest that the bone may be contemporary with or younger than Folsom age.

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Different Waves of Migration to the New World: Implications of Mitochondrial DNA Polymorphism in Native Americans

Satoshi Horai

Mitochondrial DNA sequences of the major noncoding region (482 base pairs) were determined for 72 Native Americans from 16 different local populations in the South, Central and North Americas. On the basis of a sequence comparison, 43 different types were observed. Phylogenetic analysis revealed that most Native American lineages are classified into four major distinct clusters. Individuals belonging to each cluster share at least two specific polymorphic sites that are nearly absent in other human populations, indicating a unique phylogenetic position of Native Americans. Phylogenetic analysis

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was extended with 193 individuals including Africans, Europeans, Asians and Native Americans, indicating that the four Native American clusters are distinct and dispersed in the tree (Figure 1). Although a majority of members in these four clusters are Native Americans, there are some Asian individuals in each cluster. For example, in cluster II, one Japanese appeared together with two Native Americans in a small cluster which diverged at a final branching point. This coalescence occurs at only 7% in length of the total way from the tips to the root of the tree. As the Japanese and the Native Americans reside on two different continents, ancestors of these Native Americans must have migrated after the time of initial coalescence of the two lineages. Assuming that the human mitochondrial lineage divergence took place 200,000–300,000 yr B.P., as deduced from previous studies of mitochondrial DNA polymorphism (Cann et al. 1987; Hasegawa and Horai 1991; Horai et al. 1986), the dates of this initial coalescence were estimated as 14,000-21,000 yr B.P. The same magnitude of coalescence between the Asians and Native Americans is also observed in the other three clusters.

The phylogenetic tree also suggests that the four distinct clusters containing Native Americans may represent different waves of migration to the New World. The coalescence time within each cluster is less than one-fourth of the coalescence time for the entire tree. However, the coalescence time of the four clusters is a little longer than half the latter coalescence time. It appears more likely that individuals in the four clusters are descendants of four different ancient Asian populations, which had been well isolated from each other for a relatively long period of time. I therefore postulate that the four clusters represent different waves of migration to the New World. Although it is difficult to determine the times of occurrence of the four waves of migration, they seem to have taken place 14,000–21,000 yr B.P.

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Figure 1. Phylogenetic tree of 193 mitochondrial DNA lineages constructed by the unweighted pair grouping (UPG) method. Solid lines indicate Native American lineages included in the four clusters. Other human lineages are drawn by dashed lines. The four clusters I, II, III and IV are indicated by brackets. All of the dashed lines within each cluster represent the lineages of Asians. The scale is deduced from the proportion to the deepest branch length. Coalescence of the two lineages (Native American and Asian) occurs at only 7% in depth. Coalescence of all four clusters (indicated by the solid circle) does not occur until 55% in depth.





Genetic Link between East Asians and Amerindians: Evidence from HLA Haplotypes

Katsushi Tokunaga and Takeo Juji

The human leukocyte antigen (HLA) system is composed of multiple genes clustered on human chromosome 6, and there are a number of different alleles for each of the genes. Therefore, HLA is not just a simple genetic marker but is composed of a highly informative complex of markers. There are particular sets of HLA alleles or "HLA haplotypes" that occur much more frequently than expected from random combination (Tokunaga and Juji, 1992).

For several years, we have been carrying out extensive family studies in East Asian populations in order to clarify the distribution of HLA haplotypes (Tokunaga and Juji, 1992). For the Japanese population, we have so far collected haplotype data from more than 450 families living in various regions. We have also performed collaboration studies on 100 Northern Han Chinese families and 70 families from South Korea.

Another major source of the HLA data is the 11th International Histocompatibility Workshop held in 1991. In this workshop, data on 88 different ethnic groups obtained from 15,000 unrelated healthy individuals were collected and 77 different ethnic groups could be analyzed for HLA allele and haplotype frequencies (Imanishi et al. 1993).

These data have clearly supported the genetic relationships among North-

	A24-Cw10-B61	A24-CwX-B48
South American Amerind	2.2	< 2
Tlingit	< 2	2.7
Inuit	10.6	8.9
Yakut	3.4	< 2
Briat	3.0	< 2
Orochon	3.4	11.7
Mongolian	4.2	< 2
Japanese	2.1	0.9
Northern Han Chinese	< 1	< 2
Southern Han Chinese	< 1	< 1
Thai	< 0.5	< 1
Vietnamese	< 1	< 1
Australian Aborigine	< 1	0
French	< 0.5	0
South African Black	0	0

Table 1. Distribution of two HLA A-C-B haplotypes (%).

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east Asians, Inuit, and Native Amerindians. Table 1 demonstrates two examples of the distribution of HLA A-C-B haplotypes in 'Mongoloid' populations. A24-Cw10-B61 was one of the most frequent haplotypes in the Inuit population, whereas the same haplotype was also common in South American Amerindians in Colombia, Yakuts and Briats in Siberia, Orochons and Mongolians in Northeast China, and the Japanese. A24-C blank-B48 haplotype was most common in Orochons and was also commonly observed in Inuits and Tlingits in Alaska. Some other haplotypes such as A2-Cw7-B39 were also shared among certain populations in East Asia and America. These haplotypes were proposed to have been carried by ancestors of Native Americans who migrated from Asia through Beringia.

Phylogenetic studies based on allele frequencies of various genetic markers have confirmed that there are considerable regional differences among Native American populations (see Saitou et al. 1992, for example). However, we could stillfind several HLA haplotypes common to Northern and Southern Amerindian groups and even between Northeast Asian people and Amerindian people, as mentioned above.

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Lithic Studies

Toolstone Use and Distribution Patterns among Western Pluvial Lakes Tradition Points from Southern Nevada

Daniel S. Amick

The Department of Energy has supported numerous CRM projects (e.g., Pippin 1986; Henton and Pippin 1988) on the Nevada Test Site (NTS) that have resulted in the accumulation of an impressive group of Paleoindian artifacts from the southern Great Basin. This paper summarizes the toolstone use and distributional patterns among these artifacts.

The NTS is about 110 km northwest of Las Vegas and comprises about 4000 km². The southern portion contains Fortymile Wash, a major tributary of the Amargosa River, and elevations are between 900 and 1550 m AMSL. The northern portion contains Pahute Mesa, an upland area generally between 1550 and 2300 m AMSL.

Paleoindian occupations at the NTS included Clovis and the Western Pluvial Lakes Tradition (WPLT). While Clovis is commonly considered to precede the WPLT (Willig 1991), the exact age of the WPLT remains uncertain, with estimates from 9,000–12,000 yr B.P. If the oldest WPLT dates are secure, this culture may predate or coexist with Clovis. WPLT artifacts are typically found near the shores of ancient pluvial lakes, which possibly reflects an adaptation dependent on lacustrine resources (Bedwell 1973; Hester 1973). In contrast, Davis (1978) contended that WPLT lakeshore sites represent one portion of a broader seasonal round.

Late-Pleistocene pluvial lakes at the NTS were small in regional comparison (Smith and Street-Perrott 1983). Water sources were mainly restricted to springs and ephemeral streams. During the late Wisconsin, Pahute Mesa supported pygmy-conifer woodlands above 1615 m AMSL, while Fortymile Wash contained a mosaic of desert scrub and juniper (Spaulding 1983). Lake Mojave and Silver Lake points (Amsden 1937) were found at the NTS. These WPLT projectile points typically show heavy use damage (Tuohy 1969),

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with blades usually worn to blunted nubs. Although these points may have served as projectile tips, damage patterns indicate primary use as hafted knives.

Paleoindian artifacts from the NTS include points and scrapers and some nondiagnostic tools and flakes, identified by a distinctive phenocrystic chert. Crescents, a hallmark of WPLT lakeshore occupations (Tadlock 1966), are unknown from the NTS. Reno (1985) reported one chert Clovis point and at least 86 WPLT points currently exist. Obsidian accounts for 88.4% (n = 76) of the WPLT points in this sample. The remaining WPLT points include three phenocrystic chert, two silicified tuff, two chert, and one basalt. The chert and basalt sources are found within a few hundred km.

Dr. Richard Hughes performed XRF analysis for obsidian sourcing using 44 WPLT points from the Fortymile Wash area. Most of these points (n = 32, 72.7%) were manufactured from obsidian cobble sources found within 80 km. Seven points (15.9%) could not be assigned to any known source. The remaining five points (11.4%) were assigned to these nonlocal sources: Montezuma Range (about 200 km to the northwest), Coso Volcanic Field (about 270 km to the southwest), Fish Springs (about 290 km to the west) and Brown's Bench (about 560 km to the north).

These data indicate reliance on local toolstones with a small percentage of nonlocal sources 200–560 km away. Studies by Beck and Jones (1990) at Butte Valley in northeast Nevada and Tuohy (1984) in northwest Nevada show that obsidian was the primary toolstone used to manufacture WPLT points and that obsidian source distances were sometimes 200–400 km. Frequency of nonlocal obsidian use depended on the presence and condition of local sources. In regions like the NTS, where suitable obsidian sources are locally available, use of nonlocal obsidian was minimal. At Butte Valley (Beck and Jones 1990), where obsidian cobbles were restricted in size, use of nonlocal obsidian predominated.

Dense concentrations of artifacts, which characterize later period sites, are not evident in the Paleoindian distributions. A lithic scatter in the Fortymile Wash area (26Ny4759) showed that Paleoindian occupations focused along terraces of the major washes but that individual activities were widely dispersed (Amick and Hartwell 1992). Paleoindian artifact patterns include isolated obsidian points and chert scrapers, and small groups of patinated biface thinning flakes made of phenocrystic chert. Most Paleoindian activities at the NTS appear to represent the short-term subsistence procurement component of a large land-use pattern.

Most of the WPLT points (88.4%, n = 76) were found along Fortymile Wash below 1620 m AMSL. However, 13.2% (n = 10) of the WPLT points were found on Pahute Mesa above elevations of 1850 m AMSL. These patterns indicate a focus of WPLT occupations at lowland terraces along major washes with occasional use of upland (woodland) areas. Warren and Crabtree (1986) suggest that the WPLT lacustrine focus shifted to riverine settings during the early Holocene (Pinto period) when the climate was drier. Data from the NTS suggest that riverine and upland areas were used by WPLT people in certain portions of the southern Great Basin.

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The Multipurpose Function of Great Basin Stemmed Series Points Charlotte Beck and George T. Jones

Great Basin archaeologists have long been interested in late-Pleistocene/early-Holocene occupations of that province, including not only activities associated with fluted points but also those associated with points of the Great Basin Stemmed Series. Among the basic problems yet to be solved is the temporal and/or functional relationship between these two technologies (e.g., Willig and Aikens 1988). Recently, Basgall and Hall (1991) have suggested that fluted and stemmed technologies may be contemporaneous, with fluted points serving an off-site hunting function and stemmed points serving a more general set of on-site functions. Whether or not the temporal relationship suggested is correct, we are in agreement with Basgall and Hall on the generalized function of Great Basin Stemmed Series points and we pursue this hypothesis here.

Although a great deal of attention has been given to these large stemmed points, research has focused on their morphological description and temporal placement. Over the past 40 years, no fewer than eight morphological types have been defined in the literature, all of which are believed to date to the 3,000-to 4,000-year period (11,000–7,500 yr B.P.) preceding the Desert Archaic. Points of these different types, however, are often quite similar, and this similarity led Tuohy and Layton (1977) to combine them into the Great Basin Stemmed Series.

Our own studies of point samples from eastern Nevada have led us to suggest that much of the morphological diversity within the Great Basin Stemmed Series could be due to differential resharpening, which is evident on both blade and stem segments of many specimens (Beck and Jones 1990a, 1990b). We have also suggested that such heavy resharpening may indicate that these points served a more varied set of functions than later Archaic dart points, which were used primarily as projectiles. Obviously, resharpening could be directed at repairing breakage that occurred during use as a projectile, but other characteristics of these points suggest this is not entirely the case. First, many of these points are large and often quite thick. Second, they are not always symmetrical and seldom have either sharp edges or a sharp point; the point is more often rounded, and both point and edges are often dulled. Finally, in every case we have examined, the edges, and often the base, of the stem are heavily ground; in some cases the edge-grinding is so heavy as to appear almost polished. Some of this edge-damage likely occurred through haft preparation, but we believe such heavy damage is indicative of haft "wear" resulting from abrasive contact with the walls and mastic of a socketed haft (see Musil 1988). Such haft damage is rarely seen on dart points, since the average use-life of these artifacts is generally quite short. A longer average use-life, however, combined with

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pressure caused by activities such as cutting or sawing would result in visible haft damage in the form of extreme abrasion.

If these points were multipurpose tools and not exclusively projectiles, this should be evident in the form of edge damage along the blade. Unfortunately, whole points, blades, or blade sections are far less common than stems, making this hypothesis difficult to test. We have, for instance, collected over 150 of these points from surface contexts in eastern Nevada, but only a small portion of these are blades or blade sections. We have thus far examined 26 blades and blade sections under low-power magnification (10–70X), and in every case edge damage is evident. By comparison, ten complete dart points examined in the same manner show no edge-damage and all show only minimal haft preparation.

The 26 blades and/or blade segments examined are manufactured from five different raw materials: 12 are obsidian, ten are andesite, two are chert, one is quartzite, and one is a rhyolitic welded tuff. Extensive microflaking is evident on some of these specimens; however, such damage cannot be unambiguously attributed to use or repair. Consequently, we have focused on the nature and distribution of abrasive damage. With the exception of the chert specimens, there is no apparent relationship between damage and material. For nearly every specimen, abrasion is marked along the entire edge, most often isolated on projections between flake scars. In comparison with the typical rough and pitted abrasion of stem edges, damage to blades is much smoother, and at times glossy.

In the case of the chert specimens, damage is primarily in the form of crushing and is confined to several specific projections along the edge. This is likely due to the tough nature of chert as opposed to the other, more easily abraded materials.

In 14 cases (one chert, four obsidian, one rhyolitic tuff, and eight basalt/ adesite) there is arris abrasion on the blade surface, and in one of these cases the surface appears almost polished. We do not believe this to be the result of exposure to windblown sand or water-tumbling, since in none of these cases are all arrises on the surface abraded, but abrasion occurs on both sides of the point. Obviously, this phenomenon must be investigated further.

Although we realize the need for the examination of a much larger sample, we believe these analyses are quite informative. The morphological features of Great Basin Stemmed Series points in concert with extensive resharpening as well as haft and edge damage observed on every specimen are strongly suggestive that these points served a wider range of functions than simply as projectiles. With additional analyses we hope to demonstrate wider variability in function and also that longer average use-life in conjunction with extensive resharpening has contributed to the morphological variability observed archaeologically.

