CURRENT RESEARCH IN THE PLEISTOCENE

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From the Editor

The Sinking of Beringia?

A number of archaeologists and some other writers recently have cast stale doubt upon the idea that humans migrated into America across the Bering Strait. Vine Deloria, of the University of Colorado in Boulder, rejects Beringia as a possible migration route because the concept is nothing more than a nefarious political tool to deprive American Indians of their ownership of this continent (1995:84): "The Bering Strait [Beringia?] exists and existed only in the minds of scientists" (1995:107).

Deloria is willing to consider "transoceanic migrations in boats," "migrations from other planets," and the independent creation of some peoples in an American Eden (1995:97), but the idea of a land bridge is apparently just too improbable for him to entertain seriously.

Dennis Stanford of the Smithsonian also appears ready to abandon Beringia, but for different reasons. He recently announced that "the old model that we read about in our textbooks is no longer valid" (McDonald 1998:A22). He is quoted in the *Columbus Dispatch* as claiming that there were possibly several waves of migration into the Americas across the Arctic, Pacific, and Atlantic oceans (Lore 1998:3A). Walter Neves, of the University of São Paulo, has been quoted as claiming peoples from the South Pacific reached the Americas before the Mongoloids (Borden 1998). The celebrated author Jean Auel, following a parade of might-have-beens and could-have-beens, concludes that such a transoceanic voyage "makes a better story" (1998:1675) than a long, tedious, overland trek across a dreary "frozen desert."

On a Smithsonian web page (http://www.nmnh.si.edu/arctic/html/dennis_stanford.html), Stanford notes similarities between the Old World Solutrean culture and Clovis technology and suggests that seafaring Solutrean folk paddled to America. Stanford thinks his idea is a startling, new, and "off the wall kind of theory." In fact, it was considered and rejected 35 years ago.

Emerson Greenman, in a couple of papers, explored the idea that the New World was peopled by Solutrean wayfarers (1960; 1963). He noted a large number of generally superficial similarities between various Old World Paleolithic cultures and even more various New World cultures. Nobody was persuaded. François Bordes offered the following thoughts on the Solutrean connection in particular: "The Solutrean is really quite different from the palaeo-indian complexes! The similarities arise from similarities of environment, from the fact that you cannot work flint in 36 different ways, and from a more or less equal level of development" (Bordes 1964:321). (See also the

article by Frederic Sellet in this volume, "The French Connection: Investigating a possible Clovis-Solutrean link.")

So far, no one has proposed a plausible alternative to the Bering Strait migration route. It provides a simple, elegant mechanism for getting people from there to here. The Old and New Worlds come closest here and, on a clear day, you can even see one from the other. The rise and fall of the land bridge and the waxing and waning of ice sheets are a part of the story, but they never presented insurmountable barriers to migration. It is, after all, possible to walk across the frozen waters of the Bering Strait during the winter. Moreover, any hominid who could live in Siberia could probably make a boat seaworthy enough to get across. On the other hand, there is no credible evidence for Paleolithic boats capable of sailing across vast expanses of the Pacific or Atlantic oceans. But who knows, if Clovis (or Solutrean) points are ever found on Greenland or Hawaii we may have to throw out those old textbooks after all.

The Beringia migration model is not racist dogma; it is a carefully reasoned and well-established scientific proposition. It may not be politically correct, but it's good science and, with all due respect to Jean Auel, a damn good story.

References Cited

Auel, J. M. 1998 Early Americans. *Science* 280:1674–1675.

Borden, K. 1998 Brazil Skull Intrigues Scientists. Associated Press, 21 May 1998.

Bordes, F. 1964 The Upper Paleolithic and the New World. *Current Anthropology* 5(4):321.

Deloria, V. 1995 *Red Earth, White Lies: Native Americans and the Myth of Scientific Fact.* Scribner, New York.

Greenman, E. F. 1960 The North Atlantic and Early Man in the New World. *Michigan Archaeologist* 6(2):19–39.

Greenman, E. F. 1963 The Upper Paleolithic and the New World. *Current Anthropology* 4(1):41–91.

Lore, D. 1998 Bering Strait May Not Have Been Only Route to Americas. Columbus (Ohio) Dispatch, 17 February 1998.

McDonald, K. A. 1998 New Evidence Challenges Traditional Model of How the New World Was Settled. *Chronicle of Higher Education* 44(21):A22–A23.

Archaeology

Paleoindian Archaeology at Holloman Air Force Base, New Mexico

Daniel S. Amick, Raymond P. Mauldin, and Martyn D. Tagg

During the past few years, archaeological contract work at Holloman Air Force Base (AFB) has produced new Paleoindian materials from the Tularosa Basin of south-central New Mexico. This paper reports our reanalysis of these collections conducted in August 1997. Holloman AFB contains a few contiguous land parcels (Main Base, North Main Base, and Tularosa Peak) about 13 km west of Alamogordo, and a separate parcel (Boles Wells) about 8 km south of Alamogordo. More than 7,000 hectares of these land holdings were recently surveyed for cultural resources inventory (O'Leary 1994a, 1994b; Sale et al. 1996a, 1996b).

At this writing, we have confirmed Paleoindian diagnostics at 11 of 361 archaeological sites on Holloman AFB. Most sites in this region are multicomponent, and Holocene occupational debris is usually mixed with these Paleoindian materials. One Plainview point is reported from Site HAR-095. Six sites contain Cody-complex points. Folsom is the best-represented Paleoindian component at Holloman with 6 sites producing 13 projectile points (11 Folsom, 2 Midland), 7 fluted preforms, and 16 channel flake fragments. Most of these Folsom diagnostics (92%, n = 33) are concentrated at three sites on the Main Base (HAR-166) and Boles Wells (HAR-074 and HAR-175) installations.

HAR-166 is situated on an ancient land surface lacking stratigraphy (Gile et al. 1981; Monger 1996). Repeated surface collections have produced 2 Cody point bases and several Folsom diagnostics including 4 Folsom points (2 bases, 2 corners, 1 distal), 1 Midland point base, and 3 medial channel flake fragments (Sale et al. 1996a, 1996b). Test excavations of 4 square m suggest 40–55 cm of aeolian deposit reworked by biological and pedological activity above the caliche hard pan (Sale et al. 1996b). Those excavations produced 256 lithic artifacts, predominantly small (<1 g), late-stage waste flakes made from toolstones similar to the surface Folsom diagnostics.

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There are two Paleoindian components at Boles Wells. Both are situated in alluvial fan deposits containing late-Pleistocene stratigraphy (Monger 1994, 1996). Two Folsom points, three preforms and nine channel flake fragments have already been reported from surface collections at HAR-074 (Amick et al. 1996; Mauldin and O'Leary 1994). Additional Paleoindian materials have recently been recovered at HAR-175 (Sale et al. 1996b), located 450 m south of HAR-074. Repeated surface collections at HAR-175 produced one Cody point base, four Folsom points (three bases, one miniature Folsom made on a channel flake), three Folsom preforms (one base, one corner, one distal), and four channel flake fragments (three medial, one lateral). In excavations of 8 square m to 60 cm depth, caliche hard pan was encountered. These excavations produced 145 lithics, mostly small, late-stage flaking debris.

Regionally available toolstones (Church et al. 1996) dominate the Holloman AFB assemblage of Folsom diagnostics with 56% (n = 20) Rancheria chert, 8% (n = 3) Hueco chert, and 11% (n = 4) miscellaneous chert/chalcedony. However, 25% (n = 9) are identified as nonlocal Edwards chert from 500 km east (Amick 1994, 1996, 1997). This tan variety of Edwards is superficially similar to Hueco Formation chert exploited by Paleoindian occupants at Padre Canyon on the southeastern edge of the Tularosa Basin (Mauldin and Leach 1997). Therefore, we remain confident but cautious in our identification of Edwards in the Tularosa Basin and have started investigations of the geochemical fingerprints of these toolstones.

The archaeological record from Holloman AFB contributes to the substantial evidence of Folsom and Cody occupations in the Tularosa Basin (Amick 1996, 1997). Folsom diagnostics at Boles Wells (four point bases, two point tips, six failed preforms, and thirteen channel flakes) suggest considerable rearmament activities at these localities on the valley margin (elevation 1,340 m AMSL). In contrast, Folsom diagnostics from the Main Base (six point bases, one point tip, one failed preform, and one channel flake) suggest more residential activities may have been conducted on the valley floor of the central Tularosa Basin (elevation 1,265 m AMSL). We believe that additional Paleoindian finds can be expected from repeated collections of this severely eroded landscape. For example, a recent noncollection survey at Fort Bliss Army Base in the southern Tularosa Basin recorded 14 Folsom points and preforms (Stuart 1997) from areas surveyed and collected 13 years previously (Amick 1991; Carmichael 1986).

Finally, artifact identifications resulting from our reanalysis suggest some local confusion in distinguishing Midland (unfluted Folsom) versus Cody point technology. Distinctive flaking patterns in basal treatment are the best diagnostics of Cody-complex points (Bradley and Stanford 1987), but stem maximum thickness provides a useful distinction, with Cody usually ranging between 4.0 and 6.0 mm while Midland (like Folsom) ranges between 3.0 and 4.6 mm (Amick 1995).

Original recovery of the artifacts reported in this paper was supported by the U.S. Department of Defense, Holloman Air Force Base, and the Fort Worth District of the U.S. Army Corps of Engineers. Our subsequent reanalysis was facilitated by permission of the Environmental Flight of Holloman Air Force Base.

References Cited

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

——— 1994 Edwards Chert Use by Folsom Hunters in New Mexico. *Current Research in the Pleistocene* 11:59–61.

——— 1995 Patterns of Technological Variation Among Folsom and Midland Projectile Points in the American Southwest. *Plains Anthropologist* 40:23–38.

——— 1996 Regional Patterns of Folsom Mobility and Land Use in the American Southwest. *World Archaeology* 27:411–426.

——— 1997 Folsom Patterns of Lithic Procurement and Occupation in the Tularosa Basin and Southern Jornada del Muerto. In *Proceedings of the 8th Jornada-Mogollon Conference*, edited by D. Carmichael, in press, University of Texas at El Paso.

Amick, D. S., R. P. Mauldin, and B. L. O'Leary 1996 The Boles Wells Folsom Locality in the Tularosa Basin, New Mexico. *Current Research in the Pleistocene* 13:1–3.

Bradley, B. A., and D. J. Stanford 1987 The Claypool Study. In *The Horner Site: The Type Site of the Cody Complex*, edited by G. Frison and L. Todd, pp. 405–434. Academic Press, New York.

Carmichael, D. L. 1986 *Archaeological Survey in the Southern Tularosa Basin of New Mexico.* Historic and Natural Resources Report No. 3. Environmental Management Office, Fort Bliss, Texas. Publications in Anthropology No. 10. Centennial Museum, University of Texas, El Paso.

Church, T., C. Caraveo, R. Jones, and J. Sirianni 1996 *Mountains and Basins: The Lithic Landscape of the Jornada Mogollon.* Archaeological Technical Report No. 8. Anthropological Research Center, University of Texas, El Paso.

Gile, L. H., J. W. Hawley, and R. B. Grossman 1981 *Soils and Geomorphology in the Basin and Range Area of Southern New Mexico.* Bureau of Mines and Mineral Resources Memoir No. 39. New Mexico Institute of Mining and Technology, Socorro.

Mauldin, R. P., and J. D. Leach 1997 The Padre Canyon Paleoindian Locality, Hueco Bolson, Texas. *Current Research in the Pleistocene* 14:55–57.

Mauldin, R. P., and B. L. O'Leary 1994 *HAR-074 (LA 104,267), The Boles Wells Paleoindian Site, Data Collection and Test Excavations, Holloman Air Force Base, Otero County, New Mexico.* HAFB Report No. 1994-021 (HSR 9349E). Prepared for Holloman Air Force Base, White Sands Missile Range Contract No. DAAD07-89-D-0050, Delivery Order No. 0062, prepared by Human Systems Research, Tularosa, New Mexico.

Monger, H. C. 1994 Geomorphic Setting of a Folsom Site on the Holloman Air Force Base. In *HAR-074 (LA 104,267), The Boles Wells Paleoindian Site, Data Collection and Test Excavations, Holloman Air Force Base, Otero County, New Mexico*, by R. Mauldin and B. O'Leary. HAFB Report No. 1994-021 (HSR 9349E). Prepared for Holloman Air Force Base, White Sands Missile Range Contract No. DAAD07-89-D-0050, Delivery Order No. 0062, by Human Systems Research, Tularosa, New Mexico.

——— 1996 Soil-Geomorphic Context of Paleoindian Sites and Paleoenvironmental Records on Holloman Air Force Base. In *North Main Base Cultural Resources Survey, Holloman Air Force Base, Otero County, New Mexico.* Vol. 1, edited by M. Sale et al., Appendix D. HAFB Report No. 1995-019. Prepared for U.S. Army Corps of Engineers, Fort Worth District. Prepared by Geo-Marine, Plano, Texas. Report of Investigations No. 108EP.

O'Leary, B. L. 1994a *Main Base and West Area Cultural Resource Survey, Holloman Air Force Base, Otero County, New Mexico.* HAFB Report No. 1994-006. Prepared for Holloman Air Force Base. Prepared by Human Systems Research, Tularosa, New Mexico. Report No. HSR 9349B.

——— 1994b *Boles Wells Cultural Resource Survey, Holloman Air Force Base, Otero County, New Mexico.* HAFB Report No. 1994-007. Prepared for Holloman Air Force Base. Prepared by Human Systems Research, Tularosa, New Mexico. Report No. HSR 9349D.

Sale, M., V. Gibbs, C. Browning, M. Ernst, C. Wende, and R. Giese 1996a *North Area, Tularosa Peak, and Boles Wells Cultural Resource Survey, Holloman Air Force Base, Otern County, New Mexico. Vol. 1.* HAFB Report No. 1995-004. Prepared for U.S. Army Corps of Engineers, Fort Worth District.

Prepared by Geo-Marine, Plano, Texas. Report of Investigations No. 105EP. Contract No. DACA63-93-D-0014, Delivery Order No. 0079.

Sale, M., V. Gibbs, M. Landreth, M. Ernst, B. McCarson, and R. Giese 1996b *North Main Base Cultural Resources Survey, Holloman Air Force Base, Otern County, New Mexico.* Vol. 1. HAFB Report No. 1995-019. Prepared for U.S. Army Corps of Engineers, Fort Worth District. Prepared by Geo-Marine, Plano, Texas. Report of Investigations No. 108EP. Contract No. DACA63-93-D-0014, Delivery Order No. 0182.

Stuart, T. 1997 *Evaluation of Prehistoric Archaeological Sites in Maneuver Areas 4D and 5E, Fort Bliss, Texas.* Archaeological Technical Report No. 9. Anthropological Research Center, University of Texas, El Paso.

Geographical Distribution of Hell Gap Projectile Points in Kansas and Oklahoma

Joseph E. Beaver

The Hell Gap projectile point type was first recognized as a distinct type as a result of excavations at the Hell Gap site in eastern Wyoming (Agogino 1961). The type is characterized by a contracting stem and round shoulders, but is otherwise similar to the Agate Basin type (Agogino 1961). The Hell Gap complex dates to ca. 10,000 to 9,500 yr B.P. (Irwin-Williams, et al. 1973; Frison 1991) and is known primarily from excavated sites in Wyoming and Colorado. Hell Gap points have been found elsewhere in and around the North American Plains (Agogino 1961; Mallouf 1990; Thurmond 1990).

The Hell Gap complex in Kansas and Oklahoma is known almost exclusively from surface finds. Other sources of data include the Walsh cache (a set of 15 large bifaces which may represent Hell Gap technology [Stanford 1984, 1997]), the Tim Adrian Site (a shallowly buried lithic workshop where a Hell Gap point was found on the surface [O'Brien 1984]), and the Jones-Miller Site (a bison kill/butchery site in Colorado but near the Kansas border [Stanford 1974, 1984]).

Figure 1 shows the distribution of Hell Gap projectile points in Kansas and Oklahoma (and a single point from southeastern Colorado) and raw material sources where known. The data were accumulated primarily from private collection documentation in the possession of Jack L. Hofman and also from published sources (Wyckoff 1984; Wyckoff and Taylor 1984; Thurmond 1990). Several of the included points are indeterminate between the Hell Gap and Agate Basin types.

The distribution of points tends toward the western areas of Kansas and Oklahoma, and may represent actual geographical range of the type. The effects of sampling and reporting must also be considered.

Raw material sources are an integral aspect of geographical distribution

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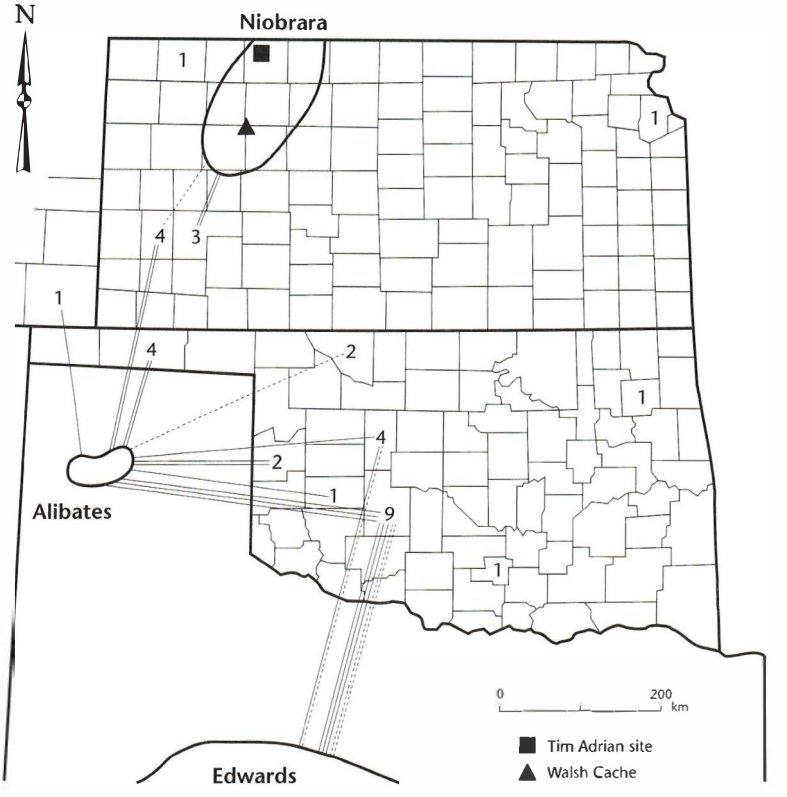

Figure 1. Distribution by county of Hell Gap points in Kansas, Oklahoma, and southeastern Colorado. Solid lines indicate probable source of raw material; dashed lines indicate tentative identification. Where the number of points is greater than the number of lines, the excess points are of local, unsourced, or unidentified raw materials.

studies. Of the 34 points in the sample, 24 have been attributed to well-known raw materials from Kansas and Texas, though the reliability of these attributions is difficult to assess. The most common lithic material in the sample is Alibates from the Texas panhandle, with Edwards Cherts from central Texas and Niobrara Jasper from northeast Kansas and southeast Nebraska being the other major sources identified.

Careful analysis of raw material distributions and other factors such as degree of reworking will be needed to further our understanding of land use and patterns of mobility and/or trade relating to Hell Gap in the region.

References Cited

Agogino, G. A. 1961 A New Point Type from Hell Gap Valley, Eastern Wyoming. *American Antiquity* 26:558–560.

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

Irwin-Williams, C., H. Irwin, G. A. Agogino, and C. V. Haynes 1973 Hell Gap: Paleo-Indian Occupation on the High Plains. *Plains Anthropologist* 18:40–53.

Mallouf, R. J. 1990 Hell Gap Points in the Southern Rolling Plains of Texas. *Current Research in the Pleistocene* 7:32–35.

O'Brien, P. J. 1984 The Tim Adrian Site (14NT604): A Hell Gap Quarry Site in Norton County, Kansas. *Plains Anthropologist* 29:41–55.