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Obsidian Source Characterization of Paleoindian Projectile Points from Yellowstone National Park, Wyoming

Kenneth P. Cannon and Richard E. Hughes

Since 1989 the Midwest Archeological Center (National Park Service) has been involved in surveying and testing sites in Yellowstone National Park (YNP), mainly as part of the compliance process for road reconstruction (Cannon 1990; Cannon et al. 1992). An integral part of this research has been the identification of obsidian sources utilized by various groups through time. Identification of source localities will help elucidate patterns of lithic procurement and group movement. As of this writing, the only clues to Paleoindian occupation of YNP come from surface-recovered artifacts. The earliest occupation is suggested by the presence of Agate Basin and Hell Gap point types, which date to approximately 10,000 yr B.P. Independent corroboration for this dating is provided by Two Hell Gap artifacts from the Indian Creek site in west-central Montana, with obsidian hydration dates of 9850 ± 278 and 9650 ± 248 yr B.P. (Davis 1986).

When material types for Paleoindian points from the Park were tabulated, a significant utilization (> 50%) of obsidian was evident. R. E. Hughes analyzed eight typologically late-Paleoindian obsidian points (all surface finds) using X-ray fluorescence spectrometry to determine the geologic sources of the obsidian. X-ray fluorescence analysis conditions and artifact-to-source (chemical type/variety) attribution procedures applicable to this group of samples appear in Hughes (1988, 1990) and Hughes and Lees (1991).

The earliest point type represented in the analysis is an Agate Basin point (Figure 1A), which was sourced to Obsidian Cliff, YNP. Hell Gap is represented

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by one complete point (Figure 1B), sourced to Bear Gulch (Hughes and Nelson 1987), Idaho, and three bases. Bear Gulch and American Falls, Idaho, were identified as sources for two of the bases, while the source of the third base has not been identified and is referred to as Unknown A. The one Alberta-like point base was sourced to Bear Gulch.

Two reworked lanceolate points attributed to the Foothills-Mountain com-

plex (Frison 1992; Husted 1969) also were analyzed. These point types date to between 8,500 and 9,000 yr B.P. The first is a heavily reworked and beveled point with grinding along the basal edge (Figure 1C). A significant number of small step fractures present on the edges of the tip suggest utilization as a drill. This point was sourced to Teton Pass, Variety 2(?), Wyoming.

The second lanceolate point has also been reworked along the blade (Figure 1D). The flaking pattern is parallel-oblique with grinding along the basal edge. The concave base appears to be fortuitous and postdates the final flaking episode, as indicated by the differences in the amount of weathering. This point was sourced to Bear Gulch.

With the exception of Obsidian Cliff, other sources represented in the assemblage are located some distance from YNP: Bear Gulch, Fremont County, Idaho, is 90 km to the west; American Falls, Power County, Idaho, is 280 km to the southwest; and Teton Pass, Teton County, Wyoming, is 125 km to the south. Continuing analysis of obsidian from YNP will contribute substantially to understanding Paleoindian group mobility patterns (see Kelly and Todd 1988).

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Archaeological Investigations of Early Land Use at the Midway Valley Site: An Opportunistic Quarry on the Nevada Test Site, Southern Nye County, Nevada William T. Hartwell and Daniel S. Amick

The Midway Valley site (26NY4759) occurs in a flat alluvial valley located just east of Yucca Mountain on the Nevada Test Site in southern Nevada. A datarecovery project was implemented during September–December of 1991 to mitigate potential adverse effects by activities associated with the Yucca Mountain Site Characterization Project. Goals of the research design included distinguishing the uses of the locality in terms of an archaeological landscape as well as comparing the data with those of similar sites in the southern Great Basin. These goals provide a means to evaluate lithic-procurement behavior within the context of technological organization. Fieldwork and subsequent analysis of recovered artifacts were carried out by the Desert Research Institute's Quaternary Sciences Center.

Field methods for the recovery of artifacts at Midway Valley involved collecting all artifacts from 18 parallel transects spaced 200 m apart, each 20 m wide and oriented east-west across the site. A total of 47.28 ha was systematically surveyed, representing approximately 10% of the site. A total of 5,452 lithic artifacts were recovered during the survey.

Differences in lithic raw materials are indicative of technological variability reflecting contrasting uses of the landscape. Most of this variability can be related to transported and non-transported toolkit components. The assemblage consists primarily of cores and debitage from the testing and reduction of large agatized chalcedony nodules (93.2%), small obsidian nodules (2.3%) and large cobbles of silicified tuff (2.4%), all of which occur locally within the alluvium of Midway Valley. Technological and spatial analysis of the collection indicates a pattern of opportunistic quarrying, with factors of nodule material, size, shape, and quality influencing reduction strategies.

Although obsidian makes up only about 2% of the total assemblage, it accounts for approximately 80% of the bifaces and projectile points. The majority of the projectile points recovered from the site are indicative of early occupations. Of the sixteen identifiable points, half are classified as members of the Great Basin Stemmed (GBS) Series. These include five Silver Lake and three Lake Mojave varieties (Amsden 1937:80-84; Jennings 1986). GBS points are believed to be representative of Paleoindian occupation of the Great Basin.

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Occupations associated with the GBS Series have frequently been referred to in the past as the Western Pluvial Lakes Tradition (Beck and Jones 1990), a designation which is undergoing reevaluation (Grayson 1992). Its cultural and temporal relationship to Clovis is still unclear, but it is generally accepted that the GBS Series is representative of a terminal-Pleistocene occupation of the Great Basin, ranging from 12,000 to 9,000 yr. B.P.

Patinated phenocrystic chert makes up about 1.5% of the total artifact assemblage. Nearly 40% of the flake tools recovered from Midway Valley, including several Paleoindian scrapers, are represented by artifacts manufactured from patinated phenocrystic chert. Use of this particular phenocrystic chert is a hallmark of Paleoindian technology in the region, and shows potential as a chronological indicator for segregating artifact distributions. Phenocrystic chert was plotted against the distribution of early projectile point types and preforms of obsidian. Results showed that the great majority of early projectile-point types and obsidian preforms have phenocrystic chert artifacts in proximity. Most of the phenocrystic chert debitage consisted of isolated biface thinning flakes or small clusters of biface thinning flakes probably produced from a transported bifacial core. The use of bifacial cores is characteristic of highly mobile Paleoindian populations (Kelly and Todd 1988) as well as residentially mobile Great Basin groups in general (Kelly 1988).

Although opportunistic quarrying of large chalcedony nodules is the principal activity represented at the Midway Valley site, it is difficult to ascribe this activity to a particular time period. The opportunistic quarrying of toolstone prospects may indicate repeated casual use of this location throughout the period of human occupation of this region. Indeed, there is evidence that toolstone resources at Midway Valley underwent significant depletion (Amick and Hartwell 1992). Several dispersed lithic quarries similar to the Midway Valley site are known throughout the southern Great Basin (Bamforth 1990; Kamp and Whittaker 1986; Wilke and Schroth 1989). Comparisons with these sites indicate differences that we believe are attributable to variability in toolstone quality and abundance. Whether or not quarrying activities at Midway Valley were contemporaneous with early land use of the site, it is evident from this study that Paleoindian technology in the southern Great Basin used a more curatorial strategy of toolkit maintenance to adapt to patterns of high residential mobility.

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Fluted Point Manufacture at the Ready/Lincoln Hills Site, Jersey County, Illinois

Juliet E. Morrow and Toby A. Morrow

Ready/Lincoln Hills (11Jy46) is a large, predominantly Paleoindian quarry/ workshop located on a high upland plateau near the confluence of the Illinois and Mississippi Rivers in Jersey County, Illinois. The site is situated near residual and stream-lag deposits of Burlington chert. Examination of 693 chipped-stone artifacts from the site in private collections, including 223 fluted points and preforms, provides the following outline of the fluted point manufacturing sequence (Morrow 1992).

Stage 1: Obtaining the Blank. Both naturally occurring tabular spalls and flake blanks were selected for fluted-point manufacture. The larger tabular pieces underwent extensive edging, trimming, and thinning to reach the proportions of Stage 4 fluted-point preforms, while the selected flake blanks generally required only minimal trimming and shaping.

Stage 2: Initial Edging and Trimming. Biface blanks made on large tabular spalls were roughly trimmed and bifacially flaked around the periphery. One or both faces often exhibit large patches of the original blank surface.

Stage 3: Primary Thinning and Shaping. Large biface blanks were thinned and shaped into a generally ovate form by the removal of deep, transverse percussion thinning flakes from both faces. Thinning flakes were removed from laterally isolated striking platforms positioned near the center plane of the biface. This reduction technique produced broad bifaces with flattened crosssections covered by several widely spaced, long, deep flake scars. This type of flaking is characteristic of Clovis bifaces recovered from the Anzick (Lahren and Bonnichsen 1974), Fenn (Frison 1991), Richey-Roberts (Mehringer 1988), and Simon (Butler 1963) caches in the western United States and is also

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demonstrated by refitted flakes from the Sheaman site in Wyoming (Bradley 1982).

Stage 4: Secondary Trimming, Shaping, and Fluting. Marginal lateral percussion trimming was employed to produce a more lenticular cross-section. Preforms prepared for fluting have a distinctive boat-shaped outline with a slightly convex base. On average, these preforms are 30 percent longer, 40 percent wider, and 25 percent thicker than the finished fluted points. Striking platforms prepared for the flute removals, extant on 13 specimens from the site, are well-isolated lobes positioned at or slightly below the center plane of the preform. These platforms generally protrude well away from the basal corners and allowed for the removal of large, broad flutes by direct soft hammer percussion. Overshots (reverse hinge fractures) and end shock resulting from the fluting process are common in the assemblage and account for over 65 percent of the late-stage manufacturing rejects.

Stage 5: Final Thinning and Shaping. Fluted Stage 5 preforms are 1 to 2 mm thicker and 10 or more mm wider than the finished points. Extensive lateral thinning reduced preforms to the approximate thickness at the flute scar terminations and refined the longitudinal taper. The crisp lateral margins of flute scars are blurred by short flakes that lightly invade the flute. The distinctly biconcave cross-section of the base was also rendered more flattened in appearance. On most specimens, the Stage 4 flute removals form the entire channel scar on at least one, and sometimes both, faces. In cases where the base was not sufficiently thinned during initial fluting, or where the initial fluting did not leave a symmetrically tapered base, one or both faces of the base were further thinned, probably by indirect percussion.

Stage 6: Edge Retouch and Haft Grinding. The lateral and basal edges of the finished fluted points were pressure-retouched to smooth out the crests left between the final percussion flake removals. Most of the 28 finished specimens exhibit moderately to heavily ground basal and lower lateral blade edges. The majority (n = 20) conform to descriptions of the Clovis type (Wormington 1957). Unresharpened or minimally resharpened Clovis points from the site average 71 mm in length, 27 mm in width, and 7.8 mm in thickness.

The Ready/Lincoln Hills fluted-point manufacturing sequence suggests a strategy for coping with the uncertainties entailed in fluted-point production, especially the high potential for preform breakage during fluting. Fluting at an intermediate stage in the reduction sequence allowed for the removal of large flutes while reducing breakage and minimizing the time invested in a preform prior to potential fluting mishaps.

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Taphonomy

Research on the Dent Mammoth Site

Robert H. Brunswig, Jr. and Daniel C. Fisher

The Dent mammoth site of northeastern Colorado was first reported in April 1932 and was partially excavated in November 1932 and July 1933. During excavation, the remains of 13 mammoths (*Mammuthus columbi*) were recovered along with two complete large projectile points, later named Clovis points (Bilgery 1935:47–57; Figgins 1933). Over the past six decades, substantive documentation of the geoarchaeological context and associated transformational processes of the site has been lacking. In October 1973, in an attempt to remedy that problem, previously unexcavated areas were tested and a relatively undisturbed stratigraphic profile was discovered and recorded during a two-day University of Colorado field project (Haynes 1974; Spikard 1973). However, no further research was done at Dent until 1987, when one of the authors (RHB) initiated a renewed long-term site-reinvestigation project. Data accumulated from the current University of Northern Colorado investigations now promise new insights into the context and processes involved in the formation of Dent.

The Dent Project research design utilizes a multi-disciplinary approach in the formulation of a hypothetical model of prehistoric human-mammoth interaction within a reconstructed paleoenvironmental framework. The site, although disturbed by long-term erosion and early 20th-century railroad construction, still retains significant clues to its late-Pleistocene context. Early in the Dent project, a tentative explanatory model was developed, based on data from previous research and UNC soil coring of the site in 1987 and 1988. That model hypothesized that Dent represented an ambush kill of a small herd of mammoths within a well-selected topographic trap feature. In order to test that model, efforts have been made to accumulate archival and field- and laboratorybased evidence on Dent. This database, augmented by continued field and laboratory research, seeks to explain the geoarchaeological context of the Dent mammoth site (Brunswig 1992).

The current explanatory model suggests that the mammoth remains of the Dent site constitute remnants of a one or more matriarchal family herds

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ambushed ca. 11,000 yr B.P. by Clovis hunters. The site chronology is well established by a series of bone-protein radiocarbon determinations (Agogino 1968; Stafford et al. 1987). The presence of a matriarchal mammoth herd at Denthasbeen inferred from the profile of dental remains (Saunders 1980:91–93, Table 2), although the possibility that this age profile could reflect multiple episodes has also been recognized (Conybeare and Haynes 1984).

Analyses of UNC soil core and CU stratified profile samples are being used to reconstruct site geomorphology and paleotopography, and the sedimentary matrix of the mammoth bone bed. Sedimentological data suggest a paleotopographic environment at Dent that made possible the ambush of a mammoth herd in a narrow draw descending from a break in low sandstone bluffs fronting the eastern bank of the late-Pleistocene South Platte River. The geomorphic data further indicate that the ambush draw may have led to a rivercrossing ford below the site.

There is also evidence, in the form of probable butchering marks on the mammoth bone and heavy use-wear patterns on the Dent projectile points, that the animals were at least minimally butchered. A study of the growth laminae of Dent molars and a tusk (by DCF) provides tentative evidence that the animals all died in the autumn, although whether this was from a single event or multiple events has not yet been determined (see Fisher 1988 for details of analytical method). This season-of-death research is continuing, and further season-of-death data, as well as information on mammoth diet and paleoenvironment, are being sought by extracting and identifying phytoliths from Dent mammoth molars. Our research model suggests that, soon after the kill and butchering event, the mammoth remains, blocking the narrow draw, were rapidly buried by silts. They remained buried until historic times, when the bone bed was redeposited down-slope and lower in the draw. The time of redeposition may be suggested by a radiocarbon date on wood, dated to 170 ± 50 yr B.P. (SMU-120), recovered from the bone-bed profile excavated by CU investigators in 1973 (Haas and Haynes 1975:358).