Stanford, D. J. 1974 Preliminary Report of the Excavation of the Jones-Miller Hell Gap Site, Yuma County, Colorado. *Southwestern Lore* 40(3-4):29–36.

——— 1984 The Jones Miller Site: A Study of Hell Gap Bison Procurement and Processing. *National Geographic Society Research Reports* 16:615–635.

——— 1997 The Walsh Cache. In *The Paleoindiens* [sic] *of the North American Midcontinent*, edited by A. Montet-White. Musée Départmental de Préhistoire de Solutré, Solutré, France.

Thurmond, J. P. 1990 *Late Paleoindian Utilization of the Dempsey Divide on the Southern Plains.* Plains Anthropologist Memoir 25.

Wyckoff, D. G. 1984 Traces to Oklahoma's Earliest Occupants, Part 1. *Oklahoma Anthropological Society Newsletter* 32(1):12–13.

Wyckoff, D. G., and L. Taylor 1984 Traces to Oklahoma's Earliest Occupants, Part 3. *Oklahoma Anthropological Society Newsletter* 32(4):7–9.

The Distribution of Cody Knives: A Distinctive Trait of the Cody Complex

Jeannette M. Blackmar

This study synthesizes the published accounts of Cody Knives, updating Agenbroad's (1978a) summary of 20 years ago. Cody Knives are a diagnostic characteristic of the Cody cultural complex dating between 9,700 and 8,000 yr B.P. The Horner site is the type site of the Cody Knife and along with Scottsbluff and Eden points comprise the key characteristics of the Cody-Complex (Wormington 1957, Frison and Todd 1987. The distinctive Cody Knife first appears in the archaeological record with the Alberta-Complex documented by Agenbroad (1978a, 1978b) at the Hudson-Meng site, where a Cody Knife was found associated with an Alberta-age bone bed. This supported conclusions drawn from Johnston's work in Alberta, Canada, that Cody Knives were related to the Alberta-Complex (Wormington and Forbis 1965).

Only asymmetrical Cody Knives defined by Wormington (1957:267, Fig. 70) as "knives with transverse blades that are usually shouldered on one side, but are sometimes characterized by a parallel sided base without an inset" are included in this study. This also includes knives that have been called Red River Knives (Johnson 1989) as well as Cody Knife Type I (Agenbroad 1978a; Bradley and Frison 1987; Dick and Mountain 1960; Irwin 1968; Irwin and

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Wormington 1970). Scottsbluff Type II points (Bradley and Frison 1987:223, Fig. 6.17; Irwin 1968; and Irwin and Wormington 1970) and Scottsbluff Type III (Wheat 1972) are not included although these more symmetrical artifacts may have functioned as knives based on technological studies (Irwin and Wormington 1970; and Bradley and Frison 1987).

Bradley and Stanford (1987) suggest that the Claypool site Cody Knives were produced by bifacial percussion followed by pressure thinning and marginal retouch. These are recognized as specialized tools that were hafted and associated with butchery activities (Ingbar and Frison 1987). Cody Knives are most commonly single-shouldered, but some have two shoulders as represented at the Horner site (Bradley and Frison 1987:221, Fig 6.15c, e) and elsewhere (Agenbroad 1978a; Frison 1976; and Johnson 1989). Agenbroad (1978b) also notes that 2-shouldered Cody Knives are less common.

This study documents a total of 69 Cody Knives. The distribution of Cody Knives recognized by Agenbroad (1978a) from Canada to New Mexico is extended to include Texas. These occur (see Figure 1) in Alberta (Wormington and Forbis 1965), Saskatchewan (Agenbroad 1978a; Linnamae et al 1988; and Wormington 1957), Manitoba (Pettipas 1970), North Dakota (Schneider 1982), Wyoming (Bradley and Frison 1987, Frison 1976,1978; Irwin-Williams et al 1973; and Satterthwaite 1957), Nebraska (Agenbroad 1978a), Colorado (Anderson 1990; Dick and Mountain 1960; Hustead 1965;

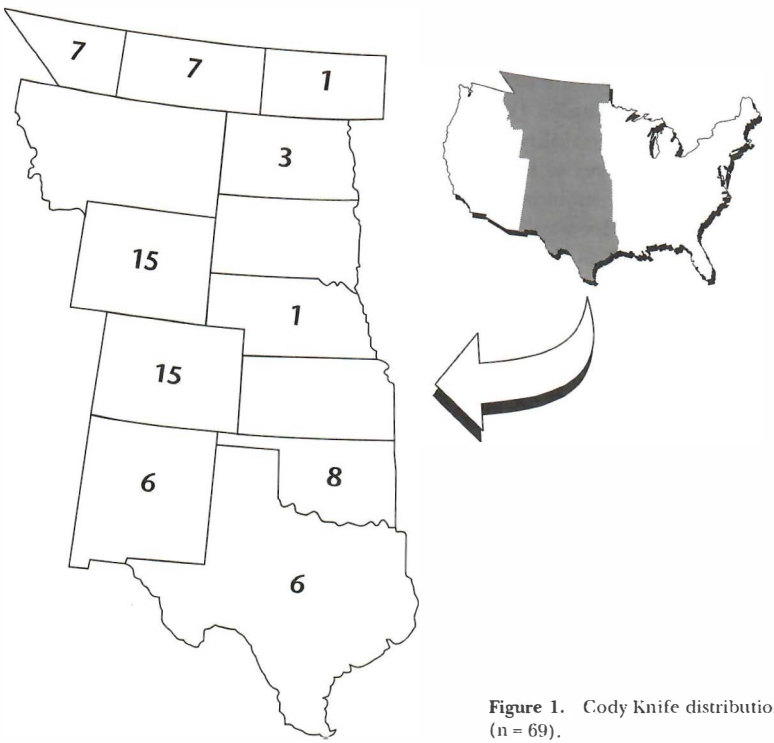

Figure 1. Cody Knife distribution (n = 69).

and McCartney 1983), Oklahoma (Blackmar and Hofman 1997; Johnson 1989; and White 1981), New Mexico (Stanford and Patten 1984), and Texas (Harrison and Killen 1978; and Johnson 1989). The highest frequencies of Cody Knives (n = 15) are documented from Wyoming and Colorado with the majority of points for each of these states represented at a single site, Horner (n = 8) in Wyoming, and Claypool (n = 11) in Colorado. In addition to the sites with Cody Knives listed by Agenbroad (1978a), this study recognizes Cody Knives from the Larson Cache, Medicine Lodge Creek, Finley, Lamb Spring, and Lake Theo. An Eden point described in the Lake Theo report (Harrison and Killen 1978) is included here as a Cody Knife. The majority of Cody Knives (n = 63) are surface finds or of uncertain provenience.

More than half (n = 29, 59%) of the 49 points with information on portion are complete or nearly complete. This is followed by base or base and blade fragments (n = 12, 24%), and tip and blade fragments (n = 3, 6%). The remaining five specimens are unassignable fragments. A total of 8 material types are represented from 34 specimens. Unidentified cherts (n = 11, 32%) are the most common material type, followed by Jasper (n = 5, 15%), Madero Chert (n = 4, 12%), Knife River Flint (n = 4, 12%), Quartz (n = 3, 9%), Alibates (n = 3, 9%), Chalcedony (n = 2, 6%) and one each of Hornfels and Felsite. The available mean dimensions are as follows: maximum length 4.60 cm (n = 12), stem length 1.58 cm (n = 20), maximum width 2.41 cm (n = 23), and thickness .53 cm (n = 22).

Although Paleoindian complexes are generally defined by projectile point styles, the entire tool assemblage needs to be incorporated when possible. This is especially true for the Cody Complex, which contains a distinctive knife that can define the complex (Wormington 1957). There still remain questions as to the role and variability of Cody Knives. Future study will assess the density ratio of Cody Knives to Eden/Scottsbluff points. For example, the Oklahoma Cody assemblage includes 96 artifacts of which only 8 (9%) are Cody Knives (Blackmar and Hofman 1997). This probably reflects different use contexts, curation, as well as function. It is crucial to have some standardization in reporting these knives. Minimally, this should include an accurate illustration of the specimen, dimensions, material type, and provenience.

I wish to thank Jack Hofman for his comments on previous versions of this paper.

References Cited

Agenbroad, L. D. 1978a Cody Knives and the Cody Complex in Plains Prehistory: A Reassessment. *Plains Anthropologist* 23:159–161.

——— 1978b *The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains*, University Press of America, Washington, D.C.

Anderson, H. V. 1990 The Anderson Collection. *Indian Artifact Magazine* 9(3):12–15.

Blackmar, J. M., and J. L. Hofman 1997 Cody-Complex Artifacts in Oklahoma. *Current Research in the Pleistocene* 14:9–11.

Bradley, B. A., and G. C. Frison 1987 Projectile Points and Specialized Bifaces from the Horner Site. In *The Horner Site, The Type Site of the Cody Cultural Complex* edited by G. C. Frison and L. C. Todd, pp. 199–231, Academic Press, Orlando.

Bradley, B. A., and D. J. Stanford 1987 The Claypool Study. In *The Horner Site, The Type Site of the Cody Cultural Complex*, edited by G. C. Frison and L. C. Todd, pp. 405–434, Academic Press, Orlando.

Dick, H. W., and B. Mountain 1960 The Claypool Site: A Cody Complex Site in Northeastern Colorado. *American Antiquity* 26(2): 223–235.

Frison, G. C. 1976 The Chronology of Paleo-Indian and Altithermal Cultures in the Bighorn Basin, Wyoming. In *Cultural Change and Continuity: Essays in Honor of James Bennett Griffin*, edited by C. E. Cleland. pp. 147–173 Academic Press, Orlando.

——— 1978 *Prehistoric Hunters of the High Plains.* Academic Press, Orlando.

Frison, G. C., and L. C. Todd 1987 *The Horner Site, The Type Site of the Cody Cultural Complex.* Academic Press, Orlando.

Harrison, B. R., and K. L. Killen 1978 *Lake Theo: A Stratified, Early Man Bison Butchering and Camp Site, Briscoe County, Texas, Archaeological Investigations Phase II.* Special Archaeological Report 1, Texas Parks and Wildlife Department.

Hustead, W. M. 1965 Early Occupation of the Colorado Front Range. *American Antiquity* 30(4):494–498.

Ingbar, E., and G. Frison 1987 The Larson Cache. In *The Horner Site, The Type Site of the Cody Cultural Complex*, edited by G. C. Frison and L. C. Todd, pp. 461–473, Academic Press, Orlando.

Irwin, H. T. 1968 *The Itama: Late Pleistocene Inhabitants of the Plains of the United States and Canada and the American Southwest.* Unpublished Ph.D. dissertation, Department of Anthropology, Harvard University, Cambridge, Massachusetts.

Irwin, H. T., and H. M. Wormington 1970 Paleo-Indian Tool Types in the Great Plains. *American Antiquity* 35:24–34.

Irwin-Williams, C., H. Irwin, G. Agogino, and C. V. Haynes 1973 Hell-Gap: Paleo-Indian Occupation on the High Plains. *Plains Anthropologist* 18:40–53.

Johnson, L. 1989 *Great Plains Interlopers in the Eastern Woodlands during Late Paleoindian Times.* Office of the State Archaeologist Report 36, Texas Historical Commission.

Linnamae, U., E. G. Walker, and D. Kelly 1988 A Summary of the Archaeology of the Saskatoon Area. In *Out of the Past: Sites, Digs, and Artifacts in the Saskatchewan Area*, edited by U. Linnamae and T. Jones, pp. 155–171, Midwest Litho Inc., Saskatoon.

McCartney, P. H. 1983 *An Archaeological Analysis of Bison Remains from the Cody Paleo-Indian Site of Lamb Spring, Colorado.* Unpublished Master's Thesis, University of Arizona.

Pettipas, L. 1970 Early Man in Manitoba. In *Ten Thousand Years, Archaeology in Manitoba*, edited by, W. M. Hlady, pp. 5–28, Manitoba Archaeology Society.

Satterthwaite, L. 1957 Stone Artifacts at and Near the Finley Site near Eden, Wyoming. *Museum Monographs* No. 4. Philadelphia: University Museum, University of Pennsylvania.

Schneider, F. E. 1982 A Preliminary Investigation of Paleo-Indian Cultures in North Dakota. *Manitoba Archaeology Quarterly* 6(4):16–42.

Stanford, D. J., and R. Patten 1984 R-6.A Preliminary Report of a Cody Site in North-Central New Mexico, Papers of the Philmont Conference on the Archaeology of Northeastern New Mexico. *New Mexico Archaeological Council Proceedings* 6(1):189–199.

Wheat, J. B. 1972 *The Olsen-Chubbuck Site: A Paleoindian Bison Kill.* Society for American Archaeology Memoir 25.

White, R. W. 1981 A Cody Knife Found in the Oklahoma Panhandle. *Oklahoma Anthropological Society Newsletter* 29(2):8–9.

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

Wormington, H. M., and R. G. Forbis 1965 *An Introduction to the Archaeology of Alberta, Canada.* Proceedings of the Denver Museum of Natural History, No. 11.

Paiján and Fishtail Points from Quebrada Santa Maria, North Coast of Peru

Claude Chauchat and Jesus Briceño

Quebrada Santa Maria is a canyon in the northern Peruvian coastal desert, about 7° 30′ south. We have intensively surveyed this permanently dry valley for more than 10 years in search of open-air sites of the local Paleoindian or early-Archaic "Paiján" culture within a general survey of the larger Cupisnique region, whose results are now being published (Chauchat et al. in press).

The surrounding outcrops are mainly of granite with occasional inclusions of crystalline or milky quartz that have been quarried by prehistoric people. Volcanic tuff and quartzite are found in lesser amounts in all the archaeological sites of the Quebrada.

The numerous early sites are either superficial middens with landsnails (*Scutalus* sp.) and flaked lithic tools, or chipping floors with numerous biface thinning flakes and some failed or broken preforms and projectile points on the surface. One of them, site No. 130, is on a remnant of alluvial terrace near the upper end of the canyon and is constituted of 28 such units. Fishtail projectile points, some of them broken during fabrication, were found on the surface of three of these units. No other site in Quebrada Santa Maria yielded any fishtail projectile points, although occurrence of discarded fragments of Paiján points is common in the numerous other lithic sites throughout the region.

Systematic recording and surface collection of the material in unit No. 1, followed by partial excavation, yielded several thousand flakes, mostly of quartz and rock crystal, with clear features of soft-hammer knapping. Fishtail points as well as Paiján point fragments were recovered in situ during the excavation. A small late-precolumbian canal crosses the midden and has overflowed at some point, causing a small gully to be formed and material therein to be displaced. It can hardly explain the mixing of fishtail and Paiján points. The three fishtail points found in this unit are not fluted, but this may be due to the small number of pieces: It is well known in South America that fluting is present only on some fishtail points. One of the Paiján points, of quartzite of unknown origin, was on the surface and could be intrusive, but the others were found inside the deposit and are made of local quartz whose source has been found about 300 m to the southeast. Compared with the numerous and well-known specimens from Pampa de los Fósiles on the coastal plain, stems have the characteristic Paiján shape but the body is wider and shorter. The typical needle-like elongated tip of the Paiján point is here scarcely outlined by two very short concave edges.

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Despite the co-occurence of two very different point types, there is no evidence whatsoever that two chronologically separated occupations did occur. There is no evidence of stratigraphic succession or mixing; the midden has only an area of 120 m^2 and there is no visible physical constraint that would oblige a later human group to camp exactly at the same place. We can only conclude that, at this place, fishtail points and Paiján points were made during the same short (seasonal?) occupation by one or a small number of knappers.

Fishtail projectile point finds are very scarce in Peru. Ossa (1976) described an isolated find from the Paiján site of La Cumbre, some 50 km south. This find was interpreted as the collection of an earlier projectile point on the part of Paiján people. A narrow stemmed unfluted fishtail point was found east of Piura (400 km north) without any context or precise provenience (Chauchat and Zevallos Quiñones 1980). In the Ayacucho region, central Peru, MacNeish, Nelken-Terner and Garcia Cook (1970) reported that the Huanta complex, defined from the lower layers in Jaywamachay cave, had several fishtail points. However, in the final publication (MacNeish et al. 1980), the Huanta complex was lumped into the subsequent Puente complex. Four photographically illustrated specimens of "Fell's cave fluted points" are definitely not fishtail points. Therefore, the lithic material from Jaywamachay lower layers, whatever its name, must not be considered a serious candidate for a fishtail point complex.

The Quebrada Santa Maria evidence indicates that the fishtail point complex, first known from Fell's Cave in Patagonia and El Inga in Ecuador and now from many sites throughout Middle and South America, is probably the origin of Paiján culture, within this same region of northern Peru. Co-occurence of both types without any intermediate form points to conscious experimentation with a new projectile point shape for a better functional adaptation (fishing on the seashore). However, recent finds of Paiján points in the higher parts of the region, near an altitude of 2,000 m and about 100 km from the sea, show that the function of the Paiján point as a fishing implement was certainly not exclusive.

References Cited

Chauchat, C., Z. Quioñnes, J. 1980 Punta en Cola de Pescado Procedente de la Costa Norte del Perú. *Ñawpa-Pacha* 17 (1979):143–146, lam. XXVIII, Berkeley.

Chauchat, C. et al. in press *Sitios arqueol—gicos de la zona de Cupisnique y margen derecha del valle de Chicama* (con la participación de C. Galvez M., J. Briceño R. y S. Uceda C.). Patrimonio Arqueol—gico, Zona Norte 4, Instituto Departamental de Cultura - La Libertad; 165 pp., 64 fig.; Trujillo, Peru.

MacNeish, R. S., A. Nelken-Terner, and A. G. Cook 1970 *Second annual report of the Ayacucho Archaeological-Botanical Project.* 46 pp. Phillips Academy, Andover, Massachusetts, U.S.A.

MacNeish, R. S., R. K. Vierra, A. Nelken-Terner, and C. J. Phagan 1980 *Prehistory of the Ayacucho Basin, Peru. Vol.3: non ceramic artifacts.* 344 pp. The University of Michigan Press, Ann Arbor.

Ossa, P. 1976 A Fluted "Fishtail" Projectile Point from La Cumbre, Moche Valley, Peru. *Ñawpa-Pacha 13* (1975):97–98, plate XXXVII, Berkeley.

An Early Stemmed Point Cache from the Lower Salmon River Canyon of West-Central Idaho

Loren G. Davis and David A. Sisson

In 1996, the University of Alberta and the Bureau of Land Management (BLM) developed a cooperative research venture to evaluate the archaeological record of a portion of the Lower Salmon River Canyon of west-central Idaho. This research was designed to address a number of issues ranging from clarifying the local cultural-historical record, establishing a geological framework of paleoenvironmental condition and change, to investigating the nature of cultural adaptation in a dynamic alluvial context.

The previous lack of reliable data in this virtually unexplored area made archaeological site evaluations difficult for federal land-managing agencies like the BLM. Information generated from this valuable partnership not only provides scientific insights but forms the basis for long-term archaeological site management. This cooperative partnership has encouraged the development of scientific research in federal cultural resource management, which in turn enables the BLM to manage archaeological sites more effectively, and creates important public interpretive information.

Geoarchaeological investigation in 1996 and 1997 provided the data necessary to establish a geologic framework of past environments, landscapes and climates. Thus far, work with local sediment, pedologic and stable isotope geochemical records has provided the first glimpses of late-Quaternary Lower Salmon River Canyon paleoecology. This geologic record will be integrated with data recovered from archaeological excavations at several sites to build a more comprehensive perspective of prehistoric human occupation in the canyon.

Archaeological field research conducted in 1997 investigated five sites and included the placement of a single test pit at the Cooper's Ferry site (10IH73), originally reported on by Butler (1962, 1969). Our intentions were to recover datable materials from previously known deposits at 10IH73 that contained early cultural material (Butler 1969), to better characterize the stratigraphy of the site, and to investigate the spatial distribution of artifacts in early assemblages in order to help elucidate the functional nature of cultural occupations.