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The Hallsville Mastodont: Evidence for Possible Human Association

Michael C. Hansen

In August 1965, excavation of a ditch to drain a former kettle lake revealed the partial remains of an American mastodont (*Mammut americanum*) in marl on the farm of Orval Pontious, west-northwest of Hallsville, Ross County, Ohio (39° 26' 50" N, 82° 50' 15" W). The kettle drains into Dresbach Creek, a west-flowing tributary of Kinnikinnick Creek, and is situated within a Wisconsinan kame complex at the proximal edge of the Lattaville terminal moraine (Quinn and Goldthwait 1985).

Olaf H. Prufer, an archaeologist from Kent State University, visited the site soon after the discovery of the mastodont and indicated (oral communication 1974) that the dragline bucket went through the main portion of the skeleton and apparently destroyed much of it. Dennis Pontious (oral comm. 1974), son of the landowner, reported that a number of skeletal elements were removed by local individuals as curios. Prufer excavated the mandibles and one complete and one partial tusk of the mastodont. The complete tusk was 216 cm in length, measured along the outside curve, and was 13 cm in diameter at the base.

Subsequent reconnaissance excavations in 1965 by a student crew from the Cleveland Museum of Natural History failed to produce additional skeletal remains. At the time of the visit of the Cleveland Museum crew, Mr. Pontious declined to donate the plaster-jacketed tusks and the mandibles of the mast-odont. The tusks were subsequently destroyed by outdoor exposure. The present whereabouts of the mandibles is unknown.

Spruce (*Picea*) wood obtained by the Cleveland Museum crew from marl at the tusk site was submitted to J. Gordon Ogden of Ohio Wesleyan University for radiocarbon dating. This sample (OWU-220) yielded a date of $13,180 \pm 520$ B.P. (Ogden and Hay 1967). A second sample of spruce wood (OWU-260A-C), submitted by Prufer, yielded dates of $12,835 \pm 275$ B.P., $12,685 \pm 244$ B.P., and $13,695 \pm 520$ B.P., respectively (Ogden and Hay 1969). A pollen profile from a

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marl sample was dominated by 64% spruce, with lesser amounts of pine (16%), fir (8%), larch (4%) and oak (2%) (R. Taggart, in Ogden and Hay 1967). The marl contained abundant shells of mollusks and oogonia of *Chara*.

The site was reinvestigated jointly in 1974 by the Ohio Geological Survey and the Ohio Historical Society. Several test trenches were dug at the site with a backhoe in an attempt to recover any remaining skeletal elements of the mastodont, but these efforts failed to produce additional elements from the specimen.

An intriguing discovery during the 1974 investigation was the presence of two small, rounded, erratic boulders, each approximately 25 cm long, in marl immediately adjacent to the area in which the tusks were reported to have been found in 1965. These boulders were the only coarse lithic materials encountered in the marl.

It is enticing to speculate that these boulders may have been used by Paleoindian hunters as hand-thrown missiles to help dispatch a mastodont mired in lake sediments or, in light of the recent theories of Fisher (1987, 1989), the boulders may have been used to anchor a cache of mastodont meat placed at the bottom of a glacial lake for later usage. Unfortunately, the circumstances of the discovery and excavation of the specimen provide insufficient data for the adequate testing of these hypotheses. The presence of Paleoindians in the area is well documented by surface occurrences of fluted points on the shore of the former glacial lake (O. H. Prufer, in Ogden and Hay 1967).

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Bone Attritional Processes at the 12 Mile Creek Site, Kansas Matthew E. Hill Jr., Jack L. Hofman and Larry D. Martin

During the last two decades archaeological interest in Paleoindian bonebeds has flourished (e.g., Davis and Wilson 1978; Frison 1991; Wheat 1972). This interest by Plains archaeologists has included research in human group organization and ecology (Kelly and Todd 1988), subsistence strategies (Davis and Reeves 1990), late-Pleistocene/early-Holocene environmental change (Anderson and Semken 1980; Graham, Semken, and Graham 1987), seasonality studies (Todd et al. 1990), and taphonomic studies (Frison and Todd 1986, 1987; Todd 1987a). While Paleoindian bonebeds have been well documented and analyzed throughout much of the Central Plains, there is a noticeable paucity of bonebeds in Kansas. An exception is the 12 Mile Creek site, located in Logan county along a tributary stream of the Smoky Hill River (Williston 1902; Rogers and Martin 1984).

In the summer of 1895, while on a fossil-collecting expedition in western Kansas, T. R. Overton and H. T. Martin, assistants in the Paleontology department of the University of Kansas, were taken by a local resident (Charles Wood) to the 12 Mile Creek site. After seeing bones protruding from the stream bank they excavated a 15-by-25-ft area (Sellards 1952:47). Numerous skeletons of *Bison occidentalis* (Lucas 1899) were identified in the field. Under the right scapula of a complete skeleton Martin discovered a small fluted projectile point (Sellards 1952:47; Williston 1902:13). This has since been interpreted as a Folsom or Clovis point by various authors. Two radiocarbon dates on bone suggest an age of 10,200 yr B.P. for the site (Rogers and Martin 1984:758).

The site is situated at the northern edge of a Cretaceous (Niobrara) chalkwall valley (McClung 1908:250). The stratum containing the bones was identified by S. W. Williston (1902:313–315) as approximately 2 ft thick and composed of fine blue-gray sand above a 4-inch sandy conglomerate laying directly on the Cretaceous chalk.

Previous discussions of the site have emphasized identification of bison species (Lucas 1899; Rogers 1984; Steward 1897) or projectile points (Rogers and Martin 1984; Sellards 1952). Recently, a taphonomic analysis of the curated faunal remains from the 12 Mile Creek site has been initiated to gain a better understanding of the site-formation processes (Hill 1992).

In the initial publication Williston (1902) reported skeletons of five or six adult bison and two or three young animals, including a fetal skeleton. Rogers and Martin's (1984) analysis increased the MNI for the site to ten bison consisting of eight adults and two subadults, based on right metacarpals and

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astragali, but could not relocate the fetal skeleton identified by Williston. The present study indicates an MNI of 12 individuals, based on right astragali. The fetal skeleton was also not found by this study; thus it is possible that 13 animals may be a more accurate MNI for 12 Mile Creek. Measurement of the distal humeri (HM7 and HM11) and proximal radii (RD4 and RD9) (see Todd 1987b) indicates that of the 12 animals represented, five are adult males, five are adult females, and two are immature animals.

The appendicular skeleton is uniformly well represented. Most striking is the very high frequency of lower-limb elements including phalanges, patellae, and sesamoids. The axial skeleton is less well represented. There is a noted absence of cranial and mandibular elements. Burgett's (1990) research on the dispersal of modern bison skeletons demonstrates that small lower-limb elements, such as patellae, carpals, tarsals, and phalanges, are easily transported or destroyed if the skeletons are not quickly buried. The high frequency of these elements, lack of preferential destruction of proximal to distal extremities in long bones, and minimal (if any) evidence of carnivore gnawing suggests little preburial destruction or dispersal. The complete nature of the limb units may support the hypothesis that hide-encased skeletons or articulated units were preserved at the site.

The limited degree of subareal weathering (Behrensmeyer 1978) of the appendicular elements also implies a quick burial of the bonebed. Roughly 92% (n = 144) of the long bones from this assemblage were coded for no weathering or limited weathering (Behrensmeyer's Stage 0 and Stage 1).

Prehistoric cultural modification to the assemblage is limited. Rogers and Martin (1984) identify human cut marks on the ventral side of an atlas vertebra and a proximal ulna. The recent reexamination of the assemblage identified possible cut marks on the diaphyses of two additional tibiae, two metacarpals, and one calcaneus. These identifications must be cautioned because of the presence of extensive modern damage. This includes easily recognizable excavation or curation cutmarks and modern dry-bone breakage. Only two tibiae and a single metacarpal show evidence of helical fracturing, possibly resulting from marrow extraction.

Evidence for limited weathering and the presence of all appendicular elements suggest that the remains were quickly buried, possibly still encased in hide or articulated by ligaments. Evidence for cultural utilization of the bison remains is very limited, and only a few elements show evidence of human butchering or marrow extraction. This is a pattern recognized at several other Paleoindian-age bison bonebeds (Kelly and Todd 1988). The rarity of either skulls or teeth is apparently not the result of weathering, but may reflect some human activity or some as yet undetermined additional factor.

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Preliminary Research on the Moon Mammoth Site

M. Jude Kirkpatrick and Daniel C. Fisher

Scuba divers in northwest Pennsylvania have discovered several mastodons and mammoths over the past few years. Unfortunately, most of these finds have been taken as souvenirs; neither the bones nor the exact locations of the sites are now available. One such site, however, was reported to the senior author in time to organize a systematic underwater-recovery effort. The Moon Site (36-ER-247) is located in the southern portion of Erie Co., in a spring-fed kettle lake. Two seasons, and excavation of an area of approximately 60 m², have produced a skeleton of *Mammuthus* sp. that is about 80% complete.

Skeletal elements of the Moon mammoth were discovered in marly, somewhat sandy, clay, 3-4 m below lake surface. The spinous process of the left scapula was exposed on the lake bottom, but other elements were excavated by gently suspending sediment through manually induced turbulence. Samples of clay processed by floatation produced seeds of pondweed (*Potomageton* sp.) and naiads (*Najas* sp.), representing aquatic, calcareous environments (pers. comm., F. B. King). We interpret this unit as a marl bench that prograded outward from the shoreline, typical of many temperate-latitude alkaline lakes (Murphy and Wilkinson 1980). Underlying the marly clay is a poorly sorted gravel, probably washed into the lake relatively soon after glacial retreat. Bone fragments from the Moon mammoth were radiocarbon dated at 12,210 \pm 120 yr B.P. (Beta-49776).

Poor visibility during recovery precluded photographic documentation of patterns of bone distribution. However, divers recorded positions of many elements by measurements to reference markers. A map of bone distribution was reconstructed onshore as removal proceeded. Major skeletal elements were individually mapped, but vertebrae, ribs, and foot bones were only recorded in these categories. Although we thus cannot judge states of articulation comprehensively, divers reported that the skeleton occurred as multiplearticulated (or only slightly disarticulated) units, separated from other such units. On the largest spatial scale, skeletal material was found in four groups, staggered along a roughly north-south shoreline. The first group encountered included vertebrae, ribs, the left innominate, left femur, and foot bones. The second group, 2 m southwest of the first, consisted of the right scapula, right innominate, right femur, and foot bones. The third group, about 3 m northwest of the first, included the mandible, a stylohyoid (with slightly abraded ventral extremity), right humerus, and right ulna. The fourth group, about 4 m north of the first, included the tusks, pointing in opposite directions, overlying the right tibia and left humerus, radius, and ulna. Scattered among these groups were epiphyses, bone fragments, and "net stones" (sandstone fragments girdled by coarse flaking) of various sizes. We do not yet know whether net stones occur

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beyond the area of bone distribution. There are almost no caudal elements, no patellae, and, except for molars and tusks, only fragments of the cranium. Representation of foot bones is good, but distal phalanges are missing (despite being larger than most recovered sesamoids), as are several sets of contiguous podials and metapodials. The skeleton is of an incompletely grown male, Laws' age class XIX (equivalent to an African elephant 32 ± 2 yr old; Laws 1966), with a late-autumn/early-winter season of death.

The Moon mammoth shows patterns of bone modification similar to those observed at other sites suspected to represent butchered proboscideans (e.g., Fisher 1984, 1987). For instance, damage to posterior scapular epiphyses, metacromion processes, and dorsal iliac borders closely resembles that seen on the Burning Tree mastodon (Fisher et al. 1991). Bone damage is often localized at sites of muscle insertion (e.g., femoral greater trochanters, olecranon processes) or in matching tracts along the periphery of conarticular joint surfaces or at contacts between epiphyses and diaphyses. Damage observed on one side is often replicated symmetrically on the other (e.g., proximal radius/ ulna articulation, distal epiphysis/diaphysis contacts of radii and ulnae, posterior aspects of proximal humeral diaphyses). Femoral heads show cutmarks and striated grooves, and the left scapula bears a piercing cut on the anterolateral aspect, near the glenoid cavity. No tooth marks have been observed. Much additional work remains in order to characterize this site adequately and reconstruct its history, but the age, sex, and season of death of the proboscidean, as well as patterns of bone distribution, bone condition, and geologic setting, resemble inferred instances of Paleoindian subaqueous meat-caching (Fisher 1987, 1989).

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Scanning Electron Microscope Analysis of Bone Modifications at Pendejo Cave, New Mexico Eileen Johnson and Pat Shipman

Excavations into the lower strata of Pendejo Cave in southeastern New Mexico (MacNeish 1992) have revealed an incredible sequence of late-Pleistocene faunas (Harris 1992) and uncovered an array of purported cultural materials and structural features that has fueled the Pre-Clovis debate in this country (Appenzeller 1992). The senior author visited the excavations at Pendejo Cave and viewed a preselected collection of 42 bones from the 1990 and 1991 excavations, including a number of alleged bone tools and bones exhibiting marks hypothesized to be human-induced. The bones were from various zones dated from 11,300 to greater than 38,000 yr B.P. (MacNeish, 1992:20). The major question was whether or not the bones showed evidence of humaninduced modifications. An initial sample of 15 specimens was chosen for examination under the scanning electron microscope (SEM). These specimens represented the variety of bone modifications noted in the preselected collection and were not intended to be limited to what might be humaninduced modifications. In addition, another ten specimens from the 1992 excavation were preselected by Dr. MacNeish for the authors to consider for SEM examination. Dr. MacNeish supplied descriptions of these specimens that included the hypothesized type of human-induced modification on each.

The specimens were evaluated in terms of hypotheses that they had been modified by humans in one or several of the following ways: burned in humancontrolled fires, deliberately fractured when fresh (i.e., for marrow retrieval or tool use), utilized as tools, and cut or shaped by humans. The Pendejo Cave specimens were compared with an extensive collection of bones previously studied by the authors from archaeological and experimental contexts. This comparative collection included all these types of human-induced modifications as well as natural processes. For many of these taphonomic events, explicit diagnostic criteria for recognition and identification of marks or modifications of unknown origin were developed by the authors (Johnson 1985; Olsen and Shipman 1988; Potts and Shipman, 1981; Shipman 1981, 1989; Shipman et al. 1984; Shipman and Rose 1984, 1988) or others (Brain et al. 1988) and were used in this evaluation.

Of the sample 25 bones, two had been used in another destructive analysis and one had been lost (Donald Chrisman, pers. comm. 1992). Of the remaining 22, eight were selected for SEM examination. The sample was reduced to this number due to redundancy, poor preservation, or certain identification of the cause of modification through binocular microscopy. These eight bones were prepared for SEM examination following a modified procedure (Rose 1983).

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The eight bones consisted of four shaft segments (catalog numbers 96 [Zone C, field #F006-337]; 78 [Zone H, field #G280-349]; 158 [Zone N, field #562-337]; and 212 [Zone N, field #713-337];) and four rib segments (catalog numbers 39 [Zone L, field #113-337]; 70 [Zone E/E1, field #257-337]; 260 [Zone K, field #905-334]; and 521 [Zone C-D to E, field #FB9366-G2146-337]) segments. Three main categories of modification were noted, i.e., burning, polish, and marks. Cracking and other structural alterations induced by burning were absent (Shipman et al. 1984) on all specimens hypothesized to be burned. Instead, widespread signs of chemical erosion were evident. This geochemical modification may be manganese staining (Parker and Toots 1970). Such staining is a common phenomenon in limestone caves, although it usually appears as a more dappled pattern rather than an overall, even distribution.

All eight specimens exhibited overall polish, frequently with highly polished edges hypothesized to be from tool use. Under SEM examination, surfaces appeared eroded, smoothed, and rounded, with non-reflective, planed-off surfaces. Unplaned patches, where they occurred, also were eroded. This type of polish matched that produced by sedimentary abrasion (Brain 1967; Johnson 1985). One specimen (catalog #70) in particular exemplified the extreme nature of the sedimentary abrasion occurring in Pendejo Cave. Not only was its entire surface worn, rounded, and polished, but no microscopic features of the bone structure were visible. Even the abraded surface between two ridges showed a featureless surface.

Seven of the eight bones exhibited various marks hypothesized to be butchery or whittling marks. Various morphological features included curvilinear or branched lines or U-shaped troughs. These features were attributed to nonhuman causes, including trampling, root action, rodent activity, biological structure, and weathering. One specimen (catalog #78) exhibited grossly apparent parallel striations reminiscent of striations formed in the troughs of cut lines produced by stone tools (Potts and Shipman 1981). However, SEM inspection revealed that these striations were actually bone laminae exposed by the abrasive effects of movement in the soft cave sediments. These bone laminae mimicked the appearance of lithic-tool–produced striations because of the eroded bone surface. Another specimen (catalog #212) had a deep, smooth groove from a periosteal blood vessel surrounded by its tiny capillary branches that followed the surface (Shipman and Rose 1984).

A third specimen (catalog #521) exhibited a groove that had rounded surfaces with a very broad and deep trough, and the cortical structure was exposed in layers along with fine desiccation cracks. The trough was a rounded V-shape in cross-section but lacked internal fine striations. The long groove had a definite curvature to it and consisted of three troughs superimposed on each other. Since none of the characteristics of cut marks made by stone tools were evident (Potts and Shipman 1981), that hypothesis was rejected. The marks did not match any human-induced modification, and the cause of the trough remains unknown.

All the bones examined have undergone complex taphonomic histories. The most common modifications are produced by sedimentary abrasion and geochemical process, followed by rodent activity and weathering. All these processes are natural and expected in a cave assemblage and suggest that the bone assemblages were not buried rapidly. Based on this small collection, we conclude that these processes have occurred throughout the various strata.

We found no evidence for human-induced modifications in this collection of 25 bone specimens or in the larger collection of 42 preselected specimens, either through visual, light microscopic, or SEM examination.

Pendejo Cave is one of the most significant late-Pleistocene paleontological localities in North America, having a well-dated, stratified sequence of faunas documenting changing ecosystems (Harris 1992) from a poorly known time period. Given its paleontological importance and the debated question of Pre-Clovis occupation, the entire assemblage of bone material from Pendejo Cave needs to undergo taphonomic scrutiny similar to that of the preselected collection of specimens described here.

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Cultural Contexts of Mammoth and Mastodont in the Southwestern Lake Michigan Basin

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Evidence of a predator-prey relationship between Paleoindians and Pleistocene proboscidians in eastern North America is limited. Associations are noted for Missouri (Kimmswick) (Graham et al. 1981), southern Michigan (Fisher 1984, 1987, 1989), and Ontario (McAndrews and Jackson 1988). Cultural associations are firm only for Kimmswick, the Michigan and Ontario locations being equivocal. Limited evidence for megafauna exploitation has fostered the conclusion that communal caribou hunting was the subsistence norm in the northern midwest and northeast regions of the continent (Deller and Ellis 1988; Gramley 1983; Mason 1981; Storck 1988).

Reevaluation of fossil specimens in regional museums, ancillary to definition of the non-Clovis-related Chesrow Complex (Overstreet 1993), provides new insights. Osteological specimens from nine sites include mammoth (*Mammuthus*), mastodont (*Mammut*), and musk ox (*Symbos*). Mammoth (Mud Lake, Schaefer, Case High School sites) and mastodont (Fenske site) remains collected from local bog and marsh deposits are exceptionally well preserved and bear many unambiguous butchering marks. Typically, these wetlands are eutrophic postglacial lakes formed on the Valparaiso, Tinley, and Lake Border moraines deposited by the Lake Michigan lobe in late-Woodfordian times (Hansel 1983; Hansel et al. 1985; Schneider 1983). The Valparaiso moraine, oldest of these landscapes, is dated to 15,000 years ago from assays on mammoth bone and peat overlying frontal outwash (Springer and Flemal 1981). A basal date for Wisbog, a pollen-study locality on the Lake Border moraine system in southeastern Wisconsin (Huber and Rapp 1992), is 12,600 ± yr B.P. (BETA 29230).

Butchering marks are consistent with those described in the literature and include three basic forms: (1) cut marks; (2) chop/hack marks; and (3) wedge

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compressions. Evidence of butchering and dismemberment consists of marks on conarticular surfaces which correspond either in location or orientation or both, cut and broad chop/hack marks and fine scratches on shafts of long bones, wedging marks on articular surfaces and linear cut marks on manus elements.

Investigations were initiated in 1992 to confirm contexts of faunal sites and to incorporate remote sensing as a site survey tool. Excavations at the Schaefer site revealed the remains of woolly mammoth (*Mammuthus primigenius*). As indicated in Figure 1, the animal has been disarticulated and redeposited in a bone pile. The bone pile occurs in a near-shore environment on marly clay lakebed overlain by 130–140 cm of undisturbed fibrous peat. Investigations will continue at Schaefer and four other faunal stations in 1993.

Proximity of various species and their hypothetical relationship to the Chesrow Complex raises several important issues. First, while it is suggested that mammoth and mastodont occupied different ranges and territories (McAndrews and Jackson 1988), the Kenosha and Racine County examples temper this conclusion. If late Pleistocene-early Holocene environments were mosaic rather than zonal we should expect proximity of species adapted to differing habitats within a limited geographic range (Graham et al. 1981). Second, exploitation of extinct elephant forms by Paleoindians may have been more habitual than current literature suggests (e.g. Deller and Ellis 1988; Gramley1983; Mason 1981; Storck 1988). Atissue here, a common taphonomic/ contextual concern, is whether the remains constitute predation or scavenging. Third, the role of predator-prey relationships in Paleoindian subsistence may



Figure 1. Plan view, Schaefer Site Mammoth excavations.

be more significant than contemporary climate-extinction models imply (McAndrews and Jackson 1988).

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Methods

"Paleoindian," "Clovis" and "Folsom": A Brief Etymology

Vance T. Holliday and Adrienne B. Anderson

Modern Paleoindian research began in 1927 with the discovery of artifacts in association with Pleistocene fauna near Folsom, New Mexico (Cook 1927). Since that discovery, Paleoindian studies, like most in archaeology, became loaded with a bewildering array of typological and cultural-historical terms. Some typological terms were explicitly defined upon their introduction (e.g., "Plainview" by Sellards et al. 1947), but the evolution of typologies for the two best-known Paleoindian artifacts—Clovis and Folsom—is considerably less clear. Moreover, the origin and concept behind "Paleoindian" are obscure. In this paper we present a brief history of these three very widely used terms whose origins are all but forgotten.

Roberts (1940) was the first to use the term "Paleo-Indian." He introduced the term in the title of his paper ("Development on the problem of the North American Paleo-Indian") and used it a few times in the lengthy article (65 pages), but nowhere was it explicitly defined. The paper reviews all sites in North America of "some antiquity" (Roberts 1940, p.54), summarized as consisting "of artifacts and skeletal materials in deposits dateable by geologic means, in association with bones of extinct species of animals and invertebrates...and also of indications of cultures that were adapted to conditions totally unlike those prevailing in modern times" (Roberts, 1940, p.54). Later, Roberts (1953, p. 256) is somewhat more explicit, using "Paleo-Indian" simply to refer to "older" or "early" Indians.

The term "Paleoindian" did not come into wide use for over a decade after its introduction. Indeed, Roberts (1951) did not use the term in his review of "Early Man" radiocarbon ages. In the 1950s several definitions appeared as did alternate terms, as discussed by Krieger (1964). For example, Sellards (1952) continued to use the term "Early Man," though considering it the equivalent of Paleoindian (Sellards, 1952, p. 10). Sellards, like Roberts (1940), considered

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Early Man sites to be "of some appreciable antiquity in a geologic sense" (Sellards, 1952, p. 5). "Paleoindian" probably gained its biggest foothold in archaeological terminology when used by H. M. Wormington in the 4th edition of her influential book *Ancient Man in North America* (Wormington, 1957).

Like the term "Paleoindian," formal differentiation between "Folsom" and "Clovis" took well over a decade to resolve following the initial Folsom discovery. Folsom points were recognized as technologically and typologically distinctive immediately upon discovery, but the terminological pigeonholes we take for granted were years in evolving. Figgins noted the distinctiveness of Folsom and lumped several "Paleoindian types" when he stated, "We have . . . in the Folsom arrowheads the third instance of a very similar type of artifact being found immediately associated with extinct bison" (Figgins, 1927, p. 234) (referring also to a fluted point from Logan County, Kansas, and lanceolate points from Lone Wolf Creek, Texas). The fluting of Folsom points soon was recognized as a particularly distinctive trait, and for a time all fluted points were considered Folsom. Renaud (1931, 1932) includes what we now recognize as Clovis points among the "Folsom points" he illustrates. In the following years, with the recovery of fluted points in association with mammoth at Dent, Colorado (Figgins, 1933), Clovis, New Mexico (Cotter, 1937), and Miami, Texas (Sellards, 1938), and elsewhere, differentiation with "True Folsom" was drawn by terms such as "Folsom-like," "Folsomoid," and "Generalized Folsom," (Wormington, 1957, p. 30).

By the late 1930s the typological and chronological distinctions between Clovis and Folsom were all but formalized. Cotter (1938, p.117), in summarizing the 1936 and 1937 excavations at Clovis, observed: "It is evident that the chalcedony points associated in speckled sand with mammoth bones were typically long and heavy for the Folsom pattern, with very slight channeling at the base. This year [1937], finds made in the bluish clay associated with bison bones were typically of a slighter design, with and without channeling."

Folsom (fluted) and Yuma (unfluted lanceolate), however, were the only formally recognized "types" at this time. In 1941 a symposium on Paleoindian terminology was held in Santa Fe, sponsored by the University Museum of Philadelphia and the Laboratory of Anthropology (Howard, 1943; Krieger, 1947; Wormington, 1948, 1957). The group decided to differentiate the various fluted types, thus defining the Folsom and Clovis types so familiar today. E. B. Howard, in his paper on the Finley site (Howard, 1943), apparently was the first to discuss the results of the conference and the first to publish the term Clovis. The Santa Fe Conference also resulted in one of the earliest and one of the few systematic attempts to differentiate the many lanceolate ("Yuma") styles (e.g., Wormington, 1948), a typological problem still haunting Paleoindian archaeologists (e.g., Knudson, 1984; Wheat, 1972).

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Recognizing Late Pleistocene Paleoshoreline Levels from Geomorphic and Stratigraphic Records of Glaciofluvial Deltas

Victor M. Levson, Daniel E. Kerr and Timothy R. Giles

Late-Pleistocene-early-Holocene glaciofluvial deltas in both marine and lacustrine environments are readily identifiable on aerial photographs and in the stratigraphic record. These deltas can be used to identify paleoshoreline elevations in areas where other shoreline indicators such as relict beach ridges are not preserved. This is particularly true for deltas deposited during glacial retreat. These deltas commonly form at or near the upper limits of marine transgressive phases or glaciolacustrine inundations and hence provide an elevational constraint on early paleoshoreline habitation sites. Determining these upper limits is important because the earliest remains of interaction between humans and Pleistocene fauna would likely be located above these levels (Haley and Solorzano 1991). In addition, the potential for discovery of Pleistocene archaeological sites near deltas and associated shorelines is greater than on most other surficial sediment types (Kerr et al. 1991). Perched deltas and raised shorelines are good targets for detailed field surveys, and these areas may have been preferred by Paleoindians inhabiting or migrating through recently deglaciated littoral areas. To illustrate the potential paleoenvironmental and geographic scope of this approach, examples of late-Pleistocene deltaic environments are provided here from current studies at three widespread locations in glaciated parts of western and northern Canada. These studies include investigations of both glaciomarine and glaciolacustrine deltaic environments.

Studies along 1,500 km of the Arctic Ocean coast between Paulatuk and Bathurst Inlet (Kerr 1992) have revealed a large number of glaciomarine deltas and raised beaches between present-day sea level and the maximum elevation of postglacial transgression (Figure 1). As Laurentide ice receded southward towards Hudson Bay, most deltas formed at the marine limit, which was established between 13 and 8 ka, up to 125 km inland from modern beaches. Determining the elevation of high-level deltas is particularly important in this area because few Pleistocene strandlines are found at or near marine limit. An association between shorelines and Paleoindian occupation sites is indicated by the presence of a number of sites on well to poorly preserved raised beaches at various elevations along the coast. Locating older sites at higher elevations, where beach ridges are not preserved, could be facilitated by conducting contour-parallel surveys near the upper limit of marine transgression as determined by delta top levels. Relatively high emergence rates (Figure 1) during deglaciation and in postglacial times may permit the use of relative sea

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Figure 1. Total number of glaciofluvial deltas along the north coast of Canada, by region, in relation to the number of deltaswithin 20 m of marine limit (marine limit in parentheses). Emergence rates in each region for 6–8 ka and 8–10 ka are shown. High marine limits and emergence rates correspond to areas of greater ice-loading to the east.

level curves for determining the age of these sites, independent of radiocarbon dates on archaeological materials.