A circular pit measuring c. 80 cm in diameter and c. 120 cm deep was discovered in the lower deposits of 10IH73. Excavation of the pit fill revealed a cache of artifacts, including a large scraper and four stemmed points, similar to Lind Coulee styles originally reported by Daugherty (1956). Charcoal and bone recovered from the associated pit fill were submitted for AMS dating, returning dates of 11,370 ± 70 yr B.P. (Beta-114949) and 12,020 ± 170 yr B.P. (Beta-114806), respectively. Deposits positioned higher in the stratigraphic column of 10IH73 contained a variety of lithic tools, including stemmed

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points and fragments thereof, similar to specimens described by H.S. Rice (1965), D.G. Rice (1972), and Ames et al. (1981), relating to the Windust phase (Leonhardy and Rice 1970). These Windust-like points were positioned below and immediately above wood charcoal with AMS dates of 8,410 ± 70 yr B.P. (Beta-114951) and 8,430 ± 70 yr B.P. (Beta-114952). Thus, it appears that cultural occupation dating to a late-Pleistocene to early-Holocene time scale is present at the Cooper's Ferry site.

Caches of finely made fluted projectile points, bifaces, and cylindrical rods of bone and ivory have been reported from several sites in western North America, whereas early stemmed point caches are not nearly as well known. Recently, Meatte (1998) suggested that two basic categories of Clovis caches may have existed in western North America, the first being associated with burials, which were not intended to be recovered, and the second being equipment caches, intended to be recovered for future use. The discovery of the four stemmed points and a scraper in a clearly defined pit feature at 10IH73 shows that early caching behaviors were not limited to fluted point-bearing cultures. Because of its lack of association with human remains or ochre, which has been suggested to possibly represent a proxy for burials or ritualistic behavior in the absence of skeletal material (Meatte 1998), the Cooper's Ferry cache may represent the storage of equipment for future use, which was never recovered.

The discovery of the Cooper's Ferry cache is intriguing, particularly in light of its temporal context. The apparent contemporaneity of stemmed points and other unfluted points with Clovis-age fluted sites, particularly as seen at the Mill Iron site (Frison 1996) and Smith Creek Cave (Bryan 1979), has led some to suggest that fluted points were not the first technological development in North America, as previously thought. Bryan (1997:1063) has stated that "the probability that people made projectile points using other technological traditions at the same time as Clovis peoples should no longer be resisted."

Future work as part of the larger University of Alberta/BLM Lower Salmon River Canyon Archaeological Project will seek to clarify the nature of early adaptation seen at Cooper's Ferry through the consideration of paleoenvironmental conditions and issues of functionality in cultural behaviors. It is expected that this work will shed new light on the timing and nature of early human settlement in North America and will help to define the unique nature of early prehistory in the Far West.

References Cited

Ames, K. M., J. P. Green, and M. Pfoertner 1981 *Hatwai (10NP143): Interim Report.* Archeological Reports No. 9, Boise State University. Boise, Idaho.

Bryan, A. L. 1979 Smith Creek Cave In *The Archaeology of Smith Creek Canyon*, edited by D. R. Tuohy and D. L. Randall. Anthropological Papers, Nevada State Museum 17, pp. 163–251, Carson City.

——— 1997 The Mill Iron Site, book review. *Journal of Archaeological Science* 24(11):1062–1063.

Butler, B. R. 1962 *Contributions to the Prehistory of the Columbia Plateau: A Report on Excavations in the Palouse and Craig Mountain Sections.* Occasional papers of the Idaho State College Museum, No. 9. Pocatello.

——— 1969 The Earlier Cultural Remains at Cooper's Ferry. *Tebiwa* 12(2):35–50.

Daugherty, R. 1956 Archaeology of the Lind Coulee Site, Washington. *Proceedings of the American Philosophical Society*, 100(3):223–278.

Frison, G. C. (editor) 1996 *The Mill Iron Site*. University of New Mexico Press, Albuquerque.

Leonhardy, F. C., and D. G. Rice 1970 A Proposed Cultural Typology for the Lower Snake River Region, Southeastern Washington. *Northwest Anthropological Research Notes* 4(1):1–29.

Meatte, D. 1998 A Closer Look at Clovis Burials and Clovis Caches. Paper presented at the 63rd Annual Society for American Archaeology conference, Seattle.

Rice, D. G. 1972 The Windust Phase in Lower Snake River Region Prehistory. Unpublished Ph.D. dissertation. Washington State University, Department of Anthropology, Pullman.

Rice, H. S. 1965 The Cultural Sequence at Windust Caves. Unpublished M.A. thesis, Washington State University, Department of Anthropology, Pullman.

Pit Features at the East Wenatchee Clovis Site and Elsewhere

Richard Michael Gramly

Mierendorf (1997:57–60) has expressed doubts about the presence of two pits at the East Wenatchee site, Douglas County, Washington, including the one containing the remarkable Richey Clovis Cache of fluted points, unifaces, prismatic blades, other bifaces, and bi-beveled bone rods. Part of his argument against their existence is that none of the eminent Paleoindian researchers who were present during the 1988 test excavations by Washington State University recognized them. The question about the existence of a pit, however, was often asked during the April 1988 fieldwork. Also, a handout prepared by Peter Mehringer, principal investigator during the 1988 work, and distributed to visitors and participants specifically addresses the possibility of a pit (Mehringer 1988).

We should not be surprised if Feature 1, the pit containing the Richey Clovis Cache, went unnoticed as hindsight tells us: 1) the 1987 digging by orchard workers had obliterated part of its northern margin; and 2) the 1-m-square test unit excavated by WSU lay completely within the feature and did not cut across its southern, western and eastern margins. It was happenstance that the WSU test-pitting failed to cross a pit boundary. It should also be noted that excavators, including graduate students Matthew Root and James Gallison who did most of the fieldwork, had to cope with a constant barrage of questions from reporters and the public. The incessant requests for "photo opportunities" hindered excavators from making observations. Too, the small size of the excavation units (1-m squares) was a nuisance as there was no room to move around among the spectacular artifacts that lay in situ. I had many opportunities to study the walls of the WSU test units as seen from ground surface, but

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confess to have overlooked the small remnant of the ancient pit "wall" that lay in the northeastern corner of one of the test pits.

I only noticed the remnant midway thorough the 1990 excavation after we had removed artifacts and had some "working room." This discovery was welcome and reassuring, as there were many precedents in the annals of Paleoamerican site investigations—especially east of the Mississippi River (cf. Deller and Ellis 1984; Gramly 1982, 1985, 1988; MacDonald 1968; Storck 1988). Such discoveries continue to be made (e.g., Gramly 1998). The pit wall, which was most clearly seen when moist, sloped inward. The soil into which the pit had been dug was slightly stiffer and paler in color than the fill itself. The contact between the looser fill and the undisturbed sediments was easily followed with a springy bamboo wand. Our supposition that a pit had been found was vindicated by the discovery of flaked tools in the fill. One large specimen, in particular, lay directly upon the pit "floor."

These finds were captured on video tape as a camera was operated throughout the excavation courtesy of John E. Gahringer, M.D., a resident of East Wenatchee. Masters of these tapes are owned by the author and Dr. Gahringer.

The recognition of pits is one of the many challenges that confront excavators of Paleoamerican encampments. Hearth pits are perhaps most easily discerned, for their fill is usually peppered with small "retouch" flakes, minute bits of whitish calcined animal bone, and more rarely small pieces of wood charcoal. On the periphery of hearths one also expects to unearth many flaked-stone tools where they were discarded anciently. Cache pits, on the other hand, may be nearly barren of artifacts except for a piece or two along the walls or resting on the floor. These isolated specimens tend to be large and seemingly still serviceable; debitage is seldom seen. Since cache (storage) pits have few artifacts to help delineate them, the artful excavator must pay extremely close attention to relative compaction of soils. It is a tiring, stressful exercise—peace and quiet are essential.

Having learned a lesson in crowd management at the 1988 WSU test excavations of the East Wenatchee site, during the 1990 fieldwork we reserved the morning hours for digging and devoted afternoons to visitors. Thanks to this strict scheduling and daily quiet periods, the boundaries of Feature 1 containing the Richey Clovis Cache did not go undetected.

Feature 2, another suspected cache pit, caught us by surprise. The mysterious presence of two large flaked tools at a depth where no artifacts were expected caused us to scrutinize our trench walls in daylight and under artificial light, to tease soils away from the walls with wands and feathers seeking contrasts in pit fill and surrounding matrix, to wet them looking for color contrasts. All this work was in vain; therefore, we turned to soil sampling. Scores of samples were passed through graduated sieves and the results plotted. We sought aberrations in particle size across pit boundaries, and some significant values were obtained. A graph of some sampling results was presented in Gramly (1992). If readers, like Mierendorf, are not satisfied with this presentation, particle-size data may be obtained from any of several repositories of the Wenatchee excavation records.

The Wenatchee site explorations, which at times assumed aspects of both a

carnival and political fund-raiser, were small-scale and preliminary. In 1990, we were unable to accomplish all our goals due to the conflicting desires of two Indian nations, property owners, professional archaeologists, state and local governments, amateur archaeologists, and myself. If doubts persist about what was learned, readers may take comfort in the fact that excavations stand to be renewed in 2008. Any working hypothesis about what still lies in the ground at SUMAC Orchards must include the concept of caching in pits at a habitation site. Pit-digging was widely performed during the Clovis phase of the Fluted Point Tradition just as it was in some Old World regions during the upper Paleolithic. We should not expect the East Wenatchee site to be qualitatively different from any other encampment of its antiquity.

References Cited

Deller, D. B., and C. J. Ellis 1984 Crowfield: A Preliminary Report on a Probable Palaeo-indian Cremation in Southwestern Ontario. *Archaeology of Eastern North America* 12:41–71.

Gramly, R. M. 1982 The Vail Site: A Palaeo-indian Encampment in Maine. *Bulletin of the Buffalo Society of Natural Sciences* 30. Buffalo, New York.

——— 1985 Recherches Archeologiques au Site Paleoindien De Vail, Dans le Nord-ouest du Maine, 1980–1983. *Recherches Amerindiennes au Quebec* 15(1-2):57–118.

——— 1988 *The Adkins Site: A Palaeo-indian Habitation and Associated Stone Structure.* Persimmon Press, Buffalo, New York.

——— 1998 *The Sugarloaf Site: Palaeo-Americans on the Connecticut River.* Persimmon Press, Buffalo, New York.

MacDonald, G. F. 1968 Debert: A Palaeo-indian Site in Central Nova Scotia. *National Museum of Canada Anthropology Papers* 16. Ottawa.

Mehringer, P. J. 1988 Richey-Roberts Clovis Cache Excavations, or Apples and Archaeology in April. Ms. on file with author (Department of Anthropology, Washington State University), 3 pp.

Mierendorf, R. R. 1997 Comments on the East Wenatchee Clovis Site (45do482), Washington State, as reported by Richard M. Gramly. *Current Research in the Pleistocene* 14:57–60.

Storck, P. L. 1988 Recent Excavations at the Udora Site: A Gainey/Clovis Occupation in Southern Ontario. *Current Research in the Pleistocene* 5:23–24.

Probable Association of Paleoindian Artifacts and Mastodon Remains from Sloth Hole, Aucilla River, North Florida

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Sloth Hole (8JE121) is an inundated Paleoindian site located in a sinkhole deposit in the lower Aucilla River channel. This site is well known for the density of ivory artifacts that have been collected here by river divers since 1960. The

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single complete ivory foreshaft recovered, with an artistic geometric pattern, has been reported (Haynes 1982, Webb et al., 1990). Forty-seven ivory foreshaft fragments from this site are curated in the research collections of the Florida Museum of Natural History. In addition, Clovis, Simpson, and Suwannee projectile points have been recovered from exposed surfaces over the years.

In 1994 the Aucilla River Prehistory Project (ARPP), of the Florida Museum of Natural History, initiated survey work seeking to confirm the presence of Paleoindian artifacts and Pleistocene megafauna and locate intact stratigraphic sequences in the bottom of the river channel at Sloth Hole.

In the center of the river channel we located a U-shaped depression, 11 m across, in the bedrock limestone. The top of the limestone wall lies 4 m below the water surface. At a water depth of 8.5 m we contacted compact peaty sediments which slope downstream (south) to 10 m below the water surface.

This depression had as much as 2 m of loose leaves (stratum 1) covering 10 alternating layers of semicompacted peats or leaves and cross-bedded sands. This sequence lay atop a solid red organic clay (stratum 12) that contained well-preserved wood radiocarbon dated to >41,980 yr B.P. (Beta 83379). Stratum 10 was a deteriorating sapropel that returned an AMS date of 4470 ± 60 yr B.P. (Beta #93652) on a native grape seed (*Vitus* sp.), giving a minimum date for the deeper, more consolidated sediments.

The 20-cm stratum 11 contained 73 alternating microstratigraphic layers of white sand and fine gray clay. In the lower portion of this finely stratified unit we discovered a juvenile mastodon (*Mammut americanum*) fibula with two parallel "cut marks" 4.4 and 4.0 cm long, and also a 12.2-cm bifacial preform cutting tool and a 1.82-kg hammerstone with five battered surfaces (Hemmings 1997). These lithics were 5 and 14 cm away from the fibula, respectively, in the same stratigraphic layer. These data indicate a probable mastodon butchery site.

Remains of a late-Paleoindian/early-Archaic Bolen-age woodworking assemblage are present in surface collections across the site. ARPP researchers have recovered seven Aucilla adzes from Sloth Hole. Gerrell et al. (1988) reported data on 47 Aucilla adzes located across the state of Florida, mainly in private collections. Only one specimen has been dated, this from Page/Ladson (8JE591), another inundated Paleoindian and Early Archaic site in the Aucilla. It was associated with charcoal 9,450 ± 100 yr B.P. (Beta 15089) (Gerrell et al., 1988).

Continuing research at Sloth Hole will include dating of stratum 11 sands, microscopic examination of the "cut" fibula and other possibly butchered mastodon bones and replication of Aucilla Adzes to be used in actualistic usewear studies.

This research is sponsored by The Florida Department of State's Bureau of Historic Preservation whose assistance is gratefully acknowledged.

References Cited

Gerrel, P., J. Scarry, and J. Dunbar 1991 Analysis of Early Archaic Unifacial Adzes from North Florida. *The Florida Anthropologist* 44:3–16.

Haynes, C. V. 1982 Were Clovis Progenitors in Beringia? In *Paleoecology of Beringia*, edited by D. Hopkins, J. Matthews, Jr., C. Schweger, and S. Young, pp 383–298. Academic Press, New York.

Hemmings, C. A. 1997 Sloth Hole Site Update. *Aucilla River Times* 10:11, 35.

Webb, S. D., J. Dunbar, and B. I. Waller 1990 Ecological Implications of Ivory Foreshafts From Underwater Sites in Florida. Sixth International Conference For Archaeozoology, proceedings p.121. Smithsonian Institution. Washington, D.C.

An Inventory of Wisconsin Paleoindian Projectile Points at the Milwaukee Public Museum

Matthew Glenn Hill, Daniel S. Amick, and Thomas J. Loebel

This paper summarizes preliminary results from our analysis of Paleoindian projectile points curated at the Milwaukee Public Museum (MPM) conducted in January 1998. This work represents one component of an ongoing systematic analysis of regional variation in Paleoindian land-use behavior in Wisconsin (Hill 1994) and northern Illinois. Our investigation is also focused on defining strategies of lithic raw material procurement, tool production, use and breakage. Ultimately this work may provide an understanding of the dynamics in Paleoindian settlement-subsistence strategies and technological organization in the western Great Lakes region.

At the MPM there are 100 Paleoindian points from 27 counties in Wisconsin (Table 1). All are surface finds. Several fluted specimens in this sample have been reported previously (Ritzenthaler and Scholz 1951; Stoltman and Workman 1969). Overall point morphology and discrete technological attributes provide the basis of our typological designations. We identified 19 Clovis, 1 Midland, 9 Plainview, 42 Agate Basin, 6 Hell Gap, and 17 Cody-complex points. One preform broken during fluting is included in the Clovis group. Five specimens referred to as non-fluted lanceolate (following Storck 1997:64-65) may represent a fluted point variant. One mid-section from Jefferson County is untyped. The Cody assemblage contains 8 Scottsbluffs, 7 eared Scottsbluffs, 1 Eden point, and 1 Cody knife.

Most specimens are manufactured from Hixton silicified sandstone (Porter 1961), which outcrops at the Silver Mound quarries in Jackson County, Wisconsin, or from mottled whitish gray chert (Table 1). The latter is probably Prairie du Chien chert (PDC) that is available throughout much of southern Wisconsin and adjacent portions of Minnesota, Iowa, and Illinois (Morrow

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Table 1. Summary of Wisconsin Paleoindian projectile points by county and toolstone in the Milwaukee Public Museum collections.

Wisconsin County	Clovis	non-fluted lanceolate	Midland	Plainview	Agate Basin	Hell Gap	Cody	untyped
Calumet	-	1	-	-	4	-	-	-
Crawford	1	1	-	1	3	-	-	-
Dane	1	1	-	1	3	-	-	-
Dodge	4	-	1	-	3	-	4	-
Fond du	1	-	-	-	-	-	-	-
Grant	-	-	-	-	1	-	-	-
Green	-	-	-	-	-	-	1	-
Green	-	-	-	2	6	-	1	-
Jefferson	5	-	-	-	6	2	-	1
Kenosha	-	-	-	-	-	-	1	-
La Crosse	-	1	-	-	-	-	1	-
Langlade	-	-	-	1	-	-	-	-
Manitowoc	2	-	-	-	1	1	-	-
Marquette	-	-	-	1	2	-	-	-
Milwaukee	-	-	-	-	2	-	2	-
Monroe	1	1	-	2	-	-	-	-
Portage	-	-	-	1	-	-	-	-
Racine	1	-	-	-	-	-	1	-
Richland	1	-	-	-	-	-	-	-
Sauk	2	-	-	-	3	-	-	-
Shawano	-	-	-	-	1	-	2	-
Sheboygan	-	1	-	-	2	-	1	-
Vernon	-	-	-	-	1	-	-	-
Washingto	-	-	-	1	1	1	-	-
Waukesha	-	-	-	-	2	2	1	-
Waupaca	-	-	-	-	4	-	1	-
Waushara	-	-	-	-	-	-	1	-
Total toolstone	**19**	**5**	**1**	**9**	**42**	**6**	**17**	**1**
Hixton	8	-	1	3	26	1	9	-
PDC?	10	5	-	6	10	5	3	1
Miline	1	-	-	-	-	-	-	-
rhyolite	-	-	-	-	1	-	2	-
KRF	-	-	-	-	2	-	-	-
unknown	-	-	-	-	3	-	3	-

and Behm 1985). However, given the range of variation and its possible confusion with other materials, we tentatively refer to this material as "PDC?" in Table 1. Other toolstones represented include a miniature Clovis point from Jefferson County made of Moline chert and two Agate Basin points made of Knife River Flint (KRF) from western North Dakota. The KRF specimens were collected in Green Lake and Sheboygan counties more than 1,200 km east of the KRF quarries. One Agate Basin and two eared Scottsbluffs are made from dull, bluish gray rhyolite, probably Marquette rhyolite from southern Green Lake County (Behm 1988). Six specimens are made of unknown materials.

Most of the Paleoindian artifacts in the MPM collections are from counties in southeastern Wisconsin, or the area east of the Wisconsin River and south of Lake Winnebago. This distribution is not surprising because historically this area contains high population density and extensive land cultivation. Lepper (1983, 1985) has pointed out similar collector bias in the recorded distribution of Paleoindian points in Ohio. However, several MPM Paleoindian points are from counties in northeastern and western Wisconsin, where modern population density is lower and land is more forested. At present, it is not clear what this distribution means in terms of Paleoindian mobility and land-use in Wisconsin. However, continued documentation of the distribution of Paleoindian points in the upper Midwest and articulation of this information with paleoecological data may improve our understanding of the adaptive strategies of early inhabitants in the western Great Lakes.