In the Mayo region, central Yukon Territory, Giles (1993) documented evidence of a large ice-dammed lake near the northern margin of the late-Wisconsinan Cordilleran ice sheet. The lake formed when drainage in the region was blocked as the McConnell glacier retreated up the Stewart River valley. Sandy deltaic deposits accumulated in the lake at the mouth of the Mayo river where it emptied into the Stewart valley. The delta deposits transgressed upslope as the lake level rose, and a large delta braidplain with several distributary channels formed. The delta has since been partially eroded by the modern Mayo River. However, the maximum lake level (550 m) can be readily determined from the elevation of the highest deltaic deposits, and early-Paleoindian archaeological sites in this area probably occur at or near this level.

Similarly, in the Front Ranges of the Canadian Rocky Mountains, glacierdammed lakes were common during the late Pleistocene. This area occurs along the western margin of the "Ice-Free" corridor, a possible migration route used to people the New World, and near the eastern limit of Cordilleran and montane glaciers (Levson and Rutter 1993; Rutter 1980). Several large lakes formed in the area prior to the late Wisconsinan, and evidence of their existence is preserved only in the stratigraphic record (Levson 1990). In addition, small ice-marginal lakes began developing in postglacial times by at least 11,900 ± 120 yr B.P. (GSC-3885; Levson and Rutter 1989). Recent research in this region has identified glaciofluvial deltaic deposits associated with lakes that developed during the beginning of the late Wisconsinan. The deltaic deposits are characterized by large-scale planar cross-stratified gravels (foreset beds) overlain by horizontally bedded and trough cross-bedded sandy and gravelly strata (topset beds). The elevation of these topset facies marks maximum lake levels and can be used to identify the elevation of paleoshorelines along which archaeological investigations can be focused.

These studies indicate that glaciofluvial deltas are good indicators of both marine and lacustrine paleoshoreline levels. They are easily recognized from both geomorphic and stratigraphic data, and they are widely distributed in glaciated areas. They appear to be particularly useful for identifying otherwise obscure postglacial shoreline levels that developed in earliest postglacial times and are most likely to be associated with the earliest, most elusive records of Paleoindian activities.

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Trace Organic Residue Analysis from Early Archaic Artifacts

Michael L. Marchbanks and Michael B. Collins

Microscopic organic residues that have adhered to or been absorbed into the structural matrix of archeological materials can be extracted, identified, and their origin (s) inferred; these inferences may aid in interpreting the use history an artifact. This note reports results from analysis of relatively early Holocene materials (near 7,000 yr B.P.) that are encouraging for the potential of artifacts of Pleistocene age.

Lipids, the organic residues analyzed in this study, were extracted from 12 chipped-stone artifacts and 18 burned rocks from the early-Archaic site of Camp Pearl Wheat in west-central Texas. The site, a single-component campsite with hearths and a limited array of stone tools buried in overbank flood

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deposits, had no preservation of bone, charcoal, or other macroscopic organic remains (Collins et al. 1990). In addition to the artifacts, three unaltered limestone rocks were tested to determine background levels and types of lipids naturally occurring in the deposit. Of the 30 cultural samples tested, 22 had lipid concentrations more than 2.5 times the average of those found on the control specimens (2.5 to 63 times on chert; 5 to 65 times on burned rock).

Lipids are compounds that are derived from living organisms, contain longchain hydrocarbon groups, are insoluble in water, and are soluble in such organic solvents as chloroform and ether. There are many types of lipids, but only fatty acids and sterols were utilized in this study. Fatty acids are characterized according to the length of their carbon chains (e.g., ¹⁸C, ¹⁶C, etc.) and the number of double bonds (e.g., :2, :3, etc.) into three sets: saturated (no double bonds); monosaturated (one double bond); and polyunsaturated (two or more double bonds). Sterols are generally classified into two groups, zoosterols (found in animal tissue) and phytosterols (found in plant tissue).

The results from the analysis can be interpreted using all the lipids present, which can be overly complicated, or by relying on characteristic ratios. In general, animal fats tend toward high percentages of saturated relative to unsaturated fatty acids—the opposite of those of plants. Therefore, the percent of saturated fatty acids (%S) can be used to characterize the parent material of a residue. Identification of parent materials from which the extracted residues derived is complicated by reduction in the total amounts and degradation of separate lipids at different rates. This affects results from pattern-recognition programs (of total lipid extract) as well as characteristic ratios (i.e., %S). To reduce these effects, lipids that alter most substantially can either be removed or weighted less heavily in the interpretation of the results of lipid analysis. For this study the characteristic ratio %S is utilized, in which a residue with a high %S is diagnostic of animal parent materials and a low %S, of plant materials. The lipids were analyzed using gas chromatography with a subgroup analyzed by gas chromatography/mass spectrometry (for identifying the different peaks).

Three dart points were analyzed, and all three yielded high %S values, indicating that the parent materials of the organic residues were animal tissue. Two bifacial preforms, one pristine, the other heat-damaged, lacked organic residues; residue on a fragment of a finished biface derived from animal tissue. Three retouched flakes yielded residues derived from plant tissue. Two flakes and another biface fragment yielded insufficient residue (above background) for analysis.

Of 18 burned rocks, seven yielded animal residues, seven yielded mixed plant and animal residues, one yielded residue that could not be confidently interpreted, and three yielded insufficient residue for analysis. The five features (hearths) from which these rocks came generally showed a mix of animaland plant-derived organic residues. Plant residues may indicate fuel, food, or both; animal residues more likely resulted from cooking food, but intentional or unintentional inclusion of fatty animal waste in the fuel is also possible. In situ hearth stones showed significantly greater concentrations of organic residues on their upper surfaces than on their lower surfaces.

The results from Camp Pearl Wheat, where macroscopic organic preserva-

tion was extremely poor, indicate that specimens from sites of even greater age—especially those with more favorable conditions for organic preservation—have the potential of yielding artifacts with traces of organic residues suitable for extraction and identification. At one such site, Wilson-Leonard in central Texas, samples of stone tools and burned rocks from Holocene- and Pleistocene-age cultural contexts have been collected and await analysis.

There are significant logistical considerations in integrating organic-residue and traditional-artifact analyses. It is best to collect and curate specimens destined for organic residue analysis without touching or cleaning them, which inhibits classification and attribute analyses; it is also best to collect more specimens than can be processed to insure adequacy of the ultimately processed sample. However, if specimens are submitted for residue analysis prior to classification and attribute study, the optimal choice of specimens (i.e., representation of classes/attributes) is not likely to be made. Partial solutions are to proceed as far as possible with classification (without washing or touching) and then select the sample for residue analysis. Also, it is possible to extract and store (potentially up to a year) residues from all collected specimens, conduct the other studies of the now-cleaned specimens, and select those for which the extracted and stored organic residue will be analyzed. The former option allows not only the selection of specimens according to results of the classification but a better opportunity to identify specific areas on specimens to be spot-sampled without wasting money on unprocessed extractions.

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Paleoenvironments: Plants

A Late Glacial Sequence from the Portage River Channel, Northeast Minnesota Edward J. Bacig and James K. Huber

A 237.5-cm peat core recovered from within the Portage River channel, an old drainage channel of Glacial Lake Duluth, has yielded datable organic material and pollen in the basal portion. Analyses of this material should help constrain the timing of the glacial lake history within the study area. The site is located in the southwestern end of the Lake Superior basin approximately 8 km east of the town of Moose Lake, Carlton County, Minnesota (92° 38′ 05″ N, 46° 27′ 50″ W).

The southwest end of the Lake Superior basin was last glaciated approximately 11,000 yr B.P. during the Nickerson Phase of Wisconsin Glaciation. As the Superior lobe ice melted, a series of small glacial lakes formed between the retreating ice margin and the rim of the Superior basin (Farrand 1960). Leverett (1929) named these glacial lakes Nemadji, Ashland, Brule and Ontonagon. As the Superior Lobe ice retreated further into the basin, these proglacial lakes coalesced to form Glacial Lake Duluth. The outlet for Glacial Lake Nemadji and the early stages of Glacial Lake Duluth are interpreted to be the Portage River channel. With further retreat of the Superior Lobe into the Superior Basin, the level of Glacial Lake Duluth dropped, opening an outlet at the Brule River and abandoning the Portage River outlet (Wright 1970).

The base of the core (230–237.5 cm) consists of medium- to fine-textured organic sands with small wood fragments. Above this is a thin zone (228–230 cm) of organic-rich clay. The remainder of the core grades from amorphous to fibrous peat. This stratigraphy is interpreted to represent a channel-fill sequence.

Three samples from the basal part of the core have been analyzed for pollen. The pollen spectra (Figure 1) are dominated by *Picea* (spruce) and *Pinus* (pine). *Picea* declines from 41% at the base to 24.5% at the top, while *Finus* increases from 1.5% to 38%. Except for a few grains, *Pinus* is composed of *Pinus* banksiana/P. resinosa-type (jack pine/red pine) pollen. Other prominent trees

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Figure 1. Pollen percentage diagram of selected taxa from the Portage River Channel core, Carlton County, Minnesota.

and shrubs include Betula (birch), Quercus (oak), Fraxinus nigra (black ash), and Salix (willow). The prominent nonarboreal pollen types are Gramineae (grass), Cyperaceae (sedge), Ambrosia-type (ragweed), and Artemisia (wormwood). Selaginella selaginoides (mountain moss), indicative of boreal forests, is also present. Indeterminable pollen (Figure 1) is 30% in the basal sample. Most of this category is composed of spherical grains too degraded to identify.

The pollen spectra from the core are representative of the transition from a boreal to a mixed conifer-hardwood forest. This transition has been dated between 10,700 and 9,500 yr B.P. at various sites in northeast Minnesota (see Huber 1992 for a review of the literature). At Kotiranta Lake, approximately 25 km to the northeast, this transition is dated at younger than 11,500 yr B.P. (Wright and Watts 1969).

A sample of the basal portion of this core has been submitted for accelerator-AMS dating. This date in conjunction with the pollen spectra will help constrain the timing of the glacial lake history in this area.

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A Late Glacial Pollen Sequence from Lake Superior

James K. Huber

The lower portion of a 635-cm core (SMNS80-1P) recovered from Lake Superior contains well-preserved pollen. Preliminary analysis indicates that the pollen record is late glacial in age. The site is located off the Michigan south shore at 89° 21′ 36″ N, 47° 11′ 24″ W. The core was recovered from a depth of 180 m.

The lithology of the core is: 0–28 cm, light gray clay; 28–83 cm, brown clay; 83–435 cm. varved dark gray clay; 435–635 cm, varved red clay. This sequence is similar to other cores reported from Lake Superior.

Six samples from 400-635 cm have been analyzed for pollen (Figure 1).



Figure 1. Pollen percentage diagram of selected taxa from Lake Superior core SMNS80-1P

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From 636–550 cm pollen, concentration is low (400–3,000 grains/gram [dry weight]). Pollen concentration increases to 16,300 at 500 cm and declines to 8,900 at 400 cm (Figure 1). The pollen assemblage is dominated by *Pinus* (pine) and *Picea* (spruce). *Picea* declines from 29% at the base to 7.7 % at the top, while *Pinus* (mostly diploxylon) ranges from 26% to 55%. Maxima of *Betula* (birch) and *Ulmus* (elm) occur at 550 cm and 450 cm respectively. *Quercus* (oak) and *Fraxinus* (ash) are present at less than 10%. Nonarboreal pollen (NAP) values are low. The most abundant NAP taxa are Cyperaceae (sedge), Gramineae (grass), *Ambrosia*-type (ragweed), and *Artemisia* (wormwood) (Figure 1).

The pollen assemblage from this core, except for the basal high pine value, is most similar to the pollen sequence for Weber Lake, northeast Minnesota, analyzed by Fries (1962). The Weber Lake *Betula* maximum has been dated at 10,550 yr. B.P. (Fries 1962). The post-glacial *Ulmus* maximum occurs between 9,000 and 10,000 yr. B.P. (Wright 1968). Maher (1977) investigated several cores from the Western Arm of Lake Superior, but none of his cores contained high percentages of *Picea* pollen at the base.

Further palynological investigations of Lake Superior cores will aid in refining the late glacial history of the lake. Pollen records in conjunction with limnological data will also contribute to understanding the dynamics of Lake Superior.

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Paleoenvironments: Vertebrates

New Excavations at San Josecito Cave, Nuevo León, México

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San Josecito Cave (Nuevo León, México) is one of the most important Pleistocene localities, both in México and the United States (Kurtén and Anderson, 1980). Previous research on its fauna focused primarily on taxonomic studies of particular taxa, without stratigraphic data or radiocarbon dates (Arroyo-Cabrales 1991; Arroyo-Cabrales et al. 1989).

Renewed excavations in the cave were undertaken in March and April, 1990, to obtain high-resolution taphonomic and stratigraphic data to reconstruct the preserved ecosystem(s) in San Josecito Cave. The six-week field season was spent excavating two test units, recording the stratigraphic profile of Stock's final pit (test pit excavated by Chester Stock's [1943] crew marking the end of the excavations in 1941), and taking sediment samples for radio-carbon dating, travertine samples for uranium-thorium assays, and samples for paleoinsect, sediment, pollen, phytolith, paleobotanical, paleomagnetic, and snail analyses. The north wall of Stock's pit was cleaned, mapped, and photographed. Two test units were opened along the north face of Stock's pit. In order to square off Stock's pit for excavation of a square-meter unit, a unit measuirng 1 m by 0.3 m (designated 533N197E) was taken down about 1.5 m by stratigraphic levels. All sediments from 533N197E were taken for the various studies later accomplished in laboratories in México and the United States.

Excavation unit 534N197E began as a 1-by-1-m unit, but was reduced to a 50by-50-cm subunit due to time constraints. The subunit was excavated stratigraphically, removing a 10-by-10-cm square at a time, to an average total excavated depth of 42 cm. A standardized field form was used to record provenience, stratigraphic data, and photodocumentation data for each level.

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In situ materials and the surface of the encountered unit were drawn to scale on the back of the form, and a photograph taken. All large and microvertebrate bone found in situ was mapped and strike-and-dip recorded. The sediments from each 10-by10-cm square by level were bagged and tagged according to stratigraphic and excavation data for water-screening through a nested series of screens (1.41, 0.96, and 0.56 mm mesh) to recover microvertebrates. Taxonomic identifications were conducted based on both comparative collections (specimens of extant and extinct species) and bibliographic references. Specimens of extant species were collected in the cave region for comparative purposes and to document present faunal composition.