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References Cited

Behm, J. A. 1988 47-GL-142: A Rhyolite Quarry and Workshop Area in Green Lake County, Wisconsin. *Fox Valley Archaeology* 12:7–22.

Hill, M. G. 1994 Paleoindian Projectile Points from the Vicinity of Silver Mound (47JA21), Jackson County, Wisconsin. *Midcontinental Journal of Archaeology* 19:223–259.

Lepper, B. T. 1983 Fluted Point Distributional Patterns in the Eastern United States: A Contemporary Phenomenon. *Midcontinental Journal of Archaeology* 8:269–285.

——— 1985 The Effects of Cultivation and Collecting on Ohio Fluted Point Finds: A Reply to Seeman and Prufer. *Midcontinental Journal of Archaeology* 10:241–250.

Morrow, T. A., and J. A. Behm 1985 Descriptions of Common Lithic Raw Materials Encountered on Wisconsin Archaeological Sites. Paper distributed at the Lithic Identification Workshop held in conjunction with the Fall Meeting of the Wisconsin Archeological Survey, Madison, November 9, 1985.

Porter, J. W. 1961 Hixton Silicified Sandstone: A Unique Lithic Material Used by Prehistoric Cultures. *The Wisconsin Archeologist* 42:78–85.

Ritzenthaler, R. E., and P. Scholz 1951 Folsomoid Points in Wisconsin. *The Wisconsin Archeologist* 32(2):45–48.

Stoltman, J. B., and K. Workman 1969 A Preliminary Study of Wisconsin Fluted Points. *The Wisconsin Archeologist* 50(4):189–214.

Storck, P. L. 1997 *The Fisher Site: Archaeological, Geological and Paleobotanical Studies at an Early Paleo-Indian Site in Southern Ontario, Canada.* Memoirs of the Museum of Anthropology, University of Michigan, No. 30. Ann Arbor.

New Data Pertaining to Swan Point, the Oldest Microblade Site Known in Alaska

Charles E. Holmes

News of a microblade component at the Swan Point site in central Alaska that dated older than 11,500 yr B.P. (Holmes et al. 1994) was received with skepticism by proponents of the theory that pre-microblade sites, i.e., the Nenana Complex, existed prior to entry or development of microblade industries in Alaska (Hoffecker et al. 1993). Excellent stratigraphic context and a charcoal AMS date of 11,660 yr B.P. suggested an age for Swan Point coeval with or older than the Nenana Complex. The evidence in 1994 was meager but solid. This initial age assessment was bolstered by two additional AMS dates, another charcoal date of 11,660 yr B.P. and an ivory (collagen) date of 12,060 yr B.P. (Holmes et al. 1996). The XAD-KOH purified collagen ivory sample, cf. mammoth (*Mammuthus* spp.), was processed as sample NSRL-2001 (Thomas Stafford personal communication, 1995).

Additional artifacts, including microblades and core fragments, were recovered from the oldest cultural layer during the 1994 field season. Three distinct raw materials are represented among the microblades and, although no whole cores have yet been recovered, a wedge-shaped core form can be inferred from fragments (Figure 1). One particular lithic flake specimen, covered with an unusual grey and black residue, was recovered from a charcoal-stained lens (likely a hearth). Upon closer inspection the specimen was determined to be a microblade core tablet (a core platform rejuvenation flake derived from a wedge-shaped core form) that appeared to be partially coated with soot and ash. The core tablet is gray chert and exhibits evidence of having been exposed to intense heat, i.e., the proximal or faceted end has experienced thermal fractures and crazing, which has partially obliterated the facets.

A tiny amount of the residue was scraped off the ventral surface of the artifact for microscopic examination and potential AMS radiocarbon dating. The sample exhibited no structural elements under low and medium power microscope. A date of 11,770 ± 140 yr B.P. (AA-19322) was obtained on a subsample of the residue submitted to the University of Arizona AMS facility. This is paramount direct dating of the microblade component at Swan Point and should dispel misgivings concerning the age of the site.

The microblade component at Swan Point has three charcoal AMS radiocarbon dates, statistically identical at the 95% confidence level, with an average age of 11,680 ± 70 yr B.P. If the ivory collagen date is included, then all four dates average 11,770 ± 60 yr B.P. The microblade core form is inferred to resemble the classic wedge-shape found in both the Dyuktai and Denali cultures. Swan point appears to have cultural antecedents in Dyuktai and derivatives in Denali.

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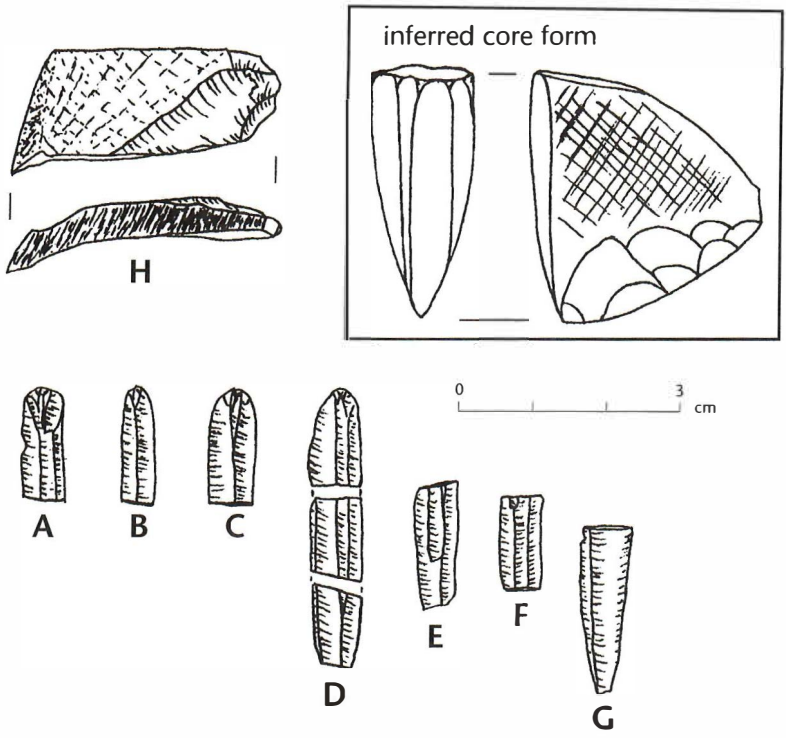

Figure 1. Swan Point microblades **(A–G)**, microblade core platform rejuvenation flake **(H)**, and inferred wedge-shaped microblade core form (in box).

References Cited

Hoffecker, J. F., W. R. Powers, and T. Goebel 1993 The Colonization of Beringia and the Peopling of the New World. *Science* 259:46–52.

Holmes, C. E., R. VanderHoek, and T. E. Dilley 1994 Old Microblades in the Tanana Valley: The View from Swan Point. Paper presented at the 21st annual meeting of the Alaska Anthropological Association, Juneau.

——— 1996 Swan Point. In *American Beginnings: the Prehistory and Palaeoecology of Beringia*, edited Fred H. West, pp. 319–323. University of Chicago Press, Chicago.

The Plainville Point: Description of a Late-Paleoindian Type

Lawrence J. Jackson

Despite flooding of thousands of square km of terminal-Pleistocene Great Lakes shorelines (Jackson and Ellis n.d.), there is increasing evidence of a complex sequence of late-Paleoindian point types in southern Ontario. These include Holcombe and Hi-Lo (southern Huron margins and north shore of Lake Ontario), Agate Basin and Hell Gap (scattered distribution), Madina (mainly Simcoe Lowlands of south-central Ontario), and Eden-Scottsbluff (Trent Waterway and east on the St. Lawrence) (Ellis and Deller 1990; Jackson 1997).

The newly recognized "Plainville" type, named after two sites in Plainville Valley (Inner City Angels and Linton), occurs south of Rice Lake and elsewhere in south-central and southwestern Ontario (see Figure 1).

There are four known complete examples and three bases—with considerable size range due to reworking. A 178-mm lanceolate on Iron Formation quartzite, with distinctive collateral flaking, occurs near Flesherton in upland southwestern Ontario (Storck 1972). A similar example on Onondaga chert, with basal notching, is recorded from the Rideau Lakes of eastern Ontario (Watson 1990). A reworked 42-mm-long point from Sturgeon Pond, southwestern Ontario, is on Onondaga chert (P. Lennox, pers. comm. 1997). A very small 28-mm reworked example on Onondaga chert is from Cherry Ridge, Hamilton (R. Griffin-Short, pers. comm. 1997).

The Inner City Angels–type specimen, a finely fashioned base on Onondaga chert, was discovered in 1985 in Plainville Valley south of Rice Lake. This lanceolate base on Onondaga chert is 22.3 mm long, 31.8 mm wide, 4.7 mm thick, 19.4 mm in basal width, and weighs 3.53 grams. Estimated total length is 80 mm. It has a slightly concave, well-thinned, "square" base with very weak basal "ears," plano-convex cross-section, and overall collateral flaking. It expands gently, shows light edge grinding, and has small lateral notches 6–10 mm above the base (see Figure 1).

A reworked Plainville base from the Linton site, Plainville Valley, on weathered red Bayport chert, is 18 mm long and 29.8 mm wide at break point. Basal width is 22.8 mm, thickness 4.9 mm, and weight 3.16 grams. It expands gently from a well-flaked and thinned "square" base, has a plano-convex cross-section, weak basal ears, light grinding, small lateral edge notches just above the base, and overall collateral flaking.

A point base from the Zander site on the southern margins of Lake Simcoe (Stewart 1984:Fig.5) also fits the Plainville type.

Defining features of the Plainville type are associated with basal treatment and flaking: straight to slightly incurvate basal edge, gentle expansion from the base, light grinding, thin, weak, and gently rounded basal ears, bilateral

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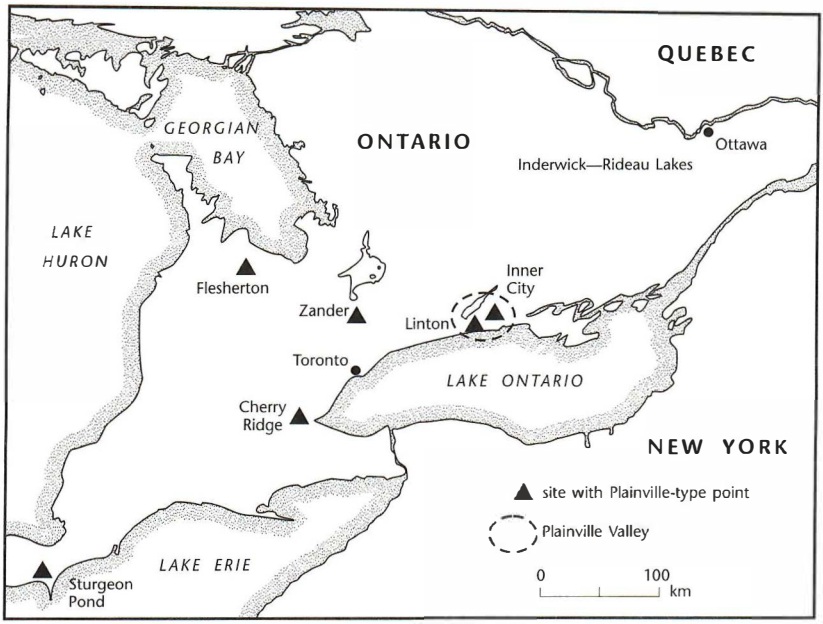

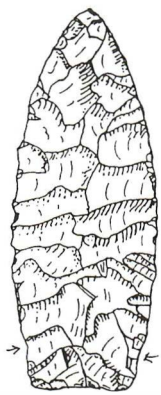

Figure 1. (above) Southern Ontario distribution of Plainville points. (right) Plainville point (reconstructed from BaGn-76 base).

indentation 6–12 mm above the base, plano to biconvex cross-section, slight basal asymmetry with one basal edge and ear protruding lower than the other, basal thinning by short parallel-sided flakes, and overall collateral flaking. Similar late-Paleoindian points, with more pronounced lateral edge expansion, are reported from the McConnell site in Ohio (Prufer 1963).

Special thanks to Donna Morrison for helpful comments.

References Cited

Ellis, C., and D. B. Deller 1990 Paleo-Indians. In *The Archaeology of Southern Ontario to A.D. 1650.* Occasional Publication 5, London Chapter, Ontario Archaeological Society, pp. 37–63.

Jackson, L. 1997 New Late Paleoindian Points for Southern Ontario. *Current Research in the Pleistocene* 14:39–41.

Jackson, L., and C. Ellis n.d. Geomorphology, Geochronology and Eastern Great Lakes Paleo-Indians: Crossing Space-Time Barriers. Paper presented at 60th Annual Meeting, Society for American Archaeology.

Prufer, O. 1963 The McConnell Site: A Late Paleo-Indian Workshop in Coshocton County, Ohio. The Cleveland Museum of Natural History, N.S. 2(1):1–51.

Stewart, A. 1984 The Zander Site: Paleo-Indian Occupation of the Southern Holland Marsh Region of Ontario. *Ontario Archaeology* 41:45–79.

Storck, P. 1972 An Unusual Late Paleo-Indian Projectile Point from Grey County, Southern Ontario. *Ontario Archaeology* 18:37–45.

Watson, G. 1990 Paleo-Indian and Archaic Occupations of the Rideau Lakes. *Ontario Archaeology* 50:5–26.

El Vano, Venezuela: El Jobo Traditions in a Megathere Kill Site

Arturo Jaimes Quero

The site of El Vano is located within an aquatic depositional setting on the north slope of the Sierra de Barbacoas, a spur of the Venezuelan Andes in the state of Lara. The site was discovered fortuitously in 1990 by the author and a group of collaborators. The first finds were two dental fragments, a femur from a megathere (*Eremotherium rusconni*), a set of vertebrae, and a unifacial scraper exposed on the possible shoreline of an ancient body of water.

The field seasons in 1990 yielded an incomplete, disarticulated carcass of a single megathere, three El Jobo projectile point fragments, two flakes with unifacial marginal retouch, a flake without modification, a chopper, a rounded pebble, and a scraper. In addition, we collected splinters and bone flakes as well as two apparent bone retouchers made of long dental roots, and a small set of dermal ossicles.

A medial projectile-point fragment was located in a set of four dorsal vertebrae; the distal fragment was found without a bone association at the same level, and a second medial fragment was adjacent to a rib fragment. This material was encountered between 30 and 60 cm from the top of a sedimentary sequence composed of compact clay layers.

The bones were assessed according to the Behrensmeyer scale of weathering (1978). The results obtained were 73.8% at stage 0–1, 19.04% at stage 1–2 and 7.14% at stage 2–3. Likewise, the same assemblage was evaluated following the Johnson scale of postmortem weathering (1985) and was placed in the 0–1 stage. The high degree of preservation in the assemblage allowed good

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assessment of cut marks, incisions, grooves, depressed fractures (with micro-splintering in the depression), micro-flakes of bone, and notches in the edges of all broken margins of processed bones—the result of processing activities undertaken by Jobo hunters. Root stains and other modifications typical of the biotic activities of low-energy wet environments were also preserved.

The spatial distribution of material showed clear clustering resulting from carcass-processing materials were found all spatially distributed showing a clear distinct separation resulting from carcass processing. People conducting the butchering may have been divided into task groups assigned to different parts of the carcass. Our impression is that different areas were used for processing different parts of the carcass. One left mandibular ramus, the right humerus, one vertebral lumbar, five rib fragments, the left fibula, the head of the right humerus, and the right ulna exhibit cut marks and impact points; all were fractured in processing. Only left tibia-fibula and both clavicles were found completed (Jaimes 1992).

Three dates on bone were obtained by AMS, but none of the three analyses is trustworthy, due to inadequate collagen content in the samples. The oldest date, 10,710 ± 60 yr B.P. (B-95602), may be the most accurate, but we consider this a minimum date.

Both the sediments and the technology found correspond to late-Pleistocene material dated and analyzed in Muaco and Taima-Taima (state of Falcón). The corresponding strata at those sites, which resemble the clay layers at El Vano, were dated between 16,000 and 12,000 yr B.P. (Ochsenius and Gruhn 1978). The technology found in these mastodon (Taima-Taima and Muaco) and glyptodon (Taima-Taima) kill sites is the same as the one in El Vano.

The three projectile point fragments (sandy quartzite) and the rounded pebble match known technology. The unifacial scraper (volcanic rock) is made in a lithology belonging to the Luna formation, which outcrops in the El Vano area. This suggests some knowledge of local resources. All the other artifacts are part of expedient technology that was discarded immediately after use (Jaimes 1994).

El Vano represents the first megathere kill site known in the Americas and a new site for the Joboid tradition. A holistic approach to archaeological data is needed to reconstruct aspects of behavior, settlement, and subsistence of Paleoindian hunter-gatherers in northwest Venezuela.

The first field season was carried out thanks to sponsorship of the Museo Arqueológico de Quibor. The second field season was possible thanks to the contribution of Dr. Erika Wagner. During both seasons, a group of good friends from Quibor collaborated generously. Very special thanks for the interest and support of Sagrario Pérez Soto, who provided the required funds for radiocarbon dating.

References Cited

Jaimes, A. 1992 El Vano: Una nueva localidad Paleoindia en el noroccidente de Venezuela. Ponencia presentada en el VI Congreso de Antropología en Colombia, Simposio: Pasado y Presente de los Cazadores-recolectores de Suramérica, Bogotá, Colombia.

——— 1994 Nuevas evidencias de cazadores-recolectores y aproximación al entendimiento del uso del espacio geográfico en el noroccidente de Venezuela. Sus implicaciones en el contexto

Suramericano. XII Congreso de Antropología Argentina, Simposio: El Paleoindio y los primeros Americanos. Mendoza, Argentina. En prensa.

Ochsenius, C., and R. Gruhn (editors) 1978 *Taima-Taima: a Late Pleistocene Paleoindian Kill Site in Northernmost South America.* Final reports of 1979 excavations. Coro-Venezuela.

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

Behrensmeyer, A. K. 1978 Taphonomic and Ecologic Information from Bone Weathering. *Paleobiology* 4:150–162.

Paleoindian Tool-Stone Utilization in Eastern Oklahoma: An Argument for Limited Mobility

Kenneth C. Kraft and Warren K. Lail

Arguments for Paleoindian mobility are often based on site type, assemblage size, occurrence of preforms, point production debitage, tool discard patterns and lithic raw material types. Explanations for regional and seasonal mobility are often proposed (see Bradley 1982; Brosowske 1996; Hofman 1991; Kelly and Todd 1988; LeTourneau 1992; Shott 1986, 1989). These explanations frequently arise following a division of Paleoindian debitage and tools into technological categories with close attention afforded to raw material. Since the source materials for many Paleoindian projectile points are known to lie hundreds of kilometers away from the find provenience (Schiffer 1987:13-23), investigators use broken and exhausted tools as a measure of the distances prehistoric groups would have traveled in order to acquire these materials. This raw material–distance correlation is central to many Paleoindian mobility models (Todd and Kelly 1988; Hofman 1991). This report draws attention to possible erroneous conclusions which may be drawn about Paleoindian movements when lithic raw materials are used as a sole measure of mobility.

Our study examines five private collections of Paleoindian artifacts recovered from gravel bars below Eufaula Dam in eastern Oklahoma (Lail 1997; Rippy and Wyckoff 1994). Interviews with the collectors did not reveal a bias for particular raw materials, since all Paleoindian artifacts were collected. As expected, locally available raw materials from the Ozark and Ouachita mountains dominate the collections. These include several cherts (Boone, Johns Valley, Keokuk, Moorefield, Reed Springs, and Woodford), and one quartzite (Johns Valley). It is worth noting that these cherts and quartzites are some of the finest knapping materials available in the region (Banks 1990:13–47). The collections also contain Paleoindian projectile points (7) and lanceolate forms (3) made of Alibates silicified dolomite, known to come from a heavily exploited source in the Texas panhandle 615 river km upstream (Figure 1).

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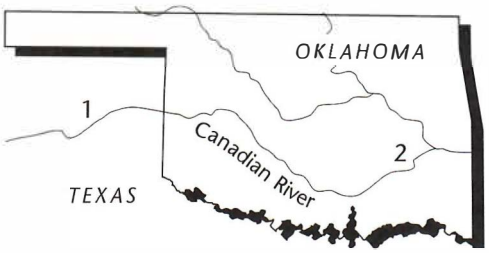

Figure 1. Location of Alibates quarry and artifacts in Oklahoma and Texas.

1 Alibates quarry
2 Study area below Eufaula Dam

The presence of Alibates artifacts in eastern Oklahoma form the basis for many of the traditional arguments for long-distance trade or mobility.

As has been previously noted in the literature, 135 knappable-sized clasts of Alibates silicified dolomite have been found in the Canadian River valley in eastern Oklahoma (Kraft 1997). Many of the clasts are of sufficient width (70–60 mm) and length (150–100 mm) to have provided enough raw material mass to manufacture many of the Paleoindian points documented for eastern Oklahoma both in the literature (Hofman 1987; Hofman and Wyckoff 1991; Johnson 1989; Kraft 1997; Wyckoff 1992) and in the collections of the Oklahoma Museum of Natural History. We suggest that these clasts could easily have served as the source material for any and all of the Alibates stone tools found in eastern Oklahoma, thus eliminating the need for long-distance travel or trade. Our argument is further strengthened by the fact that the materials abundant in the region at least equal the knappable qualities of the Alibates materials (Banks 1990:13-47; Wyckoff, pers. comm. 1997).

We recognize that our view contrasts with general assumptions about trade and long-distance mobility as the sole means for acquiring Alibates silicified dolomite by peoples outside of the Texas panhandle region. Based upon our research, we now argue for less mobility, at least with respect to the acquisition of Alibates silicified dolomite, by Paleoindian groups on the eastern Plains. Although no new model has been suggested, the evidence for use of locally available Alibates materials by Paleoindian groups in eastern Oklahoma has been established, and will become more apparent, we argue, with future studies from this region.

We thank avocational archaeologists John and Ann Coffman, John Carter, Billy Ross, Jay Maulsby, and Jack and Ann Bullard for making their collections available for study. We also thank Jesse Ballenger for proofreading our manuscript. We are especially grateful to Dr. Don Wyckoff for supporting and encouraging us in this endeavor.

References Cited

Banks, L. D. 1990 Ozark-Arkansas-Ouachita Area. In *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippi South, the Southern Plains, and Adjacent Southwest.* Oklahoma Anthropological Society, Memoir #4, Norman.

Bradley, B. A. 1982 Flaked Stone Technology and Typology. In *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains*, edited by G. C. Frison and D. J. Stanford, pp. 181–280. Academic Press, New York.

Brosowske, S. D. 1997 Identifying Relative Levels of Mobility for Selected Southern Plains Hunter-Gatherers. Unpublished M.A. thesis, Department of Anthropology, University of Oklahoma, Norman.

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

——— 1991 Folsom Land Use: Projectile Point Variability as a Key to Mobility. In *Raw Material Economies Among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 335–356. Publications in Anthropology #19. University of Kansas, Lawrence.

Hofman, J. L., and D. G. Wyckoff 1991 Clovis Occupation in Oklahoma. *Current Research in the Pleistocene* 8:29–32.

Johnson, L., Jr. 1989 *Great Plains Interlopers in the Eastern Woodlands During Late Paleoindian Times: The Evidence from Oklahoma, Texas, and Areas Close By*. Texas Historical Commission, Office of the State Archaeologist Report #36

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

Kraft, K. C. 1997 The Distribution of Alibates Silicified Dolomite Clasts Along the Canadian River. *Current Research in the Pleistocene* 14:106–109.

Lail, W. K. 1997 Gravel Bar Archaeology: Paleoindian Flaked Tools, Mastodon Remains and Other Intriguing Finds in Eastern Oklahoma. Paper presented at the 55th Annual Plains Anthropological Conference, Boulder.

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

Rippy, C., and D. G. Wyckoff 1994 Woodland Musk Oxen in Oklahoma. *Current Research in the Pleistocene* 11:95–97.

Schiffer, M. B. 1987 *Formation Processes of the Archaeological Record*. University of New Mexico Press, Albuquerque.

Shott, M. J. 1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. *Journal of Anthropological Research* 42:15–51.

——— 1989 Technological Organization in Great Lakes Paleoindian Assemblages. In *Eastern Paleoindian Lithic Resource Use*, edited by C. J. Ellis and J. C. Lothrop, pp. 221–237. Westview Press, Boulder, Colorado.

Wyckoff, D. G. 1992 The Cody Complex in Oklahoma's Arkansas Basin. *Current Research in the Pleistocene* 9:47–49.

Romer's Rule and the Paleoindian/Archaic Transition

Roger Marks La Jeunesse and John Howard Pryor

The Paleoindian/Archaic Transition is poorly documented and not well understood (Beck and Jones 1997; Haury 1986:436-440; Willey and Phillips 1958:111-113; Willig and Aikens 1988:1). The lack of well-dated sites having stratigraphic integrity makes the interpretation of this transition difficult to

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understand. Results from the Skyrocket archaeological site may provide a clearer view of this transition.

Skyrocket, located in the central Sierran foothills 40 miles east of Stockton, California, has yielded nearly 500,000 artifacts; recovered from seven sedimentary strata, they represent eight cultural components spanning over 9,000 years. The oldest of these deposits, dating between 9,400 and 7,000 yr B.P., were sealed and show no evidence of mixing, reducing the likelihood that any of the artifacts discussed below were intrusive (Bieling, La Jeunesse, and Pryor 1996; La Jeunesse and Pryor, 1996). These materials strongly suggest that parts of the Paleoindian adaptation were *conserved* and carried over into the Archaic, due in part to changing climates.

This perspective is the result of our recent analysis of the materials from Skyrocket's deepest stratum, previously referred to as Component 8 (La Jeunesse and Pryor 1996). In fact, it contains two temporally distinct assemblages, one dating from 9,400 to 8,500 yr B.P., the other from 8,500 to 7,000 yr B.P. This subdivision is based on the reanalysis of *only* those artifacts recovered from the site's large stone platform, whose surface area measures approximately 158 m^2 and whose average thickness is 30 cm. The botanical and geological evidence suggests that this feature was built into a marsh, possibly allowing the site's inhabitants access to its resources and at the same time keeping them dry while they fabricated tools and processed foods. Samples of charcoal taken from this feature's base, middle, and top date to 9,410 ± 250 (WSU 4929), 8,550 ± 150 (WSU 4614), and 7,000 ± 70 yr B.P. (WSU 4616), respectively. The 8,550 yr B.P. date comes from a hearth that stratigraphically separates these two assemblages.

Below the hearth, the oldest assemblage is represented by bifaces, including points and knives, unifaces, and ground stone. The most commonly occurring point type is from the Western Stem series. The knives are large leaf-shaped, which have been characterized elsewhere as Paleoindian in manufacture (Bieling, La Jeunesse, and Pryor 1996). Also present but at a much lower frequency are Pinto points. Unifaces were the least frequent type of tool recovered, representing only 12% of the assemblage.

In all, 253 pieces of ground stone were recovered, accounting for 61% of the artifacts in this assemblage, including 183 milling slabs (28/m^3) and 70 hand stones (11/m^3). All the milling slabs were broken or exhausted, and some of the hand stones were fire-cracked. The relatively thin milling slabs possess long oval basins and appear to have been used in crushing, but not grinding, large objects such as nuts and tubers.

A large quantity of ground stone and a small number of Pinto points (2) and unifaces (21) associated with tools made by Paleoindian flaking technology, all within the context of a large rock platform, define this site as the earliest expression of the Paleoindian/Archaic Transition.

The assemblage above the hearth, which represents a later manifestation of this transition, contains the same tool classes as the lower one but in strikingly different proportions. In this deposit, ground stone and unifaces become the predominant tool classes. What characterizes the chipped stone assemblage is the relative proportion of Pinto points and the wide variety of unifaces,

suggesting a shift from the production of tools intended for hunting large animals to the manufacture of tools intended for hunting smaller ones and for processing plants.

Pinto points (7), the most characteristic biface type in this assemblage, co-occur with large leaf-shaped knives (4). Their juxtaposition in the same soil stratum suggests that Paleoindian flaking technology, required for the manufacture of these knives, coexisted alongside the more expedient tool types often associated with the Archaic.

This assemblage suggests that the transition from the Paleoindian was a stepwise process, one in which older technologies and lifeways were gradually eliminated while slowly adjusting to new circumstances.

The hearth, which separate the two assemblages, temporally coincides with a climatic change that affected much of central California, including the Central Valley and surrounding foothills (Adam and West 1983; Davis 1990; Davis and Moratto 1988). During this period, oak savanna replaces coniferous forests. This climatic change was part of a larger warming trend that affected much of the western United States soon after the end of the last Ice Age (Grayson 1993).

There is heuristic value in borrowing evolutionary principles from the biological sciences in order to explain cultural change. For example, "Romer's Rule" (Krantz 1973:631-633) argues that adaptations themselves are means by which animals maintain their way of life instead of extending it. An example of this principle (Romer 1966) was the evolution of the first tetrapods (amphibians) from their fishlike ancestors. The latter, who faced increased desiccation during the Devonian, were forced to hunt for new pools of water to continue their aquatic life-style and as a consequence developed terrestrial locomotion.

An application of this principle to the archaeological assemblages recovered at Skyrocket helps resolve some of the difficulties we have in understanding the transition from Paleoindian to Archaic lifeways. This evolutionary principle, if applied to the site's data, would suggest that the Paleoindians, faced with a changing environment, and in an effort to maintain their life style, developed certain tools and techniques that we identify with the Archaic.

References Cited

Adam, D. P., and. G. J. West 1983 Temperature and Precipitation Estimates through the Last Glacial Cycle from Clear Lake, California. Pollen Data. *Science* 219:168–170.

Beck, C., and. G. T. Jones 1997 The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin. *Journal of World Prehistory* 11(2):161–236.

Bieling, D. G., R. M. La Jeunesse, and J. H. Pryor 1996 Skyrocket, a Central Sierran Paleoindian Archaic Transition Site. *Current Research in the Pleistocene* 13:4–6.

Davis, O. K. 1990 Preliminary Report of the Pollen Analysis of Tulare Lake. Newsletter of the Tulare Lake Archaeological Research Group. *TULARG Report* 3(5):2–4.

Davis, O. K., and M. J. Moratto 1988 Evidence for a Warm Dry Early Holocene in the Western Sierra Nevada of California: Pollen and Plant Macrofossil Analysis of Dinkey and Exchequer Meadows. *Madrono* 35(2):132–149.

Grayson, D. K. 1993 *The Desert's Past.* Smithsonian Institution Press, Washington, D. C.

Haury, E. 1986 Thoughts of After Sixty Years as a Southwestern Archaeologist. In *Emil W. Haury's*

Prehistory of the American Southwest, edited by J. J. Reid and D. Doyel, pp. 435–464. University of Arizona Press, Tucson.

Krantz, G. S. 1973 Romer's Rule and the Origin of Stone Tools. *Man* New Series, 8(4):631–633.

La Jeunesse, R. M., and J. H. Pryor 1996 *Skyrocket Archaeological Site Report* (CA-Cal-629/630), Synthesis Volume. California State University, Fresno.

Romer, A. 1966 *Vertebrate Paleontology*, 3rd ed. University of Chicago Press.

Willey, G. R., and P. Phillips 1958 *Method and Theory in American Archaeology*. University of Chicago Press, Chicago.

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

Fluted Points, Mastodons, and Evidence of Late-Pleistocene Drought at the Hiscock Site, Western New York State

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The late-Quaternary Hiscock site in western New York (Laub et al. 1988; Laub 1994, 1995) includes a Pleistocene component of fossiliferous spring-laid gravel (Muller & Calkin 1988:62; Laub 1995) that contains fluted bifaces and bones of megafauna. The oldest radiocarbon date obtained from this unit is 11,390 ± 80 yr B.P. (AA-6977). Most dates, however, fall within 11,200 to 10,200 radiocarbon years, with two outlying dates around 9,500 and 9,200 yr B.P.

Hiscock is the only locality east of the Mississippi River cited by C. V. Haynes (1991) in his discussion of evidence for a widespread North American drought during the late Pleistocene, correlated with megafauna extinction and Paleoindian occupation. His interpretations of Hiscock, however, are based upon an early radiocarbon record that has subsequently become much more detailed. Specifically, there is now evidence of one or more low water-level events at Hiscock during the late Pleistocene.

The spring gravels commonly lie on a surface of closely spaced cobbles. In one area, this surface had been penetrated by a 70-cm-deep excavation which was subsequently filled in with gravels containing bones of Pleistocene megafauna. The adjacent cobble surface was overlain by 15 cm of Pleistocene gravel, which was in turn covered by 10 cm of concentrated cobbles. The latter is presumed to be part of the spoil pile of material dug out from the ancient excavation. This 3-part sequence was capped by Holocene peat.

The excavation is a wedge-shaped embayment cut into the slope of the main basin, apparently by an agent standing in the basin and digging laterally. Its

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distinct margins suggest that the feature was produced when this area was emergent. The excavation extends horizontally 310 cm into the bank. In plan view it resembles the longitudinal section of a funnel, 200 cm across the mouth, tapering to a 150-cm width 150 cm into the bank and retaining that width to its end. The maximum relief (below the top of the Pleistocene deposits) is 85 cm, suggesting a water table drop of at least that much. The present Pleistocene/Holocene boundary, however, is an inconformity, so the water table probably stood higher in the past than is implied by the current level of Pleistocene sediments.

On the floor of the ancient excavation lay the tusk of a female mastodon (field no. H7NW-181). Three AMS dates were obtained from this specimen: 10,930 ± 70 (GX-22038-AMS), 11,070 ± 70 (CAMS-30529) and 11,100 ± 80 yr B.P. (CAMS-30528). While its tip was quite worn, the tusk as a whole showed little evidence of weathering. Chemically, the ivory protein was superbly preserved and yielded 100% modern pseudomorphs after decalcification in dilute, cold HCl (Thomas Stafford, pers. comm.). Its fresh condition suggests the tusk came to rest on the floor of the pit not long before the pit was backfilled. If so, then the excavation was filled in 11,260 to 10,790 radiocarbon years B.P. (95% confidence level). Assuming that the digging occurred during a period of low water level, the dry period ended sometime during the above interval.

This excavation resembles some produced by modern elephants digging in the soil for minerals (see Redmond, 1992). In fact, Hiscock is unusually rich in minerals, judging by the high fluoride content of the spring water and the mastodon bones (Tankersley et al., in press).

A second feature is a 50-cm-wide hole in the cobble surface. Here the cobble surface lies 137 cm below ground level, and the hole penetrates approximately 30 cm deeper. The tusk of a male mastodon (field no. G4NE-92) lay with its distal end in the hole, which is filled in with Pleistocene gravel. This feature resembles wells dug by modern East African elephants during times of drought (e.g., G. Haynes, 1987).

These two ancient excavations are interpreted as evidence of one or more episodes of dramatic water table subsidence during the period while the fossiliferous Pleistocene gravels were being deposited at Hiscock. Two other observations seem to support this conclusion:

First, broken tusk tips (the point present, but no pulp cavity) are typical of the areas around wells that modern elephants dig during very dry periods (G. Haynes, 1987; 1991). At such times, they are deposited at drought refuge water holes in Zimbabwe at a variable rate of 1 to 7 (or more) per week. Perhaps 10–30% of the tusk tips are buried and preserved. Similar fragments are common features at Hiscock. A survey of the Hiscock Site collection yielded 17 premaxillary tusk tips from an excavated area of 586 m^2. The same area also yielded 34 tips of chin-tusks and deciduous premaxillary tusks. It should be noted that the Hiscock Pleistocene fossils accumulated over a period of about 800 to 1,600 radiocarbon years (Laub, 1996, p. 376), but a census of the bones indicates that many that were originally deposited were not preserved.

The second observation is more subjective but nevertheless interesting for

its implications. A number of Pleistocene bone fragments from the site show signs suggesting cultural modification. Thirteen of these have been cited as confirmed artifacts (Tomenchuk & Laub, 1995; Laub, Tomenchuk and Storck, 1996), and their distribution may be relevant to the present subject:

The Hiscock basin is filled with water virtually year-round. If all sediment above the cobble level were removed and the water table dropped to 90–120 cm below the current ground surface, the result would be a small pond with several elongate diverticulae. Seven of the reported bone artifacts lie in two tight clusters, each associated with one of these diverticulae. These objects may have been deposited in work areas around elongate, fingerlike extensions of the pond during times of low water-level.

The Hiscock Site is excavated annually by the Buffalo Museum of Science with generous support from the George G. and Elizabeth G. Smith Foundation (Buffalo), and the dedicated work of scores of volunteers.

References Cited

Haynes, C. V., Jr. 1991 Geoarchaeological and Paleohydrological Evidence for a Clovis-Age Drought in North America and Its Bearing on Extinction. *Quaternary Research* 35(3):438–450.

Haynes, G. 1987 Where Elephants Die. *Natural History* 96(6):28–33.

——— 1991 *Mammoths, Mastodonts, and Elephants: Biology, Behavior, and the Fossil Record.* Cambridge University Press, Cambridge.

Laub, R. S. 1994 The Pleistocene/Holocene Transition in Western New York State: Fruits of Interdisciplinary Studies at the Hiscock Site. In *Great Lakes Archaeology and Paleoecology: Exploring Interdisciplinary Initiatives in the Nineties*, edited by R. I. MacDonald, pp. 155–167. The Quaternary Sciences Institute, University of Waterloo, Waterloo, Ontario.

——— 1995 The Hiscock Site (Western New York): Recent Developments in the Study of the Late-Pleistocene Component. *Current Research in the Pleistocene* 12:26–29.

——— 1996 The Masticatory Apparatus of the American Mastodon. In *Palaeoecology and Palaeoenvironments of Late Cenozoic Mammals*, edited by K. M. Stewart and K. L. Seymour, pp. 375–405. University of Toronto Press, Toronto.

Laub, R. S., M. F. DeRemer, C. A. Dufort, and W. L. Parsons 1988 The Hiscock Site: A Rich Late Quaternary Locality in Western New York State. In *Late Pleistocene and Early Holocene Paleoecology and Archeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 67–81. Buffalo Society of Natural Sciences Bulletin 33.

Laub, R. S., J. Tomenchuk, and P. L. Storck 1996 A Dated Mastodon Bone Artifact from the Late Pleistocene of New York. *Archaeology of Eastern North America* 24:1–17.

Muller, E. H., and P. E. Calkin 1988 Late Pleistocene and Holocene Geology of the Eastern Great Lakes Region: Geologic Setting of the Hiscock Paleontological Site, Western New York. In *Late Pleistocene and Early Holocene Paleoecology and Archeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 53–63. Buffalo Society of Natural Sciences Bulletin 33.

Redmond, I. M. 1992 Erosion by Elephants. In *Elephants: Majestic Creatures of the Wild*, edited by J. Shoshani, pp. 128–130. Rodale Press, Emmaus.

Tankersley, K. B., K. D. Schlecht, and R. S. Laub in press Fluoride Dating of Mastodon Bone from an Early Paleoindian Spring Site. *Journal of Archaeological Science.*

Tomenchuk, T., and R. S. Laub 1995 New Insights Into Late-Pleistocene Bone Technology at the Hiscock Site, Western New York State. *Current Research in the Pleistocene* 12:71–74.

The Quemado Lake Paleoindian Artifacts, West-Central New Mexico

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This paper reports two Paleoindian-age artifacts (Figure 1) recovered from multicomponent sites near Quemado Lake in west-central New Mexico. Located in the Largo and Agua Fria Valley area of the Upper Colorado River drainage at an elevation of 7,900 feet AMSL, the sites are on the bench of a gently sloping ridge covered with upland forest vegetation overlooking the modern lake. LA 89057 was discovered by land surveyors in 1991 (Gadd n.d.). Located about 100 m away, LA 72622 was initially recorded during a survey for a proposed campground (Dechambre and Hotsenpiller 1989).