Continued attempts were made to match photographs taken during Stock's excavations with marks and other features still visible on the cave walls. A rock was located that showed chisel marks marking the 60-ft level, according to one of Stock's photographs. The 55-ft-level mark on the cave wall also was located. Stock's 55-ft level corresponded almost exactly to our 2225-m elevation. Although subjected to weathering for the last 50 years (it was located below the main entrance) and quite faint, carbide-lamp marks placed on the cave wall by Stock's crew to mark the 55-ft level could still be interpreted.

Excavation unit 534N197E was located at the boundary of Stock's Block 2 and 3 (Arroyo-Cabrales et al. 1989). Eleven stratigraphic units were uncovered that accounted for, in part, Stock's levels 55 ft to 57 ft (2225 m to 2224.4 m). These stratigraphic units (strata 780 to 680) ranged in depth from 1 to 8 cm (totaling an average depth of 42 cm). Eighty-eight specimens were collected in situ. These specimens for the most part were microvertebrate bones, primarily bats and mice. Only one large specimen, a calcaneum (catalog number SJC-5387) from the extinct horse *Equus alaskae*, was recovered in situ. The washing of the sediments and sorting of concentrates revealed an enormous amount of microvertebrate remains that are being studied.

Remnant sediments were found at the top of the uppermost travertine sample point (travertine sample #25), approximately 9 m above the present floor at the north quadrant of the cave (Block 5). These sediments were correlated with some of the top strata of the original floor. An excavation unit (542N196E) placed in this alcove revealed five stratigraphic levels that correlated with Stock's 34-ft level (2235.6 to 2235.37 m) as deduced from Stock's photodocuments taken from the same point in the cave. Ten medium and large-sized bones were recovered from this unit, including remains of ground sloth (*Nothrotheriops shastensis*) bones (tooth, SJC-5344; calcaneum, SJC-5346; haemapophysis, SJC-5354; two thoracic vertebrae, SJC-5348, SJC-5349). This material can be correlated with the ground sloth remains that Stock's crew recovered at the 34-ft level.

A flowstone shield with a thin, loose sediment deposit on the underside, referred to as the Bat Alcove, was found below the lowermost travertine sample point (travertine sample #1), approximately 6.5 m above the present excavation floor at the north quadrant of the cave (Block 5). The sediments contained an abundance of microvertebrate bones, particularly those of bat. Due to the importance of the bat fauna from this cave (Arroyo-Cabrales and Ray, in press), a small sample of this deposit (20 x 20 cm) was excavated from unit 545N194E.

An almost-complete skull (SJC-5371) of the Pleistocene vampire bat *Desmodus* stocki was recovered from this deposit.

Eleven species have been identified based on the in situ bones recovered from the three excavation units. Three species (Desmodus stocki, Nothrotheriops shastensis, and Equus alaskae) are extinct, and one species (Neotoma mexicana) is not known from Stock's (1943) work. Jakway (1958) has identified N. albigula in Stock's collection, but based on the current material, this identification needs to be verified. Harris (1984) notes the problems in confusing N. albigula and N. mexicana. Taphonomic data have been collected, including rodent gnawing on many large and small bones, and manganese staining (Allison 1990; Parker and Toots 1970), that in some cases make the bone almost black. Clear signs of weathering on the bones are lacking, indicating that sediments were deposited rapidly. Finally, the new materials and associated radiocarbon dates (Arroyo-Cabrales et al., in prep.) underscore the erroneous past treatment of the San Josecito materials as a single time-related entity, and therefore a cohesive local fauna (e.g., Jakway 1958). Numerous chronologically separate assemblages are represented in the stratified cave deposits forming a series of local faunas spanning thousands of years of the late Pleistocene.

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A Late Pleistocene Record of the Ringtail from South-Central Texas

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North American late-Pleistocene (late-Wisconsinan) records of the ringtail (*Bassariscus astutus*) have been reported from over a dozen localities in Arizona, California, Nevada, New Mexico, and Texas (Graham 1987; Harris 1985:184; Kurtén and Anderson 1980:177). Ringtail elements from late-Pleistocene deposits at the Richard Beene site (41BX831) represent only the second Pleistocene record for this mammal from central Texas.

The Archaeological Research Laboratory, Texas A & M University, conducted archaeological investigations at the multicomponent Richard Beene site (41BX831) from November 1990 through August 1991. This open-air site is located in the lower Medina River Valley in southwestern Bexar County, 25 km south of San Antonio, and contains late-Pleistocene through late-Holocene deposits (Thoms 1991, 1992a, 1992b; Thoms and Mandel 1992). The Edwards Plateau, the southern and lower portion of the Great Plains extending to the Balcones Fault Zone, is located a few dozen kilometers to the northwest. The site setting is presently a floodplain/terrace, riparian environment. Environmentally, the immediate site area appears to have been relatively stable since the late Pleistocene (Thoms 1992a, 1992b).

Approximately 10,000 vertebrate remains were recovered from throughout the site (Baker and Steele 1992a, 1992b). The late-Pleistocene component produced a well-preserved vertebrate assemblage dating to ca. 12,000 yr B.P. (Thoms and Mandel in press), though no definite cultural material was identified from the late-Pleistocene deposits. Preliminary identifications from the late-Pleistocene sample (N = 3,000) include frog/toad (Anura), water turtle (*Chrysemys* sensu lato), softshell turtle (*Trionyx* sp.), snake (Serpentes), perching bird (Passeriformes), rabbit (*Sylvilagus* sp.), squirrel (Sciuridae), cotton rat (*Sigmodon* sp.), ringtail (*Bassariscus astutus*), deer (*Odocoileus* sp.), and bison-sized manumal (Baker and Steele 1992a).

The presence of ringtail is significant because of its rarity in studied assemblages from central Texas predating the late Holocene. Today ringtails can be found throughout the state, except in extreme portions of the lower Rio

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Grande and southern Texas Coastal plains (Jones and Jones 1992:69). Ringtails are often found near water, and may den in logs, hollow trees, brush piles, caves, rock outcrops, or other animal burrows (Schmidly 1983:254; Toweill 1976).

Ringtail elements were recovered from a weakly developed late-Pleistocene paleosol designated Soil 7 (Thoms and Mandel in press), which produced an AMS ¹⁴C date of $12,745 \pm 190$ yr B.P. (Beta 47562/ETH 8539). This dated charcoal sample was obtained from an amorphous feature, probably a tree throw, in Soil 7.

The ringtail sample includes a right mandibular horizontal ramus, one left femur fragment (proximal end), one femur fragment (distal end), and one complete left calcaneus. The mandible ramus is fragmented mesial to pml and distal to m2, and retains pm3, pm4, and m2. Numerous other postcranial elements from this sample (FS#7482) compare favorably with ringtail. If these additional elements are ringtail, they represent the remains of a single individual.

While Semken (1961:304) reported ringtail from late-Pleistocene deposits in the eastern Edwards Plateau of central Texas at Longhorn Cavern, Burnet County, Texas, no additional Pleistocene records are known from this area (see Graham 1987). In addition, Graham's (1987) review of the area revealed only one Holocene subfossil record of ringtail from the eastern Edwards Plateau. This specimen is from the Barton Road site, Travis County, Texas, and dates to 1,000 yr B.P. (Graham 1987:60, 77).

While the ringtail is known more commonly from the late Pleistocene and earlier Holocene of the western Edwards Plateau (Graham 1987), researchers have generally assumed that *Bassariscus* colonized the eastern Edwards Plateau and neighboring areas only within the very late Holocene (Dalquest et al. 1969:216–217). The presence of ringtail in late-Pleistocene deposits dated to ca. 12,500 yr B.P. at the Richard Beene site supports Semken's (1961:304) assessment that the species has been endemic to central Texas since the Pleistocene.

Research at the Richard Beene site was funded by the San Antonio Water Board. Investigations were carried outby the Texas A&MArchaeologicalResearch Laboratory under contract to Freese & Nichols, Inc. The U.S. Army Corps of Engineers, Fort Worth District, oversaw the project. Brian S. Shaffer, D. Gentry Steele, and Alston V. Thoms, are thanked for their comments on this paper. Ernest Lundelius, Jr. is thanked for his insight on Quaternary ringtail biogeography.

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Rancho La Brea Mammoths

John M. Harris and Shelley M. Cox

Over 34 mammoths from Rancho La Brea (RLB), California, constitute one of the largest samples of a late-Pleistocene proboscidean species from North America but have never been fully described. Most of the RLB mammoths came from Pit 9, and were excavated between November 1913 and August 1914, but only recently has the Page Museum laboratory program concentrated on restoration of the RLB proboscidean remains.

Swarth (1915) identified the RLB mammoth as the "imperial elephant," as did Wyman, although he labeled an RLB specimen as a Columbian mammoth

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(Wyman 1918, fig. 7). Stock (1930) asserted that both the imperial mammoth (*Mammuthus imperator*) and the Columbian mammoth (*M. columbi*) were represented at RLB. Specimens from this site have subsequently been referred to as either the imperial mammoth (e.g., Harris & Jefferson 1985; Osborn 1942) or the Columbian mammoth (e.g., Jefferson 1991). We concur that there is only one mammoth species represented dentally at RLB, and that females of this species tend to have slightly smaller teeth with less widely spaced plates than those of males. Using Saunders's criteria (in press), the RLB mammoths appear intermediate between *Mammuthus columbi* and *M. jeffersonii* on the basis of molar plate number, but probably represent late representatives of the former.

The minimum numbers of mammoth individuals from RLB based on teeth comprise one from Pit 50, four from Pit 17 and 29 from Pit 9. This contrasts with a previous estimate of a total of 18 individuals based on isolated foot bones (pers. comm. S. Cox in Stock, 1992). In terms of "African elephant years" (Laws 1966), two individuals were less than two years old at the time of their death, seven were between the ages of 20 and 30, and the rest were older than 40. We recognize only five female dentitions. The apparent preponderance of adult males is intriguing, given the ratio of females to males in extant proboscidean herds.

The scarcity of mammoths at RLB, except at Pit 9, has yet to be satisfactorily explained. Perhaps mammoths were only present during the time interval represented by the Pit 9 sequence, or perhaps only at Pit 9 were conditions favorable for the accumulation and preservation of large proboscidean remains. The presence of Bison latifrons hints that the Pit 9 assemblage may be older than most others from the asphaltic deposits. Fossil wood from 8.5 ft below ground level in Pit 9 has been dated at about 13,000 yr B.P. whereas wood from below 10.5 ft has been dated in excess of 38,800 yr B.P. (Marcus and Berger, 1984). All the mammoth specimens from Pit 9 came from 10 ft or more below ground level, and most came from horizons dated between 34,000 and 40,000 yr B.P. However, at other sites from which both bone and wood dates were obtained, such as Pits 4, 16, and 91, wood samples persistently provide older age estimates than bone samples from the same horizons. Additional dating on bones from Pits 9, 17 and 50 is currently being pursued. Mammoth remains have been recovered from 39 other sites in Los Angeles County, but only three of those sites have been dated and all three are older than 20,000 yr B.P. (Jefferson 1991).

Wyman's unpublished field notes for Pit 9 recorded the generally poor state of preservation of much of the fossil bone (compared with that from other RLB localities) and the unusually large quantity of fossil wood encountered, some of which "had the appearance of being washed in." It is possible that the mammoths only exploited the vicinity of RLB during intervals when riparian woodland extended out from the Santa Monica Mountains onto the coastal plain. The timing of this (or these) occurrence(s) must await further radiometric determinations.

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Fossil Grizzly Bears (*Ursus arctos*) from Prince of Wales Island, Alaska, Offer New Insights into Animal Dispersal, Interspecific Competition, and Age of Deglaciation *Timothy H. Heaton and Frederick Grady*

The Alexander Archipelago poses a complex island biogeographic puzzle, with each island being home to a unique subset of mainland species. Prince of Wales Island, for example, contains just over half the species of terrestrial mammals that inhabit southeast Alaska. Since glaciers once filled the straits that now

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separate the islands, colonization may have been easier in the past for some species, and therefore the current distribution may be relictual rather than an equilibrium between dispersal and extinction. Islands of the Alexander Archipelago are closely spaced, usually about 5 km apart, and large mammals such as deer and bears are known to swim such distances. Why some large-bodied species are absent from some islands is therefore a mystery.

Grizzly bears (*Ursus arctos*) and black bears (*Ursus americanus*) both inhabit southeast Alaska, but the two species rarely coexist on offshore islands. Prince of Wales Island, in spite of its large size and proximity to the mainland, has only black bears, and these bears parallel the habits of grizzlies by including fish in their diets. Since grizzlies tend to dominate black bears wherever the two coexist, it was once thought that grizzlies must never have colonized the island.

Last year we reported on a fossil bear den being excavated from El Capitan Cave on the northern part of Prince of Wales Island (Heaton and Grady 1992a, 1992b). During July 1992, we opened the sealed den entrance and conducted a full excavation of the site, recovering parts of at least four black bears and three grizzly bears. This site is located in a glacial valley near the bay below El Capitan Peak. Skulls of two additional grizzlies (both juveniles) were recovered by cavers from deep shafts in Blowing in the Wind Cave in the alpine karst on El Capitan Peak. These fossils demonstrate that grizzlies did in fact colonize Prince of Wales Island and occupied diverse habitats there before disappearing.

The large bear previously reported from El Capitan Cave (Heaton and Grady 1992a, 1992b) has now been positively identified as an enormous, aged grizzly. It was radiocarbon dated at 9,760 ± 75 yr B.P. (AA-7794). Its remains, including cranium and upper dentition, were scattered in the rubble near the entrance of the bear den. A second individual, somewhat smaller, was later identified from the same site, but too much glue was used during preparation of the single femur shaft to allow for dating. A third grizzly, smaller still, is represented by many heavily chewed but beautifully preserved elements found farther inside the den passage. This animal was radiocarbon dated at $12,295 \pm 120$ yr B.P. (AA-10445), the oldest from the site. Of the two juvenile grizzlies from Blowing in the Wind Cave, the smaller one contains almost no collagen and is therefore undatable. The larger one has excellent preservation and was radiocarbon dated at 9,995 ± 95 yr B.P. (AA-10451), an age bracketed by the El Capitan Cave grizzlies. The oldest black bear from El Capitan Cave was radiocarbon dated at 11,565 ± 115 yr B.P. (AA-10448), so black and grizzly bears coexisted on the island for at least 1,800 years.

These data raise as many questions as they answer about bears and island populations. First, it is unusual to find both black and grizzly bear remains spanning a long time interval from the same den. Remains of both species have been found together in caves but are not likely synchronous (Emslie and Czaplewski 1985, Grady 1988, Heaton 1988). Grizzlies rarely den in caves, and that helps explain their generally poor fossil record compared with black bears (Kurtén and Anderson 1980). The second enigma is the extinction of grizzlies on Prince of Wales Island. The fact that grizzlies outnumber black bears from the two caves and that their record is older offers the hint that grizzlies reached the island first and outnumbered black bears for a time. Given that black bears, a native American species, have generally not fared well in areas invaded by grizzlies, especially in coastal Alaska, their lone survival on Prince of Wales Island is strange indeed.