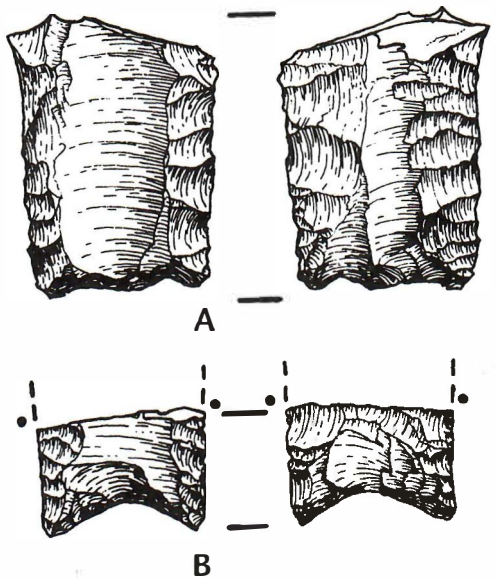

Figure 1. **(A)** Folsom preform from LA 89057. The preform is of a pinkish chert of an unknown source. The point was successfully fluted, but a perverse fracture initiation to a bending fracture caused a failure during manufacture. **(B)** A finished Midland base from LA 72622. The material is a greyish chert from an unknown source. The point appears to have been broken in haft and does not look to have been fluted.

LA 89057 is a scatter of ceramics and lithics covering an area of 1,700 m^2. A Folsom preform (Figure 1, A) was collected from the surface of this site (Gadd n.d.), but limited testing produced no subsurface material. LA 72622 covers nearly 7,500 m^2, also consisting of a dispersed scatter of lithics and ceramics. The excavation of 10 shovel tests and 160 1-by-1-m units at this site yielded hundreds of chipped and ground stone artifacts, ceramics, and some small- to

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medium-size fauna (Gadd n.d.; Newton and Gadd 1992). A single charcoal stain feature was noted. The location of a surface-collected Midland base (Figure 1, B) was tested with a 2-by-2-m unit. Subsurface material from this excavation included chipped stone debris of various colors of chert, basalt, obsidian, rhyolite, and chalcedony, and burned and unburned bone (Gadd n.d.). Aside from the Folsom preform and Midland base, no other artifacts attributable to the Paleoindian period were recovered from these two sites and no raw material similar to either the Folsom preform or Midland base was noted in the debitage.

In a recent review of Folsom land use in New Mexico, Amick (1994a–b) suggests that Folsom-age hunters seldom occupied upland, forested settings. Of the 86 Folsom-age sites in his study (Amick 1994b:14), only 17 (19.8%) occurred above 7,000 ft AMSL and no sites were found above 8380 ft AMSL. Additionally, all Folsom material above 7320 ft AMSL was represented by isolated artifacts. The two isolated Folsom artifacts from Quemado Lake are consistent with this pattern. Aside from three possible Folsom base fragments reported from Devils Park (Peterson 1988:113–114), the Quemado Lake finds represent the only Folsom-age evidence on the Gila National Forest. However, heavy ground cover and general low surface visibility in forested regions may play an as yet unrealized role in current models of Folsom land use in New Mexico.

The authors would like to thank Daniel S. Amick for reviewing the Folsom material and providing the information in the caption for Figure 1, and Robert Schiowitz of the Gila National Forest for permission to review the collection.

References Cited

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

——— 1994b Technological Organization and the Structure of Inference in Lithic Analysis: An Examination of Folsom Hunting Behavior in the American Southwest. In *The Organization of North American Prehistoric Chipped Stone Tool Technologies*, edited by P. J. Carr, pp. 9–34. International Monographs in Prehistory, Michigan.

Dechambre, D. J., and K. V. Hotsenpiller 1989 Quemado Lake Campground and Facilities: A Cultural Resource Survey. Ms. on file, Supervisor's Office, Gila National Forest, Silver City.

Gadd, P. n.d. Quemado Lake Data Recovery Program Final Report. Ms. on file, Supervisor's Office, Gila National Forest, Silver City.

Newton, R., and P. Gadd 1992 Quemado Lake Campground: Site AR-03-06-09-547 and AR03-06-09-550, Subsurface Testing Results and Data Recovery Plan. USFS Report No. 1992-06-048. Ms. on file, Supervisor's Office, Gila National Forest, Silver City.

Peterson, J. A. 1988 Settlement and Subsistence Patterns in the Reserve Phase and Mountain Mogollon: A Test Case in Devils Park, New Mexico. *Kiva* 53(2):113–127.

More Evidence of Paleoindian Occupation of the DB Site, Northeastern Kansas

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Three projectile points (Figure 1) are additional evidence of Paleoindian occupation of the DB site, a stratified, multicomponent occupation on a loess-mantled ridge in northeastern Kansas. Previously reported points of that period include a Folsom fragment and two Dalton fragments (Logan and Johnson 1997). The DB site overlooks the Missouri River Valley and that of its tributary, Salt Creek, on the Fort Leavenworth reservation. The site was excavated in 1995 and 1996 to mitigate the impact of construction of a new U.S. Disciplinary Barracks (Logan 1995, 1996, 1998).

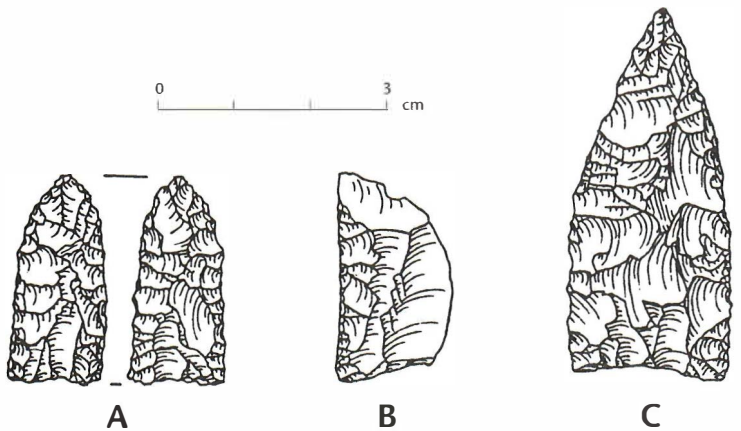

Figure 1. Paleoindian projectile points from the DB site, Fort Leavenworth, Kansas.

Cultural deposits at DB are in soils developed in Pleistocene and Holocene loess, including: 1) Peoria loess to within c. 1.3 m of the surface; 2) the Brady soil, a Pleistocene-Holocene transition soil that is discontinuously distributed throughout the Central Plains; and 3) the modern soil developed in Holocene-age Bignell loess. The A horizon of the Brady soil has been extensively eroded from the ridge and its B horizon is incorporated into that of the modern soil (Johnson 1998; Logan and Johnson 1997).

The modern soil horizon contains two ceramic-age components, one late Middle Woodland (Edwardsville phase, c. 1,600–1,400 yr B.P.) and the other

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late Prehistoric (Steed-Kisker phase). The latter occupation at DB has been AMS radiocarbon dated c. 700–600 yr B.P. The richest cultural assemblage from the site is pre-ceramic in age, and most of it was recovered from the welded B horizons. Stylistic attributes of projectile points and knives date it to the middle- and late-Archaic periods (c. 8,000–2,500 yr B.P.). Occupation during the terminal Archaic is also supported by AMS radiocarbon dates c. 2,800–2,600 yr B.P. (Logan 1998).

Five of the six Paleoindian points recovered at DB were clearly associated with the Brady B horizon and found at depths of 50–70 cm. Their original association was probably with the Brady A horizon, subsequently deflated. The stratigraphic provenience of the sixth point (Artifact C herein) is unclear.

Artifact A was found at a depth of 59–60 cm in a test unit dug during preliminary excavations in 1995 (Logan 1996). This complete lanceolate point is basally thinned, ground on stem edges, and made of an unidentified chert. It is 27.6 mm long, 12.6 mm wide, and 5.9 mm thick. Its small size is unusual but not unknown for Paleoindian points, and it is stylistically ambiguous. However, its stratigraphic context and depth as well as its lanceolate form suggest a Paleoindian affiliation.

Artifact B is the partial base of a Folsom point, one of two from the site (Logan and Johnson 1997). It is severely fire-fractured with one lateral edge and partial base edge remaining. Base and stem edges are heavily ground, and a flute is evident on one side; the other side has been removed by heat spalling. Retouch of the flute scar on the one visible surface indicates preparation for similar treatment of the other face, suggesting it had been fluted before spalling took place. Its maximum thickness is 4.2 mm. This point was found in the 1996 block excavation at a depth of 50–60 cm. It is made from Wreford chert, which occurs in primary bedrock contexts in the Flint Hills more than 50–60 km (37 mi) west of DB.

Artifact C is a complete lanceolate point, nicely thinned basally. While the base is finished, the blade edges appear unfinished. With respect to its general morphology, basal concavity and basal thinning, it is similar to a Plainview point. Slight beveling to the edge and hinge fractures on the blade suggest it had been used and resharpened while hafted. It is 48.5 mm long, 21.7 mm wide, and 5.4 mm thick. It is made from Plattsmouth chert, which occurs in bedrock outcrops of Hancock Hill 1 km south of DB. The point was displaced during mechanical stripping of the site in 1996; its depth provenience is imprecise.

Paleoindians were probably attracted to the DB ridge by the vista it presented of any game in Salt Creek and Missouri River valleys. The small number of points and the fragmented nature of most indicate the occupations were brief and included the refitting of hunting implements. These artifacts provide further evidence of upland settlement in the eastern Central Plains during the late Pleistocene. Their buried context and the clear association of most of them with the Brady soil underscore the archaeological potential of the Lower Missouri River loess uplands.

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References Cited

Johnson, W. C. 1998 Geoarchaeology. In Prehistoric Settlement of the Lower Missouri Uplands: The View from DB Ridge, Fort Leavenworth, Kansas, edited by B. Logan, pp. 25–62. *University of Kansas, Museum of Anthropology, Project Report Series* No. 98.

Logan, B. 1995 The DB Site: National Register Evaluation of a Multicomponent Occupation, Fort Leavenworth, Kansas. *University of Kansas, Museum of Anthropology, Project Report Series* No. 92.

——— 1996 The DB Site: Data Recovery Plan for a Stratified Prehistoric Upland Occupation, Fort Leavenworth, Kansas. *University of Kansas, Museum of Anthropology, Project Report Series* No. 96.

——— 1998 Prehistoric Settlement of the Lower Missouri Uplands: The View from DB Ridge. Report submitted to the Kansas City District, U.S. Army Corps of Engineers and Fort Leavenworth, Kansas. *University of Kansas, Museum of Anthropology, Project Report Series* No. 98.

Logan, B., and W. C. Johnson 1997 Paleoindian Occupation of the Lower Missouri River Loess Hills: Buried Evidence from DB Ridge, Fort Leavenworth, Kansas. *Current Research in the Pleistocene* 14:48–50.

Stratified Paleoindian Deposits at the Big Eddy Site, Southwest Missouri

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Excavations at the Big Eddy site (23CE426) along the Sac River have demonstrated the presence of stratified Paleoindian deposits, as well as underlying pre-Clovis deposits dating to the 13th millennium B.P. The Sac River lies along the western flank of the Ozarks at the prairie-forest border. During the 1960s and 1970s, intensive research was undertaken in the neighboring lower Pomme de Terre Valley, establishing a long sequence of human occupancy and a geochronological record of nearly 100,000 years (Haynes 1985; Kay 1982; King 1973; McMillan 1971; Saunders 1977; Wood and McMillan 1976). However, the search for in situ Paleoindian deposits in the Pomme de Terre Valley proved largely elusive.

The Big Eddy site contains multiple Paleoindian components in thick, well-stratified, dateable alluvial deposits. Although the site also has Archaic, Woodland, and Mississippian components, the 1997 excavations focused on the earliest prehistoric deposits associated with a paleosol developed in late-

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Pleistocene/early-Holocene alluvium. The alluvial unit, exposed in a 5.2-m-high cutbank, is similar to the Rodgers Formation defined in the lower Pomme de Terre River valley (Brakenridge 1981; Haynes 1976, 1985). In the lower Sac River valley, this formation consists of at least three distinct alluvial members, tentatively identified as early Rodgers (Ia), middle Rodgers (Ib), and late Rodgers (Ic).

The early Rodgers alluvium, approximately 2.2 m thick, consists of a silty clay loam grading down to a sandy loam overlying gravel. It is pedogenically altered by a buried A-Bt-BC profile designated Paleosol 1. Diagnostic Paleoindian artifacts and AMS-dated charcoal from early Rodgers fill indicate deposition about 13,000–10,000 years ago. Early-Archaic artifacts occur just above Paleosol 1, indicating an early-Holocene age for initial deposition of middle-Rodgers alluvium. Basal middle Rodgers alluvium associated minimally with Graham Cave points have been AMS-dated to 9,525 ± 65 yr B.P. (AA-27479), whereas basal late-Rodgers alluvium yielded late-Archaic artifacts and a standard age of 4,020 ± 80 yr B.P. (Beta-109009).

Late-Paleoindian artifacts are confined to the 3Ab horizon of Paleosol 1. At least two late-Paleoindian components have been identified, San Patrice and Dalton. Due to small sample size, it is unclear if San Patrice and Dalton are stratified within the paleosol. Three San Patrice points were recovered from the upper 15 cm of Paleosol 1 (Figure 1A–C). One is a classic San Patrice (Collins 1995; Ensor 1986; Webb et al. 1971); the other two are St. Johns variants of San Patrice (Duffield 1963). Charcoal recovered adjacent to the classic San Patrice point yielded an AMS date of 10,185 ± 75 yr B.P. (AA-26653). The central portion of the 3Ab has produced an AMS date of 10,400 ± 75 yr B.P. (AA-27487), and the basal portion has yielded dates of 10,470 ± 80 yr B.P. (AA-27488) and 11,280 ± 75 yr B.P. (AA-27485).

Prior to our excavations, at least three Dalton points had been found on the site's cutbank by collectors. We recovered three Dalton point fragments (Figure 1D–F). Two were found in situ in the cutbank in the upper portion of

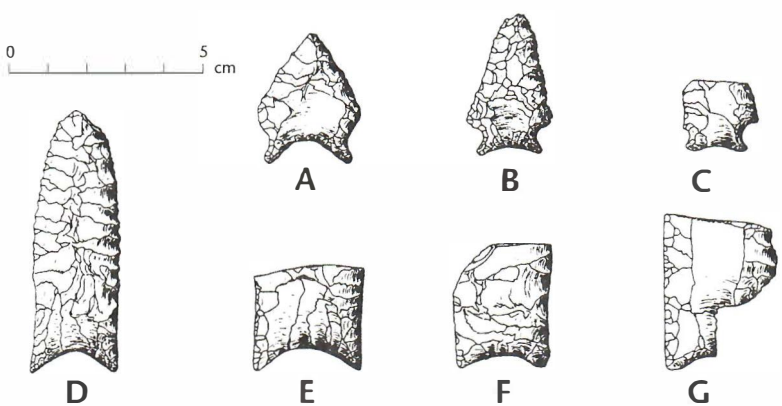

Figure 1. Projectile points found at Big Eddy site: **A–C,** San Patrice points; **D–F,** Dalton point fragments; **G,** fluted point fragment.

the 3Ab horizon of Paleosol 1. The third Dalton point was found displaced on the cutbank. Besides Dalton and San Patrice, five Packard-like and two Plainview-like points have been found on cutbank slumpage by collectors.

A large amount of lithic manufacturing debris, preform rejects, and preform fragments occur in the 3Ab horizon of Paleosol 1. Fourteen lithic features were recorded, all consisting of dense concentrations of debitage and occasional broken preforms. These lithic features comprise collected piles of knapping debris (presumably swept-up/dump piles). They represent discrete episodes of lithic reduction, primarily of stream cobbles of a high-quality fine-grained variety of Jefferson City chert (Ray 1983).

Early- to middle-Paleoindian artifacts were recovered from the 3Btb1 horizon about 10–30 cm below the base of the 3Ab horizon. The only in situ diagnostic artifact is a fluted point fragment (Figure 1G), found at 3.30–3.31 m below ground surface. Remarkably, two refit (midsection and basal) pieces of the same point were found 0.35 m apart, separated vertically by 0.01 m. It has a strong affinity to the Gainey type (Simons et al. 1984), having flutes the entire length of the fragment on both faces. A piece of charcoal found 2 cm below the fluted point yielded an AMS assay of 10,710 ± 85 yr B.P. (AA-26654). Another piece of charcoal 0.16 m below the fluted point dated to 10,940 ± 80 yr B.P. (AA–26655).

Some in situ artifacts were also recovered well below the Clovis/Gainey point. Three large manuports and three flakes were found at a depth of 3.7–3.8 m, directly above an extensive gravel bed situated at about 3.8–3.9 m below surface. The gravel bed, 0.10–0.15m thick, extends across a large portion of our excavations, thereby sealing any potential cultural deposits located below 3.9 m. Several small fragments of charcoal were recovered below the gravel lens. One fragment from 4.1 m below ground surface (0.05 m below the base of the gravel bed) yielded an AMS date of 12,950 ± 120 yr B.P. (Beta–109008). This date and the artifacts found just above the gravel lens suggest the possibility that pre–Clovis materials may be present as deep as 80 cm or more below the Clovis levels; however, excavations at these depths have been extremely limited.

References Cited

Brakenridge, G. R. 1981 Late Quaternary Floodplain Sedimentation along the Pomme de Terre River, Southern Missouri. *Quaternary Research* 15(1):62–76.

Collins, M. B. 1995 Forty Years of Archeology in Central Texas. *Bulletin of the Texas Archeological Society* 66:361–400.

Duffield, L. F. 1963 The Wolfshead Site: An Archaic-Neo-American Site in San Augustine County, Texas. *Bulletin of the Texas Archaeological Society* 34:83–141.

Ensor, H. B. 1986 San Patrice and Dalton Affinities on the Central and Western Gulf Coastal Plain. *Bulletin of the Texas Archeological Society* 57:69–81.

Haynes, C. V., Jr. 1976 Late Quaternary Geology of the Lower Pomme de Terre Valley. In *Prehistoric Man and His Environments: A Case Study in the Ozark Highland*, edited by W. R. Wood and R. B. McMillan, pp. 47–61. Academic Press, New York.

——— 1985 *Mastodon-Bearing Springs and Late Quaternary Geochronology of the Lower Pomme de Terre Valley, Missouri*. The Geological Society of America Special Paper No. 204.

Kay, M. 1982 *Holocene Adaptations Within the Lower Pomme de Terre River Valley, Missouri, Vols. I–III.* Illinois State Museum Society, Springfield.

King, J. E. 1973 Late Pleistocene Palynology and Biogeography of the Western Missouri Ozarks. *Ecological Monographs* 43:539–565.

McMillan, R. B. 1971 *Biophysical Change and Cultural Adaptation at Rodger's Shelter, Missouri.* Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Ray, J. H. 1983 A Study of Ordovician and Mississippian Chert Resources in Southwest–Central Missouri. *The Missouri Archaeologist* 44:109–134.

Saunders, J. J. 1977 *Late Pleistocene Vertebrates of the Western Ozark Highlands, Missouri.* Illinois State Museum Reports of Investigations No. 33, Springfield.

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

Webb, C. H., J. L. Shiner, and E. W. Roberts 1971 The John Pearce Site (16CD56): A San Patrice Site in Caddo Parish, Louisiana. *Bulletin of the Texas Archaeological and Paleontological Society* 42:1–49.

Wood, W. R., and R. B. McMillan, editors 1976 *Prehistoric Man and His Environments: A Case Study from the Ozark Highland.* Academic Press, New York.

Recent Field Research at the Folsom Site (29CX1), New Mexico

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The Folsom site (29CX1) is one of the most widely known archaeological localities in North America. Yet it is also one of the least known—in scientific terms. The original excavations (1926–1928) by crews from the Denver, and American, Museums of Natural History focused on documenting the association of the artifacts with the bison skeletons and determining the site's age (Meltzer, in press). All together, nearly 270 m^2 of the site was excavated, mostly in 1928, producing the remains of nearly 30 *Bison antiquus.* During and since the excavations, at least 24 Folsom fluted points were recovered, along with a flake knife and a quartzite flake scraper (Todd and Hofman, in press; also, Brown 1928; Dixon and Marlar 1997; Howard 1943:228; Howarth to Cook, February 26, 1932, Cook Papers, Agate Fossil Beds National Monument; Meltzer, unpublished data; Reed 1940).

In an effort to enhance our understanding of the site, an interdisciplinary field project was initiated in 1997. The work, which includes analyses of museum collections and archival materials (see also Todd and Hofman, in press), focuses on several issues: the scale of the kill, bison butchering patterns, the taphonomy of the bone bed, artifact technology and variability, the site's topographic, geomorphic, stratigraphic, and paleoenvironmental set-

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ting, and whether there exists a Folsom-age camp or other activities associated with the bison kill (e.g., Hofman 1996; Jodry 1992).

Analyses of the data recovered in 1997 continue and most results are preliminary, but we can report several provisional findings. The site is presently bisected and exposed by Wild Horse Arroyo, but at the time of the Folsom occupation was alongside the paleochannel of Wild Horse Arroyo. Both the modern and Pleistocene drainages cut into the Pierre shale (Cretaceous) bedrock, roughly on northwest-southeast trend. The Folsom bonebed was not situated fully within the paleochannel, but instead appears to extend from what would have been the southern edge of that channel up into a tributary headcut which heads southwest of the present (and paleo) arroyo. Machine coring, hand augering, and geophysical surveys suggest the main channel of that headcut may still exist deeply buried at the site, and that the valley wall on the western edge of the headcut was at least 2 m above the bone bed floor. Whether this valley wall influenced or otherwise guided the tactics of the kill (e.g., helping trap or maneuver the bison) is yet unknown.

The west side of the bone bed yielded skeletons "more or less mixed," in apparent contrast to isolated individual bison that occurred in the eastern half of the site. Moreover, the west side apparently yielded a higher density of bison remains (Brown 1928). These raise the possibility a bison processing area was present but unrecognized in this part of the site. Testing in 1997 revealed portions of the bone bed may extend (perhaps several meters) into the west wall of the original excavations, opening the possibility of testing whether remnants of butchering and processing areas are present here.

The stratum containing the bison and artifacts—unit *f2* of Haynes (Haynes et al. 1992)—slopes from southwest to northeast across Wild Horse Arroyo (based on the 1928 data, the slope was 9 cm per meter across the bone bed; across the entire site, based on our coring, the slope is just 3 cm per meter). In 1928, bone was found on both sides of the arroyo: within approximately 1.5 m of the surface on the south side, but nearly 3.6 m below the surface on the north side (Kaisen 1928). The 1928 records indicate most bone was found at a depth of 2 m below the surface; the fluted projectile points generally occurred nearly 3 m below the surface (Kaisen 1928; Carl Schwachheim, unpublished diary). That difference may reveal the difficulty Folsom hunters had in retrieving their weaponry from the deeper carcasses.

Unit *f2* extends southwest into the tributary headcut, approximately 50 m beyond the southern limit of the 1928 excavations. It is not yet known whether archaeological materials occur in that area, but charcoal was found in the augering, and bison bone was found in a test unit placed a few meters south of the 1928 excavations. The augering and coring results also strongly hint that the surface of *f2* plateaus approximately 6–10 m beyond the southern edge of the 1928 excavations (thereby accounting for the different slopes for the *f2* surface, noted above). This may have been the closest area of level ground to the bone bed, where Paleoindian groups would have had easiest access to the kill and to water, and where they would have been able to protect the bison carcasses from scavengers. Whether or not any kill-related or camp activities took place there is not yet known.

Archaeological surface surveys in 1997 yielded no trace of any Folsom-age activities on the uplands surrounding the site. This finding confirmed Anderson's earlier (1975) results, which showed a noticeable scarcity of archaeological material of *any* age in this area. A preliminary survey of the modern vegetation conducted by Lisa Huckell (1997) found that subsistence plant foods are very rare in this area. Such scarcity of vegetation would preclude hunter-gatherers from staying for prolonged periods; subsistence activities were therefore probably ephemeral and involved exploitation of local game resources—as corroborated by Anderson's (1975) disproportionately high tallies of projectile points (relative to other tools).

If plant foods were also rare in late-Pleistocene times (as large-scale paleoclimatic models might suggest), it naturally raises the question of whether Folsom Paleoindians would have found sufficient resources to linger beyond the period necessary to prepare the meat from their kill—or even for them to overwinter in the area (the kill took place in late summer [Todd and Hofman, in press]). What other resources beyond bison may have been available is unknown; archival data indicate deer and a few species of small mammals were also recovered in the bone bed, but their association with the Folsom activities is unknown. Efforts are underway to fill in the details of the late-Pleistocene environments using a variety of analyses (including isotopic studies) on bison bone, sediment, pollen, and gastropod samples from the site and the area.

The site is extensively eroded, but apart from the cutting of Wild Horse Arroyo itself, most of the erosion took place in already excavated areas of the site and did not significantly impact deposits left intact after 1928. The Folsom site thus appears to have sufficient undisturbed areas to again yield important information on North American Paleoindian occupations. Additional work is planned at the site.

Research at Folsom involved the help and collaboration of several colleagues: for their contributions, we would like to thank Grant Hall, C. Vance Haynes, Bruce and Lisa Huckell, Robert L. Kelly, Roger Phillips, Jim Theler, Doug Wiens, and Crayton Yapp. We are grateful to all the crew members—many of whom were volunteers—who participated in the fieldwork. We received helpful advice and cooperation from several individuals in various agencies of the State of New Mexico: special thanks are extended to Norm Nelson, of the New Mexico State Land Office, for keeping a friendly eye on the site and our work. We are indebted to Emily Burch Hughes and Tom Burch, Carl Schwachheim's niece and nephew, for providing a copy of their uncle's diary, a valuable record of his important work at the site. For their gracious hospitality and much appreciated logistical support, we are most grateful to Leo and Wende Quintanilla, and Fred Owensby. This work was supported by the Quest Archaeological Research Fund.

References Cited

Anderson, A. B. 1975 "Least Cost" Strategy and Limited Activity Site Location, Upper Dry Cimarron River Valley, Northeastern, New Mexico. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Brown, B. 1928 The Folsom Culture. Unpublished paper prepared for the 23rd International Congress of Americanists, New York.

Dixon, E. J., and R. Marlar 1997 A New Discovery at the Folsom Type Site. *Plains Anthropologist* 42:371–374.

Haynes, C. V., R. Beukens, A. T. Jull, and O. K. Davis 1992 New Radiocarbon Dates for Some Old Folsom Sites: Accelerator Technology. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 83–100. Denver Museum of Natural History, Denver.

Hofman, J. 1996 Early Hunter-Gatherers of the Central Great Plains: Paleoindian and Mesoindian (Archaic) Cultures. In *Archaeology and Paleoecology of the Central Great Plains*, edited by J. Hofman, pp. 41–100. Arkansas Archaeological Survey Research Series, No. 48.

Howard, E. B. 1943 The Finley Site: Discovery of Yuma Points, in situ, Near Eden, Wyoming. *American Antiquity* 8:224–234.

Huckell, L. 1997 Folsom Site Modern Vegetation Summary. Unpublished report on file, Department of Anthropology, Southern Methodist University, Dallas, Texas.

Jodry, M. 1992 Fitting Together Folsom: Refitted Lithics and Site Formation Processes at Stewart's Cattle Guard Site. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology*, edited by J. Hofman and J. Enloe, pp. 179–209. BAR International Series 578.

Kaisen, P. 1928 Record of Folsom Bison Quarry. Unpublished Field Notes on file, Department of Vertebrate Paleontology Archives, American Museum of Natural History, New York.

Meltzer, D. J. in press Status and Ranking at Folsom. In *Folsom Archaeology*, edited by M. Jodry and D. Stanford. Smithsonian Institution Press, Washington, D.C.

Reed, E. K. 1940 Archaeological Site Report on Folsom, New Mexico (Theme I: Early Man). Unpublished manuscript prepared for the Historic Sites Survey, Region III, National Park Service. Santa Fe, New Mexico.

Todd, L., and J. Hofman in press Variation in Folsom Age Bison Assemblages: Implications for the Interpretation of Human Action. In *Folsom Archaeology*, edited by M. Jodry and D. Stanford. Smithsonian Institution Press, Washington, D.C.

1997 Excavations at the Martens Site, 23SL222

Julie Morrow

Archaeological excavation of 139 m^2 at the Martens site in Chesterfield, Missouri, was accomplished in the summer of 1997 with the help of over 124 volunteers. The Martens site contains a Clovis habitation area that was previously documented (Koldehoff et al. 1995). This site is located in the uplands overlooking the Missouri River Valley. Since discovering the site in 1968, Dick Martens collected many early- and middle-stage bifaces, fluted points and fluted preforms, end scrapers, side scrapers, a limace, two blade cores and numerous blades (J. Morrow 1996). Based on the numbers of diagnostic Clovis artifacts recovered from the surface and subsurface thus far, 23SL222 appears to be one of the most intensively occupied Clovis habitation sites in the Midwest. When it was learned that the site was slated for a housing development, a major effort was made to negotiate with the landowner and an associated development corporation for permission to conduct excavations before the site was destroyed.

Fortunately, Dick Martens had the foresight to map many of the artifacts he

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surface-collected at 23SL222. Using Dick's map, the excavation area was narrowed down to a 2-acre area. It took a year to obtain permission, design the excavation strategy, and plan logistics. We were given one month to excavate. To my knowledge, this was the first archaeological excavation of an upland Clovis site in St. Louis County. A 2-acre area of the site was kept out of cultivation in the spring of 1997. This area was tested by excavating several widely spaced 1-by-1-m units. The plow zone was excavated as a single level by shovel skimming. Below the plow zone, arbitrary 5-cm levels were excavated using trowels. Except for five 20-by-20-cm and one 50-by-50-cm stratified soil columns, all excavated soil was screened through ¼-inch hardware cloth.

In sub-plow zone levels, all artifacts larger than 2 cm were piece-plotted. The soil profiles of the initial 1-by-1-m test units indicated that much of the 2-acre area was severely eroded. The northwest corner of the fallow area yielded Clovis artifacts and multiple piece-plotted artifacts within and below the plow zone, so further excavation focused primarily in this area. Of the total 139 m^2, a block of 96 m^2 was excavated in an area of the site that contained many artifacts below the plow zone (Figure 1). A smaller block of 12 m^2 was located to the northwest. The soil profile in the smaller block was more severely eroded, but did yield a Clovis side scraper and a Clovis preform base from below the plow zone. Although no cultural features or charcoal was encountered during our excavation, a number of Clovis tools and debitage were recovered. Many of these were derived from the B soil horizon, below the plow zone.

Excavated Clovis tools include one complete fluted point (Figure 1A), one end scraper, several side scrapers (Figure 1C and D), many unmodified, modified, and utilized blades (Figure 1F), one crested blade (Figure 1E), and several single- and multiple-spurred gravers (Figure 1B). Raw material frequency of diagnostic Clovis tools and debitage appears to be roughly equivalent to that of the surface collection. Burlington chert is the dominant raw material, occurring as nearly every type of tool. Salem chert is the second most common raw material, occurring predominantly as fluted and unfluted bifaces. Burlington chert is available within a few kilometers of the site. Salem chert occurs as fist-sized to basketball-sized nodules in the drainage heads surrounding the site. Most of the blades at the site were made of Burlington chert. Sediment analyses and refitting will be used to interpret the cultural and natural processes that created the spatial arrangement of artifacts at the site. Use-wear analysis of select Clovis tools is also planned.

My deepest thanks go to the many dedicated volunteers and local residents who helped in various ways during the Martens site excavation, especially Dick Martens, Larry Kinsella, and Joe Harl. Mr. C. Randall Aselage and The Nooning Tree Partnership are commended for their support and patience. I am grateful to The Missouri Archaeological Society, the Greater St. Louis Archaeological Society, and the Arkansas Archeological Survey for supporting our research at the Martens site. To Toby Morrow, who helped me make this project a reality, I am eternally indebted. I accept responsibility for any errors herein.

References Cited

Koldehoff, B., J. E. Morrow, T. A. Morrow, and R. E. Martens 1995 The Martens Site (23SL222):

Haynes, C. V., R. Beukens, A. T. Jull, and O. K. Davis 1992 New Radiocarbon Dates for Some Old Folsom Sites: Accelerator Technology. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 83–100. Denver Museum of Natural History, Denver.

Hofman, J. 1996 Early Hunter-Gatherers of the Central Great Plains: Paleoindian and Mesoindian (Archaic) Cultures. In *Archaeology and Paleoecology of the Central Great Plains*, edited by J. Hofman, pp. 41–100. Arkansas Archaeological Survey Research Series, No. 48.

Howard, E. B. 1943 The Finley Site: Discovery of Yuma Points, in situ, Near Eden, Wyoming. *American Antiquity* 8:224–234.

Huckell, L. 1997 Folsom Site Modern Vegetation Summary. Unpublished report on file, Department of Anthropology, Southern Methodist University, Dallas, Texas.

Jodry, M. 1992 Fitting Together Folsom: Refitted Lithics and Site Formation Processes at Stewart's Cattle Guard Site. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology*, edited by J. Hofman and J. Enloe, pp. 179–209. BAR International Series 578.

Kaisen, P. 1928 Record of Folsom Bison Quarry. Unpublished Field Notes on file, Department of Vertebrate Paleontology Archives, American Museum of Natural History, New York.

Meltzer, D. J. in press Status and Ranking at Folsom. In *Folsom Archaeology*, edited by M. Jodry and D. Stanford. Smithsonian Institution Press, Washington, D.C.

Reed, E. K. 1940 Archaeological Site Report on Folsom, New Mexico (Theme I: Early Man). Unpublished manuscript prepared for the Historic Sites Survey, Region III, National Park Service. Santa Fe, New Mexico.

Todd, L., and J. Hofman in press Variation in Folsom Age Bison Assemblages: Implications for the Interpretation of Human Action. In *Folsom Archaeology*, edited by M. Jodry and D. Stanford. Smithsonian Institution Press, Washington, D.C.

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A Clovis Occupation in St. Louis County, Missouri. *Current Research in the Pleistocene* 12:24–26.

Morrow, J. E. 1996 The Organization of Early Paleoindian Lithic Technology in the Confluence Region of the Mississippi, Illinois, and Missouri Rivers. Ph.D. dissertation, Department of Anthropology, Washington University, St. Louis.

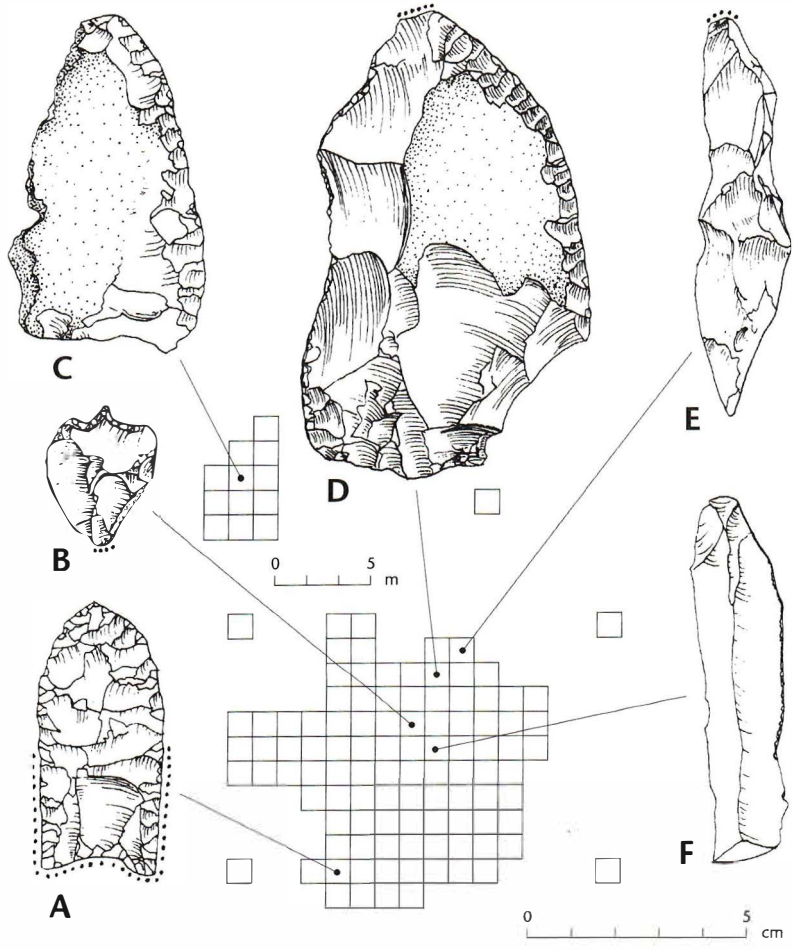

Figure 1. Plan map showing a portion of the Martens site excavations and selected Clovis tools. **A,** fluted point; **B,** unifacial graver; **C** and **D,** unifacial side scrapers; **E,** crested blade; **F,** utilized blade.

Preliminary Results of Excavations and Analysis of Little River Rapids: A Prehistoric Inundated Site in North Florida

Mark Muniz

During October 1996 and May 1997, the Aucilla River Prehistory Project (ARPP) resumed archaeological/paleontological research at the Little River Rapids site (8Je603), a prehistoric inundated site in the eastern panhandle of Florida. The site exists within the confines of the Aucilla River channel, at depths ranging from 1.83 m to 4.88 m below mean tide level. A controlled surface collection of the site was conducted in 1987 by the Paleontological and Archaeological Research Team of Florida (PART) lead by Craig Willis (1988). While this initial collection established the presence of Paleoindian through mid-Archaic occupation of the site, little else was known about the potential for in situ cultural deposits. The ARPP's goal in conducting research at the site is to evaluate the stratigraphic integrity of sediment deposits along the margins of the river channel, as well as to document site formation processes unique to a karst river setting, such as the Aucilla River.

Excavations conducted during the 1996 and 1997 field seasons revealed an intact stratigraphic column documenting the terminal Pleistocene environment. At approximately 2.75 m below mean tide level, a soft, gray sandy loam was encountered (Zone 3) which produced a radiocarbon date of 10,910 ± 110 yr B.P. (Beta-111676). Zone 3 continued for approximately 0.5 m and overlay a pebbly, gray loamy sand (Zone 4) which yielded a radiocarbon date of 11,770 ± 80 yr B.P. (Beta-111677). Both these dates were made on bulk sediment samples. The lower levels of Zone 4 increased in limestone pebble and cobble content before revealing a layer of extinct faunal remains lying just above a paleosol (Zone 7). The extinct fauna include mammoth (*Mammuthus columbi*); horse (*Equus* sp.); ground sloth (*Megalonyx jeffersonii*); tapir (*Tapirus veroensis*); and muskrat (*Ondatra zibethicus*). The remains have undergone a minor redeposition yet represent some of the latest dated examples of these species. Radiocarbon dates from wood fragments directly associated with the extinct faunal remains are 11,450 ± 90 yr B.P. (Beta-107296), 11,730 ± 70 yr B.P. (Beta-107297) and 12,130 ± 70 yr B.P. (Beta-111675), the last date coming from material that was slightly redeposited from the surface of the paleosol directly below the extinct faunal layer. A radiocarbon date of 13,130 ± 230 yr B.P. (Beta-107295) was taken from tree stump remains growing in the upper level of the Zone 7, while a bulk sediment sample from deeper within Zone 7 gave a date of 25,280 ± 390 yr B.P. (Beta-102273). Chert fragments recovered from the extinct fauna bearing level of Zone 4 and the surface of Zone 7 are not cultural in origin, yet attest to the nearness of a possible outcrop.