Grizzly remains in upper Alaska date to the early Wisconsinan, but the earliest dates south of the ice are around 13,000 yr B.P. (Kurtén and Anderson 1980). It is highly unlikely that grizzlies could have reached the Alexander Archipelago prior to—or survived there during—the last glacial. Local ice-free conditions during the height of glaciation have been documented on the Queen Charlotte Islands farther south (Warner et al. 1982), but the Alexander Archipelago is thought to have been fully covered by the Cordilleran Ice Sheet until at least 14,000 yr B.P. (Clague 1991). The Quaternary history of southeast Alaska has not received the attention that coastal British Columbia has, but this is changing. Since El Capitan Cave is located in a glacial valley, our date of 12,295 \pm 120 yr B.P. (AA-10445) on a grizzly bear provides a new minimum age for substantial deglaciation on northern Prince of Wales Island, which is near the center of the Alexander Archipelago.

We thank Kevin Allred, Steve Lewis, Paul Matheus, Dan Monteith, and other members of the Tongass Caves Project for help in finding and collecting the fossils. Jim Baichtal has been instrumental in attracting scientists to the karst of southeast Alaska, and we appreciate his support. Funding for radiocarbon dates, travel, and supplies was provided by Tongass National Forest and the National Geographic Society.

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Additions to the Vertebrate Fauna of the Kuchta Sand Pit Locality (Late Blancan-Early Irvingtonian), Yankton County, South Dakota

Timothy H. Heaton and H. Gregory McDonald

A series of quarries in the Bon Homme Gravel have yielded isolated elements of over a dozen taxa of large mammals. The most significant quarry is the Kuchta Sand Pit located 19 km west of Yankton, reported by Johnson and Milburn (1984) and Pinsof (1985, 1986). The age of this deposit is late Blancan to early Irvingtonian based on the presence of *Stegomastodon mirificus*, *Equus* cf. *giganteus, Gigantocamelus spatulus*, and *Titanotylopus*. Several new specimens have been collected from the Kuchta Sand Pit and donated to the University of South Dakota since 1986, including additional material of *Equus* and *Hemiauchenia*. Of greater significance are two new additions to the fauna, *Megalonyx* and *Camelops*.

McDonald (1977) demonstrated that Pleistocene Megalonyx comprise a single lineage that underwent a steady increase in size and can be conveniently divided into three chronospecies: *M. leptostomus* of the late Blancan and earliest Irvingtonian, *M. wheatleyi* of the later Irvingtonian, and *M. jeffersonii* of the Rancholabrean. The Kuchta specimen is a right third metacarpal (USDVP 1180), and its size is small when compared with the same element at other sites (Figure 1). It is most similar to *M. leptostomus* from the Inglis 1 A locality of the early Irvingtonian of Florida, so we refer it to that species.

There have been two previous reports of *Megalonyx* from South Dakota. The first is a right femur (UNSM 88438) from an isolated locality near Philip in Haakon County, first reported by Hay (1914) and illustrated by Pinsof (1986). Although no species-level identification was given, it is probably *M. jeffersonii* based on its large size. Warren (1952) and Flint (1955) reported *Megalonyx* from the Bergner Gravel Pit, an Irvingtonian deposit 160 km NW of the Kuchta site. M. R. Voorhies was unable to find sloth material in the Bergner collection at the time of Pinsof's (1986) work but has since located a single second phalanx from digit four of the pes (UNSM 88506). We assign it to *M. wheatleyi* based on its size and the associated taxa; the Kuchta fauna slightly predates the Bergner Pit fauna (Pinsof 1985, 1986). If these identifications are correct, South Dakota deposits have produced all three chronospecies of *Megalonyx*, but only one specimen of each!

The other new addition to the Kuchta fauna is *Camelops* sp., represented by a left I/2 (USDVP 1176), a right astragalus (USDVP 1177), and a first phalanx (USDVP 1178). These were compared with *Camelops* from Natural Trap Cave

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Figure 1. Bivariate plot showing measurements on *Megalonyx* third metacarpals. Material from Inglis 1A, Florida, and the Kuchta Sand Pit, South Dakota, is *M. leptostomus* (late Blancan/early Irvingtonian). Material from McLeod, Florida, and Port Kennedy, Pennsylvania, is *M. wheatleyi* (middle Irvingtonian). The Rancholabrean material is *M. jeffersonii* and includes 3 specimens from American Falls Reservoir, Idaho; 2 from Ichetucknee River, Florida; 2 from the Nova Road Site, Florida; and the holotype of *M. jeffersonii* from an unknown cave in West Virginia.

(KU) and the Bergner Gravel Pit (SDSM 5181) and found to be identical. The proximal phalanx is particularly distinct because the suspensory ligament scar extends so far distally on the shaft, a character noted and illustrated by Breyer (1974) and Voorhies and Corner (1986). The phalanx measures at the upper end of the size distribution for *Camelops* with a maximum length of 126.5 mm and a proximal transverse width of 50.4 mm. The astragalus has a lateral length of 83.5 mm and a minimum length of 65.3 mm, making it large compared with Nebraska *Camelops* (Breyer 1974) but typical of those from Rancho La Brea (Webb 1965).

Green (1977) reported an upper canine of *Camelops* (SDSM 7522) from another quarry of similar age in Yankton County, and *Camelops* is known from deposits as early as middle Blancan in Nebraska (Barbour and Schultz 1937, Voorhies and Corner 1986), so its presence in the Kuchta Sand Pit is no surprise.

We extend thanks to Robert L. Kuchta for collecting fossils from his quarry and donating them to the University of South Dakota. We also thank Gary D. Johnson of the University of South Dakota (USDVP), Philip R. Bjork and Janet L. Whitmore of the South Dakota School of Mines and Technology (SDSM), Michael R. Voorhies and R. George Corner of the University of Nebraska State Museum (UNSM), Larry D. Martin of the University of Kansas (KU), and John D. Pinsof of Daemen College for access to fossils in their care and for helpful discussions concerning this project.

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Anomalous Dentitions in Holocene Woodland Voles (*Microtus pinetorum*) from Duhme Cave, Eastern Iowa

Carmen M. Jans

Examination of vole remains from Duhme Cave, which contains late-Pleistocene through Holocene fossiliferous deposits, revealed specimens of *Microtus pinetorum* (woodland vole) with an unusual first lower molar (m1) occlusal pattern: the fourth triangle is bifurcated into two smaller salient angles (Figure 1) on approximately one-third of the woodland vole m1s recovered.

The Duhme Cave woodland-vole sample consists of specimens recovered from five of the six examined 10-cm excavation levels. Only the bottommost level, dated $21,780 \pm 240$ yr B.P. (B-56040; CMAS-3815), does not contain *M. pinetorum*. Separation of *M. pinetorum* from *M. ochrogaster* followed techniques of Johnson (1972), Van der Meulen (1978), and Martin (1974).

A minimum of 44 individuals were recovered from the five levels; 15 display the unusual m1 fourth triangle. The anomaly is present in varying degrees, but

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5

11

15

10

3

0

2

5

5

2

1

0

40

45

33

20

33

Figure 1. Degrees of bifurcation
in Microtus pinetorum mls from
Duhme Cave, percent distribution
of woodland vole anomalous first
lower molars in Duhme Cave, and
biogeographic distribution of the
anomalous pattern in eastern Iowa.
DC = Duhme Cave

PC = Pictured Rocks Shelter

RR = Rock Run

WC = Willard Cave

K = Keystone

apparently with a general increase in frequency from level 8 to level 1 (Figure 1). The slight inversion between levels 1 and 4 and between 7 and 8 may be due to small sample size or bioturbation, as recent burrows were observed near the excavation.

0-10

30-40

50-60

60-70

70-80

80-90

1

4

6

7

8

9

To determine the biogeography of the anomaly, specimens from other late-Pleistocene and Holocene sites in eastern Iowa were examined. To date, woodland voles with the aberrant ml pattern also have been identified at Keystone, Pictured Rocks, Willard Cave, and Rock Run (Figure 1).

The evolutionary significance, if any, of the anomalous molars is uncertain. Evidence from the fossil record suggests that lower microtine molars have become more complex over time by the addition of salient angles on the anterior margin (Guthrie 1965). Usually, penetration of reentrant angles into the lateral margins of the anterior cone produces new salient angles (Guthrie 1965). If the bifurcated angle is a prelude to development of a sixth triangle, it is in an unusual position and would result in a distinct but previously undocumented morphological change. Perhaps the secondary bifurcation is an alternative mechanism to increase the amount of enamel available for mastication.

In summary, the unusual *M. pinetorum* population from Duhme Cave and other sites in eastern Iowa 1) records a previously unrecognized population variant that has been present in eastern Iowa through much of the Holocene, 2) indicates this pattern becomes more abundant with time, and 3) suggests a direct, linear relationship for woodland voles in this region throughout the Holocene.

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A Late Pleistocene Small Mammal Fauna from South Texas

Eileen Johnson

A late-Pleistocene sand and gravel deposit, located within the coastal Gulf Plain in Nueces County along Petronila Creek near the town of Driscoll in South Texas, was discovered, mapped, and excavated intermittently over a 4-year period (Lewis 1985 to 1989 field notes). A radiocarbon assay of bone apatite yielded an age of 18,180 \pm 330 yr B.P. (TX-5835), while two samples of organics from overlying clays produced ages of 16,880 \pm 380 yr B.P. (TX-5373) and 17,190 \pm 400 yr B.P. (TX-5372) (Lewis 1988:16, 1990:11, pers. comm. 1993).

Lewis (1988, 1990) proposes that the locality represents a hunting and fishing camp by pre-Clovis peoples. Whether or not this late-Pleistocene locality is a pre-Clovis archaeological site is open to debate, but few dated Wisconsinan paleontological localities are known for South Texas or the Pleistocene southern grasslands in general. A preliminary identification of the bones has produced a tentative but extensive Rancholabrean fauna representing all vertebrate classes (Lewis 1988, 1990:2–3). Because of its importance as a dated, comprehensive fauna, verifying the faunal identifications and establishing the paleoecologic significance are critical to placing the locality within the broader perspective of the late-Pleistocene southern grasslands ecosystem.

The micromammal teeth analyzed (n = 474) represent primarily rodents (98.48%), with a few rabbits (1.13%) and a small carnivore (0.38%). The faunal list is composed of *Sylvilagus* spp. (cottontail), *Lepus* cf. *californicus* (black-tailed jackrabbit), *Cynomys ludovicianus* (black-tailed prairie dog), *Spermophilus* cf. *variegatus* (rock squirrel), *S. mexicanus* (mexican ground squirrel), *Geomys* cf. *attwateri* (Attwater's pocket gopher), *G. cf. personatus* (Texas pocket gopher), *Reithrodontomys fulvescens* (western harvest mouse), *Reithrodontomys* sp. or *Perognathus* sp. (harvest or pocket mouse), *Sigmodon hispidus* (cotton rat), *Neotoma floridana* (eastern woodrat), *N. micropus* (Southern Plains woodrat), and an

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unidentifiable small carnivore. While none of the species are extinct, prairie dogs and rock squirrels no longer occur in the region.

Of the 474 specimens, 265 (55.9%) were identifiable at least to family. However, of these, the overwhelming number (238) represented prairie dog (89.8%). Rock squirrel was a very distant second (3.4%; n = 9). Prairie-dog remains were localized in two blocks and particularly concentrated in one unit. Remains were centered (83.6%) in a 30-cm zone in the middle of the section and particularly concentrated (26.5%; n = 63) in one 5-cm level at midsection. Lewis (1990:7) noted that small bones frequently occurred in 2- to 3-cm-thick lenses and that these lenses probably account for the concentrations of teeth seen in particular levels and units.

Five taphonomic modifications affecting the prairie-dog sample are solution pitting (35%; n = 86) and sculpting (21.4%; n = 51), blackened discoloration (24%; n = 57), waterworn (2.6%; n = 6), and root etching (1.3%; n = 3). Solution pitting and sculpting indicate that some (if not all) of the remains had been affected by stomach acids. The blackened discoloration appears to be manganese staining. Manganese staining is common in fossils, particularly in limestone regions (Berner 1968, 1981), and is the result of decomposition of organic matter during early diagenesis (Berner 1981; Parker and Toots 1970). Despite being a fluvial deposit, the teeth are not waterworn, indicating little movement and a primary context for the remains.

The prairie-dog teeth are classified into four age categories based on the state of tooth wear: unworn (7.1%; n = 17), slightly worn (5.0%; n = 12), worn (83.2%; n = 198), and highly worn (4.6%; n = 11). Based on age, tooth, and level by unit, an MNI = 86 is established. This MNI number is distributed across the age categories as 13 young (unworn), 10 juvenile (slightly worn), 58 adult (worn), and 5 old (highly worn). This profile fits neither an attritional nor a catastrophic mortality pattern (Shipman 1981), although it is closer to a catastrophic mode. Adult prairie dogs are being targeted.

Coyote is a faunal element at the site (Lewis 1990), and all the small mammals recovered are preferred prey of coyotes (Davis 1974; Jones et al. 1983). These animals are part of a prairie-dog or pocket-gopher community, and these smaller communities serve as focal points for the larger short-grass faunal community. Cutbanks are a favored denning location for coyotes whose young are born April through June; dispersal of the young takes place in the fall (Jones et al. 1983). Prairie-dog young are born in March or April and come above ground five to six weeks later (Jones et al. 1983).

Based on available evidence, coyotes preying on prairie dogs is offered as an alternative scenario to Lewis's (1990:11) postulation of humans as the predator. The prairie-dog remains, having gone through a digestive system, are deposited on the sand bar in scats (represented by the lenses), covered in primary context, and not deposited or redeposited by water action. Coyote predation, based on the age data of the prairie dogs, would have occurred from late spring through fall.

The small-mammal fauna is characteristic of a short-grass prairie. The two pocket gophers generally are allopatric in their ranges, but a contact zone occurs in the county and along the Nueces River. Only a few areas are known in North America where two species of *Geomys* coexist (Williams 1982; Williams and Genoways 1981). This contact zone, then, appears to have a long antiquity.

The Petronila Creek locality dates to the glacial maximum during the late Wisconsinan (Porter 1983). Few specifics are known for this time period for the region, although in general, an equable, humid, maritime climate existed. Based on the data from this locality, the Southern Plains grasslands ecosystem extended beyond the modern physiographic boundaries down to the Gulf Coastal Plain. This interpretation is strengthened by the similar but undated fauna from Ingleside (Lundelius 1972). Regardless of whether or not pre-Clovis peoples were involved with the Petronila Creek locality, this locality, based on the small-mammal data, potentially is crucial to the understanding of the late Wisconsinan in South Texas, the glacial maximum period, the changing boundaries of the Southern Plains ecosystem, and the paleoclimate and paleoecology of the time. The critical needs in realizing that potential are the continuation of verifying the taxa represented and initiation of broader-based taphonomic analyses.

My sincere appreciation to C. R. Lewis for his willingness to let me analyze this material and for funding for trips to Corpus Christi and the Petronila Creek locality. This study is part of the ongoing regional research of the Lubbock Lake Landmark into the changing late Quaternary Southern Plains ecosystems and paleoclimates.

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Sangamon Local Faunas of Western North America John D. Pinsof

Recognition of Sangamon (125,000 to 75,000 yr B.P.) localities is inherently difficult. One of the foremost problems is that the Sangamon lies just beyond the range of radiocarbon dating, so assignment rests chiefly upon geologic evidence and/or the "character" of the fauna. Nine local faunas in western North America assigned to or strongly believed to be Sangamon have been identified and described. These include American Falls, Idaho (Pinsof 1992); Mesa de Maya, Colorado (Hager 1975); Silver Creek, Utah (Miller 1976); Newport Bay Mesa Locality #1066, California (Miller 1971); San Pedro, California (Miller 1971); Medicine Hat Fauna 7, Alberta (Harington 1978; Russell and Churcher 1972); Old Crow River (Locality 44), Yukon Territory (Harington 1978); Fort Qu'Appelle, Saskatchewan (Harington 1973, 1978); and the composite Riddell fauna, Saskatchewan (Skwara and Walker 1989; SkwaraWoolf 1980,1981; SkwaraWoolf and Millar 1981). The composite Riddell fauna includes fossil materials from the Riddell site and Riddell Member sand (SkwaraWoolf 1980, 1981), the Saskatoon site (Harington 1978; Lammers 1968), and the Duh site (Russell 1943), all of which are located in the Saskatoon area, Saskatchewan (see SkwaraWoolf 1981). This review does not include Sangamon fossils and localities from the middle and eastern United States and Canada, as discussions of these appear elsewhere.

Because of differences in local conditions, taphonomic histories, and the great distances separating Sangamon localities, it is difficult to formulate an encompassing view of Sangamon environments. Albeit preliminary, the emerging picture of Sangamon mammals suggests a mixture of large extinct herbivores such as *Glossotherium* (mylodont ground sloth), *Camelops* (camel), *Equus* (horse), *Bison* (buffalo), and *Mammuthus* (mammoth), with small to medium-sized extant taxa such as *Lepus* (jack rabbit), *Spermophilus* (ground squirrel), *Taxidea* (badger), *Erethizon* (porcupine), *Canis* (dog, coyote, or wolf), and *Ondatra* (muskrat). Of the 91 species tabulated from the Sangamon localities, 63 (70 percent) are extant. A preponderance of the extinct species are ground sloths, proboscideans, and the larger ungulates and carnivores. With few exceptions the extant fraction of the Sangamon fauna is similar in composition to the modern fauna of the same area.

The common environmental factor seen among the Sangamon localities is the prevalence of open grasslands. Most local faunas are dominated by presumed grazing taxa (see Akersten et al. 1988), although many supplemented their diet with browse on a seasonal or availability basis. Studies on extant herbivores (e.g., Martin 1982) suggest that a highly diverse group of grazing

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species could be supported in a grassland if both primary production and floral diversity were high. The near-cosmopolitan occurrences of *Camelops, Equus, Bison,* and *Mammuthus,* all major grazing taxa, during the Sangamon support the hypothesis that open habitat of some variety was the predominant environment in western North America. The occurrences of cursorial (or presumed cursorial) carnivores such as *Canis latrans* (coyote), *Canis dirus* (dire wolf), *Panthera leo atrox* (American lion), and *Felis concolor* (cougar), particularly at American Falls and Silver Creek, likewise suggest the presence of open areas. Marginal to the grasslands were woody, brushy, and riparian habitats, and, depending on the locality, a permanent water source.

Based upon the mammalian, lower-vertebrate, and invertebrate faunas (see primary sources for each locality), interglacial or at least warm equable conditions prevailed at nearly all localities, an interpretation in concordance with climatic conclusions derived from other mid-latitude fossil assemblages. The single exception is the Old Crow River locality, where certain vertebrate taxa (*Alopex lagopus* [arctic fox], *Spermophilus parryii* [arctic ground squirrel], *Lemmus sibiricus* [brown lemming], and *Lepus arcticus* [arctic hare]) show definite tundra affinities but otherwise indicate a climate "possibly as warm as at present" (Harington 1978:62). SkwaraWoolf and Millar (1981) noted that the geology of a Saskatchewan deposit containing a cranium of *Ovibos moschatus* (musk ox) suggested periglacial conditions, but they could not demonstrate stratigraphic equivalence to the Riddell fauna.

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A Snowshoe Hare, *Lepus americanus*, from the Lange/Ferguson Clovis Kill Site, Shannon County, South Dakota

J. D. Stewart and James E. Martin

The Lange/Ferguson site (39SH33), located in the White River Badlands of South Dakota, produced Clovis artifacts, at least two butchered mammoths, and associated vertebrate and invertebrate remains (Martin 1987; Hannus 1990).

Martin (1984, 1987) mentioned the distal end of a leporid femur (collected by Martin and Greenwald), South Dakota School of Mines (SDSM) 12289. Because of the preliminary nature of the survey and because specific identification of leporid postcranial remains is usually not attempted (Grayson 1977), the femur was identified only recently as that of a snowshoe hare. The specimen and a Clovis point were two of the stratigraphically highest-occurring items in the assemblage, found at about the level of a carbonaceous claystone (Martin, 1987:317), which was dated at $10,670 \pm 330$ yr B.P. (Teledyne Isotopes I-11, 710; White, 1982). A bone from the main deposit was dated at $10,730 \pm 530$ yr B.P. (Hannus, 1990; Teledyne Isotopes I-13, 104).

SDSM 12289 (Figure 1A, B) is the distal 2.9 cm of a right femur of *Lepus* americanus, the snowshoe hare. Its distal width is 13.8 mm. The method of measuring this parameter is illustrated in Figure 1C. Femoral distal width measurements for *L. californicus* (14.4–18.2 mm, n = 10) and *L. americanus* (12.7–14.9, n = 15) overlap somewhat, but the width of SDSM 12289 (13.8 mm) is outside of the range of the former. Sylvilagus aquaticus is larger than *L. americanus*, unlike other North American species of Sylvilagus. The observed range of the distal femoral width parameter in Sylvilagus aquaticus is 15.2–16.1

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Figure 1. Distal end of a right femur of Lepus americanus, SDSM 12289.

- A. Anterior view
- B. Posterior view
- C. Diagrammatic representation of how distal width is measured.

mm (n = 9); for S. floridanus it is 11.4–13.9 mm (n = 15); for other Sylvilagus species, the observed range is 9.3–11.75 (n = 12).

Qualitative differences between the femora of *Lepus americanus* and those of *Sylvilagus floridanus* include the following: (1) the medial ridge of the patellar groove of the femur of *S. floridanus* is markedly undercut; that on the femur of *L. americanus* may or may not be; (2) in posterior view, there is no distinct ridge ascending from the intercondyloid fossa in the femur of *S. floridanus*. In *L. americanus*, there is such a ridge, usually offset to the lateral side, creating a flat, depressed surface on the shaft above (proximal to) the medial condyle (Figure 1B).

SDSM 12289 is the first occurrence of *Lepus americanus* in South Dakota, but this taxon is known from five Wisconsinan sites in northern Kansas and Nebraska (Stewart 1984, 1987; Voorhies and Corner 1985). At two sites, Jewell County, Kansas, and Harlan County, Nebraska, the snowshoe hare is associated with spruce fossils (Wells and Stewart 1987). The snowshoe hare is a crepuscular and nocturnal inhabitant of both conifer and hardwood forests, and of thick stands of shrubs along watercourses (Zevloff and Collett 1988), a habitat that mirrors the conclusions of Martin (1987). *Picea* and Cyperacae were the most abundant pollen types (30% and 40%) in the sediments containing the bone bed, and the pollen profile has been interpreted as indicating open spruce woodland with open glades (Hannus 1990). Spruce also occurred concurrently 480 km to the northeast at Pickerel Lake, South Dakota (Watts and Bright 1966), and 340 km to the northeast at the Strouckel Locality at 12,220 \pm 150 yr B.P. (Beta 30,559; Martin and Klukas 1989).

The addition of *L. americanus* to the assemblage discussed by Martin (1987:328) alters slightly the areas of sympatry. Northeastern South Dakota is thus excluded from the area of sympatry, leaving only parts of eastern North Dakota. Based upon the presence of *L. americanus* in the Badlands at this time, we predict also a Black Hills habitation and persistence in this island refugium upon extirpation from the Badlands. Many smaller boreo-montane organisms continue today to occupy the Black Hills, including *Clethrionomys gapperi*, which also was recorded from the Lange/Ferguson locality, *Marmota flaviventris*,

Tamiasciurus hudsonicus, and *Microtus longicaudus*. All but the last taxon have been recorded in Wisconsinan sites farther south (Stewart, 1987; Voorhies and Corner, 1985).

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A Systematic Survey of *Smilodon fatalis* Skulls from Rancho La Brea

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A recent systematic survey of saber-toothed cat (*Smilodon fatalis*) skulls in the Hancock Collection from Rancho La Brea was undertaken during basic inventory of this collection. Catalogue information, as well as accessory specimen

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data, generated by this survey can be a valuable research tool. These data have been compiled in both a ledger catalogue and computerized database, and are now available to interested researchers.

There are 1,035 complete or nearly complete *Smilodon* skulls presently catalogued in the Hancock Collection, housed at the George C. Page Museum. Data appearing on each specimen may include catalogue number, excavation locality pit numbers 2 through 91, alphanumeric grid coordinates (x, y axis), depth in feet (z axis) and the date excavated. In many cases, excavation data (grid and depth) can be correlated with radiocarbon dates from specific stratigraphic horizons (Marcus and Berger 1984). The *Smilodon* skulls are arranged serially by excavation-locality number, then catalogue number.

During examination of each skull, catalogue information, specific features and attributes were recorded on custom-designed data sheets. Morphometric measurements following Merriam and Stock (1932) were not taken at this time owing to the large size of the collection.

Standard recorded information included catalogue number(s), excavation



Figure 1. Smilodon fatalis skull: The ledger entry for skull number LACMHC A3315. A, dorsal view; B, ventral view. Shaded regions indicate missing elements (the premaxillae, nasals, pterygoidal hamuli, supraoccipitals; a portion of the left jugal) and areas of abrasion or pit wear. After Merriam and Stock 1932.

locality pit data, physical condition (completeness), associated elements (dentaries, canine teeth, etc.), development (unfused/fused sutures), dentition and cranial-bone inventory, the presence of pathology, publications (figured and/or measured) and notes.

Dorsal and ventral diagrams (Figure 1) of each specimen were marked or shaded to indicate physical condition, the presence of abrasion or wear, missing cranial elements or the location of any damage received during excavation. The presence of structural anomalies, asymmetries and developmental abnormalities such as bony prominences and unusual tooth positions were also noted, as were restoration techniques used to reconstruct missing or damaged portions of skulls.

The dorsal/ventral diagrams are available for addition to the database as more sophisticated electronic data-capture and image-processing capabilities become available. All other ledger information was entered into a database designed with REFLEX v1.0 (Borland International, Inc.).

Information stored in this database is readily available for statistical analyses, and individual *Smilodon* skulls can be easily located. Using this database, investigators can electronically search for specimens from a specific excavation site, depth and/or grid coordinates, or locate skulls with certain osteologic/ dental pathologies or abnormalities.

Preliminary analysis of the computer database has revealed some interesting new information about aging in *Smilodon*. In other species, suture-fusion rates can be used to estimate approximate age of individual specimens. However, the *Smilodon* data reveal that pairs of cranial and facial sutures fuse in different combinations. For example, data from pit 67 show ten skulls with the four observed sutures completely fused; 25 skulls have one suture open (m/p); 35 skulls have o/p and m/p sutures* open; another 19 skulls have p/s and m/p sutures open; 21 skulls have only their b/b suture fused. This leads to a greater uncertainty in age determinations based solely on suture-fusion patterns.

Morphological variations in *Smilodon* include C- and S-shaped distortions in the symmetry of the sagittal plane occurring in 26.8% of the specimens. These data currently await correlation with observations of the symmetry of post-cranial material, particularly of cervical vertebrae.

Parietal pits, a newly identified phenomenon, are concave, crater-like indentations that are distributed asymmetrically over the posterior parietal and supraoccipital surfaces of a specimen, often spanning both bony elements at the lambdoidal suture. This phenomenon is found in 53% of the specimens from Rancho La Brea. Apparently restricted to adult specimens, these pits range from 0.2 cm to 2.3 cm in width and can be up to 2.0 cm deep. The largest pits are accompanied by significant midline distortion. Their bottoms and sides are smooth and do not reveal the interior, trabecular level of bone structure, indicating a slow rate of formation. Most parietal pits are not deep enough to completely penetrate bony surfaces; however, two specimens from pit 67 do

^{*} b/b = basioccipital/basisphenoid

m/p= maxilla/premaxilla

o/p = occipital/parietal

p/s = posterior sagittal

possess parietal pits that perforate the supraoccipital crest. Parietal pits have not been found in modern tiger, lion and hyena crania, although *Smilodon* skulls from the Talara, Peru, tar seeps also have this phenomenon.

Initial hypotheses attempted to relate the presence of parietal pits to asymmetries (or twists) in the sagittal plane. Only 15.6% of the collection share both these features, and thus a causal relationship between sagittal twists and parietal pits is unlikely. The relative absence of parietal pits in juvenile skulls may indicate a positive correlation with aging. Correlation of the presence of parietal pits with sexual dimorphism has not been ruled out.

Merriam and Stock (1932) ignored individual structural variation in both their illustrations and text, yet five of the *Smilodon* skulls selected for their nine plates have parietal pits and three have sagittal twists.

This study would not have been possible without the support and encouragement of the George C. Page Museum staff and the museum's Rancho La Brea Volunteer Program. P. Kersting electronically captured much of the data from the ledger catalogue, C. Shaw critically reviewed this manuscript and, with G. Jefferson, provided invaluable assistance and advice. K. Seymour of the Royal Ontario Museum helped arrange the author's inspection of the Talara specimens.

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