A coring project conducted in January 1997 provided detailed information

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on the geomorphology of the site. Ground penetrating radar surveys and sediment analyses were conducted by the Soil and Water Science Department of the University of Florida.

Nearly 80 percent of the artifact assemblage was surface collected in 1987, with the remainder of the assemblage recovered from both surface and stratigraphic contexts over the past two field seasons. The lithic assemblage, with just under 3,000 pieces, is currently undergoing analysis. Debitage is being analyzed with the Sullivan and Rozen (1985) "interpretation-free" approach as well as Ahler's (1989) mass analysis method. Rough estimates show shaped and unshaped tools constituting nearly 25 percent of the entire assemblage, with cores accounting for about 2 percent of the total. The assemblage seems to represent a base camp occupation and should provide insight into what has been termed the "water hole hypothesis." This hypothesis was originally proposed to account for why Suwannee and other Paleoindian artifacts seemed to continually occur in association with extinct fauna in the context of a flowing spring in the karst plain of Florida (Neill 1964; Dunbar et al. 1989).

Diagnostic artifacts include Hardaway Side Notched, Bolen, Arredondo, Kirk, Hamilton, and Archaic stemmed projectile points. Other diagnostic artifacts are ivory foreshaft fragments, a fluted biface preform, Aucilla adzes, and Hendrix scrapers, which are all characteristic of the Paleoindian and early-Archaic traditions of Florida (Bullen 1975; Daniel and Wisenbaker 1987; Purdy 1981). A single flake was recovered from Zone 3, level 2 which was dated 10,910 ± 110 yr B.P. (Beta-111676).

The assemblage includes more than 900 bone and antler artifacts, the vast majority (more than 775) being bone pin and point fragments. Nearly 50 complete pins and points were recovered, as well as a number of fish hooks and atlatl spurs. Analysis of all artifacts should be complete by summer 1998.

References Cited

Ahler, S. A. 1989 Mass Analysis of Flaking Debris: Studying the Forest Rather Than the Tree. In *Alternative Approaches to Lithic Analysis, Archaeological Papers of the American Anthropological Association 1*, edited by D. O. Henry and G. H. Odell, pp. 85–118.

Bullen, R. P. 1975 *A Guide to the Identification of Florida Projectile Points*. Kendall Books, Gainesville, Florida.

Daniel, I. R., Jr., and M. Wisenbaker 1987 *Harney Flats: A Florida Paleo-Indian Site*. Edited by R. W. Moeller, Baywood Publishing Co., Inc., Farmingdale, New York, pp. 41–97.

Dunbar, J. S., S. D. Webb, and D. Cring 1989 Culturally and Naturally Modified Bones from a Paleoindian Site in the Aucilla River, North Florida. In *Bone Modification*, edited by R. Bonnichsen and M. Sorg, pp. 473–97. Orono, Maine: Center for the Study of the First Americans.

Purdy, B. 1981 *Florida's Prehistoric Stone Technology*. University Presses of Florida, Gainesville, pp. 32–51.

Sullivan III, A. P., and K. C. Rozen 1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50(4):755–779.

Willis, C. 1988 Controlled Surface Collection of the Little River Rapids Site (8Je603): A Stratigraphically Deflated Site in the Aucilla River, North Florida. *The Florida Anthropologist* 41(3):453–470.

The Trull Site (40PY276): A Paleoindian-Mastodon Association in Tennessee

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The Trull site (40PY276) is located on an unnamed, secondary tributary of the Tennessee River in Perry County, Tennessee. This site is situated in the lower Tennessee River Valley within the Western Valley physiographic region (Fenneman 1938). The Trull site was discovered by Allen Trull, a high school biology teacher who recovered a mastodon tooth (*Mammut americanum*) and the distal portion of a tusk. A second mastodon tooth was found by another individual approximately 25 m downstream.

The ivory fragment is the distal portion of a tusk, which is thought to be mastodon as indicated by the recovery of the two teeth. The proximal end of this portion is rounded and displays wear, suggesting use as a billet for flint knapping (Figure 1). The remainder of the billet does not exhibit any modification characteristics of stream action. This implement measures 25.3 cm in length and tapers from 55.82 mm at the proximal to 33 mm at the distal diameters.

Figure 1. Mastodon billet recovered from the Trull site.

A visit to 40PY267 revealed a shallow stream fed by an adjacent spring system. This stream system drains this heavily dissected hill and valley region. The mastodon items were recovered from an exposed gravel bar, where small pieces of the ivory tusk were collected from the original location. Although no formal tools have yet been recovered, several blade-like flakes were found in the site vicinity. Close examination of the stream bed and environs, along with

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the non-tumbled appearance of these mastodon items, led to the interpretation that this ancient deposit has only recently been exposed by natural forces. This site may have been preserved and protected by deposits typical of a flooding sequence, or by deposits laid down by a beaver pond.

The geologic positioning of the Trull site and proposed depositional sequence are very similar to the Paleoindian-Mastodon association at the Coats-Hines site (40WM31) in middle Tennessee (Breitburg et al. 1997). Excavations are planned to determine if intact cultural deposits still exist here. This site will provide a better understanding of Paleoindian site selection, as well as add new information toward a predictive model for Paleoindian-Mastodon associations in the lower Tennessee River Valley.

References Cited

Breitburg, E., J. B. Broster, A. L. Reesman, and R. G. Stearns 1997 The Coats-Hines Site: Tennessee's First Paleoindian-Mastodon Association. *Current Research in the Pleistocene* 13:6–8.

Fenneman, N. M. 1938 *Physiography of Eastern United States.* McGraw Hill, New York.

Paleolithic Excavations in Tsagaan Agui Cave, Southern Mongolia

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From June to August 1997 the Joint Mongolian-Russian-American Archaeological Expedition (JMRAAE) continued a program of Paleolithic field research initiated in 1995. The preliminary results of the 1995 expedition, including a brief history of the multinational project, have been published as a trilingual monograph (Derevianko et al., 1996). A similar publication presenting principal results of the 1996 expedition (Derevianko et al.) is expected to be released in 1998.

The dolomitic limestone solution cavity in the eastern Gobi Altai range of south Mongolia, called Tsagaan Agui (White Cave), consists of a narrow inclining entryway, a lower grotto, a rotunda-like main chamber, and at least two smaller chambers behind the main rotunda.

In 1997, JMRAAE's focus of activity in Tsagaan Agui was to link the original Soviet-Mongolian soundings of 1988–1989 and our own excavations of 1995–1996 to yield a continuous longitudinal profile of the cave's main chamber down to the bedrock floor of the solution cavity.

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The cave's "lower grotto" was tested in 1995 and 1997, yielding many hundreds of artifacts typologically earlier than those recovered in the main Tsagaan Agui sequence. Interpretation of this assemblage is problematical at the moment, since some preliminary sediment analyses suggest that the lower grotto may contain materials redeposited from elsewhere in the Tsagaan Agui complex.

More than 2,800 stone artifacts have been recovered in the Tsagaan Agui excavations since 1995 in addition to perhaps twice that many pieces of debitage and unused flakes. Preliminary data from the 1997 excavations at Tsagaan Agui reinforce several general conclusions drawn from analyses of archaeological materials from the two previous field seasons: (1) raw material appears exclusively local (obtained within just a few hundred meters of the cave entrance), consisting mostly of jaspers and other cryptocrystalline quartz; (2) a stratified cultural sequence representing the late prehistoric/early Bronze Age through middle Paleolithic has been identified; (3) tools recovered from the deepest strata consist mostly of flake scrapers and constitute only a small portion (approximately 4%) of the lithic collection from these horizons; (4) flakes were derived from both prepared platform "Levallois" (Okladnikov 1986; Alekseev 1990) and polyhedral cores, with primary reduction having taken place outside of the cave, principally at the source of the raw material just above the cave entrance. Detailed contour and scatter density mapping of this workshop was completed in 1996, and ongoing analysis of these data is proving instructive as regards the origins of raw materials encountered in the Tsagaan Agui stone industry.

The large and diverse faunal sample recovered in the Tsagaan Agui excavations is currently undergoing analysis in Russia by Professors G. F. Baryshnikov (large vertebrates) and A. K. Agadjanian (microfauna). A wide range of mammalian and avian species has been identified thus far, many with important paleoecological implications (e.g., bison, gazelle, horse, and ostrich). In 1997, additional midden samples were collected from *Ochotona* (pika) and *Alticola* (vole) nests in the vicinity of the cave, since chronometric determinations performed on the 1996 samples yielded ages of no more than 1,300 ± 140 yr B.P. (GX-22673). University of Arizona doctoral candidate Jason Rech is currently analyzing these and other rodent middens from JMRAAE excavations at Chikhen Agui Cave (c. 150 km west of Tsagaan Agui) to provide a line of paleoecological inference supplementing faunal, palynological, sedimentological and similar data.

A series of chronometric dates is currently available for Tsagaan Agui, and more are expected by mid-1998 based on additional samples collected in 1997. Stratum 3 in the cave's main chamber has yielded an AMS ^{14}C date on wood charcoal of 33,840 ± 640 yr B.P. (AA-23158), and Stratum 4 is AMS ^{14}C dated at 32,960 ± 670 yr B.P. (AA-23159), also on wood charcoal. An infinite radiocarbon date (>42,000 yr B.P., MGU-1449) was obtained using conventional methods on a wood charcoal sample from Stratum 5, about midway down the stratigraphic section of the cave's ramped entryway. A paleomagnetic determination indicating reversed sediments is associated with the bottom of this same sedimentary column. Paleomagnetic samples were collected from the

cave's lower grotto this year in an attempt to help resolve the depositional history of that accumulation.

Tsagaan Agui's principal inner chamber was tested in 1996, and additional excavations were carried out this year. Wood charcoal collected in contact with and beneath a stone slab feature of indeterminate function (altar?) yielded an AMS ^{14}C date of 3,820 ± 55 yr B.P. (AA-23159), suggesting late Neolithic or early Bronze Age use of the cave's deep interior.

References Cited

Alekseev, V. P. (editor) 1990 *Paleolit i Neolit Mongolskogo Altaiya.* Novosibirsk: "Nauka."

Derevianko, A. P., J. W. Olsen, and D. Tseveendorj (editors) 1996 *Archaeological Studies Carried Out by the Joint Russian-MongolianAmerican Expedition in 1995.* Novosibirsk: Izdatelstvo, Russian Academy of Sciences, Siberian Branch, Institute of Archaeology and Ethnography.

——— 1998 *Archaeological Studies Carried Out by the Joint Russian-Mongolian-American Expedition in 1996.* Novosibirsk: Izdatelstvo, Russian Academy of Sciences, Siberian Branch, Institute of Archaeology and Ethnography.

Derevianko, A. P., and V. T. Petrin 1995 *Issledovaniya Peshchernogo Kompleksa TsaganAgui na Yuzhnom Fas Gobiskogo Altaiya v Mongolii.* Novosibirsk: Izdatelstvo, Russian Academy of Sciences, Siberian Branch, Institute of Archaeology and Ethnography.

Okladnikov, A. P. 1986 *Paleolit Mongolii.* Novosibirsk: "Nauka."

Anzick-Style Fluted Projectile Point

William L. Parsons and Kristen M. Parsons

During the summer of 1997, the basal section of a fluted projectile point was found in Cascade County, Montana. In discussion with Robson Bonnichsen it was confirmed that this projectile point is remarkably similar to some of the projectile points found as a part of the Anzick cache material (Wilke et al. 1991). This point was discovered on private property in a freshly plowed field. The soil composition is glacial till and loess overlying the geological unit known as the Kootenai Formation (Ross, et al. 1955). Within a 100-m radius of the discovery spot there were no artifactual lithic materials or features of any distinguishable nature appearing on the surface. The closest water source is a spring that occurs less than a mile from this field. Lithic debris representing several cultural components is abundantly scattered about this spring.

The projectile point (Figure 1) was made from a brownish gray translucent dendritic agate. In macroscopic comparison with chert specimens at the Holland Lithic Laboratory, it was found to be most similar to Shell chert from the Madison formation outcropping around the township of Shell in Big Horn County, Wyoming. The cross-section of this projectile point is plano/convex. The plano surface has a near opaque white patination. The transverse break at

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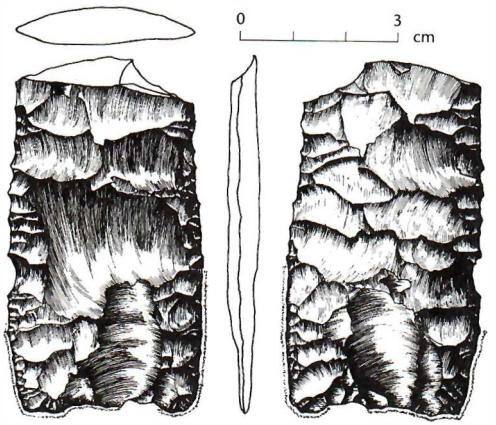

Figure 1. Fluted projectile point basal section from Cascade County, Montana. Line indicates ground edges. Illustration by William L. Parsons.

midsection has minimal patination, suggesting that the break occurred after the specimen was discarded.

Essential measurements are as follows:

66.47 mm length of fragment
6.79 mm thickness at midsection break

Grinding has occurred along lower edges and along the basal edge. The grinding on one edge is intact; the other edge is interrupted by random flaking shortly before its distal termination. A small portion of the ground edge along the base has been damaged in a similar fashion. In both cases it would appear that these points of damage occurred after the knapping process had been completed.

The measurements are:

29.37 mm grinding along complete edge
22.80 mm grinding up to damage

The measurements pertaining to the channel flakes are as follows:

23.70 mm length of channel flake on convex surface
15.39 mm maximum width of convex channel flake
22.39 mm length of channel on plano surface
15.66 mm maximum width of plano channel flake

The angle of the radius in relation to the concave basal edge is 9 degrees.

We are indebted to Robson Bonnichsen of the Center for the Study of the First Americans for his observations as to the stylistic nature of this specimen, John Holland of the Holland Lithic Laboratory at the Buffalo Museum of Science for his instruction and the use of his lithic reference collection, and John Tomenchuk of the Royal Ontario Museum for his discussions of use wear analysis. Also we would like to thank Richard Laub, Curator of Geology, and Kevin Smith, Curator of Anthropology at the Buffalo Museum of Science, Buffalo, N.Y., for their instruction, advice and encouragement.

References Cited

Ross, C. P., D. A. Andrews, and I. J. Witkind 1955 *Geologic Map of Montana,* Prepared in cooperation with the Montana Bureau of Mines and Geology

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

A New Fluted Stemmed Point from Belize and Its Implication for a Circum-Caribbean Paleoindian Culture Area

Georges A. Pearson and Peter A. Bostrom

Like that of many other areas of Central America, the Paleoindian record of the Yucatan Peninsula consists of undated surface finds. Thus far, diagnostic remains have only been encountered in Belize. Projectile points assigned to the Paleoindian period include a fluted example from the Ladyville site (Hester et al. 1986), several fluted stemmed types and the base of a possible Plainview point from the Sand Hill localities (MacNeish et al. 1980). All were discovered during the Colha Project and the Belize Archaic Archaeological Reconnaissance (BAAR) surveys (Hester 1979, MacNeish et al. 1980).

In the fall of 1997, the junior author acquired an unreported fluted stemmed point (Figure 1) from an avocational archaeologist who formerly owned land in Belize. Although the exact location of the point was not recorded, we know that it was found near the shore of the New River Lagoon in northern Belize, next to the Mayan site of Lamanai (Pendergast 1981). Unfortunately, it has not been possible to determine if this point is an isolated

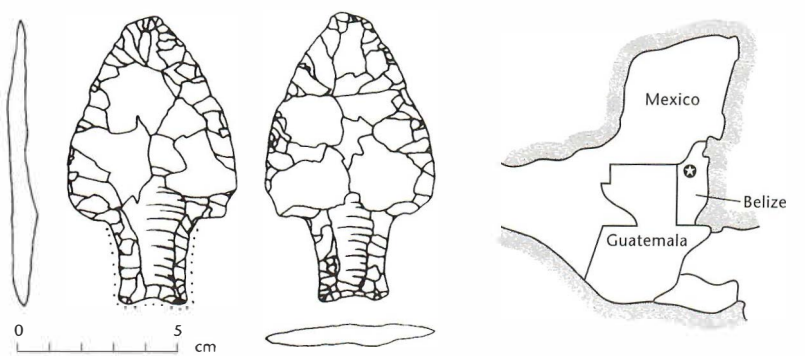

Figure 1. Fluted stemmed point found on surface in northern Belize.

find or part of a larger assemblage. It is made of chert and is now a dull, off-white color with a chalky pitted texture due to extreme patination (Hester et al. 1982). The point is fluted on both faces and possesses a heavily ground stem 26 mm long and 21 mm wide at the base. It measures 90 mm in length and has a maximum width and thickness of 52 mm and 6.9 mm, respectively. Both flutes extend beyond the stem and measure 39 mm and 29 mm in length. The point was manufactured by removing a series of large expanding flakes from

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the opposing margins. These flakes overlapped at the point's midline and effectively flattened its central surface. Final shaping was accomplished using bimarginal light percussion and pressure. The removal of both flute scar terminations by lateral thinning and the shaping of the stem attest to considerable post-fluting reduction during manufacture.

Similar points, described as fishtail Madden Lake–like (Ranere and Cooke 1991) and El Inga–like (Bell 1965), were discovered by MacNeish et al. (1980) during the BAAR survey and were included in their Lowe-ha complex. The shoulders on the Belize points are slightly broader and more angular than the classic South American Fell I types, which tend to taper gradually towards the stem (Bird 1969, Bird and Cooke 1978, Politis 1991, Schobinger 1972). However, these morphological variations might simply be attributable to different degrees of resharpening.

This new point shares technological characteristics with Madden Lake projectiles in that it was manufactured by thinning a large flat flake as opposed to being the end product of multi-stage bifacial reduction (Bird and Cooke 1978). This technological rapprochement, combined with the point's general typological characteristics, suggests a connection between these two areas. It is worth mentioning that some Belize specimens also resemble resharpened versions of Restrepo points from Colombia, which could extend the geographical distribution of this type (Ardila 1991, Bray 1984, Correal Urrego 1983, Reichel-Dolmatoff 1965).

In any case, we believe this latest example represents evidence of an ancient culture area associated with a Paleoindian population that inhabited and spread along the eastern coast of lower Central America and possibly South America. Radiocarbon dates from future sites will hopefully trace the direction of this expansion via this tentative route. It is important to note that other technological similarities, between waisted Clovis-like points of Florida and Panama (Faught and Dunbar 1996), indicate that population movements along the eastern coasts of the Americas may have begun earlier in time and encompassed the Gulf of Mexico (Painter 1983:66).

References Cited

Ardila, G. 1991 The Peopling of Northern South America. In *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 261–282. Center for the Study of the First Americans, Oregon State University, Corvallis.

Bell, R. E. 1965 *Investigaciones Arqueologicas en el Sitio de El Inga*. Casa de la Cultura, Quito.

Bird, J. B. 1969 A Comparison of South Chilean and Ecuadorian "Fishtail" Projectile Points. *The Kroeber Anthropological Society Papers* 40:52–71.

Bird, J. B., and R. G. Cooke 1978 The Occurrence in Panama of Two Types of Paleo-Indian Projectile Points. In *Early Man from a Circum-Pacific Perspective*, edited by A. L. Bryan, pp. 263–272, Occasional Papers No.1. Department of Anthropology, University of Alberta, Edmonton.

Bray, W. 1984 Across the Darien Gap: A Colombian View of Isthmian Archaeology. In *The Archaeology of Lower Central America*, edited by F. W. Lange and D. Stone, pp. 305–338. University of New Mexico Press, Albuquerque.

Correal Urrego, G. 1983 Evidencia de Cazadores Especializados en el Sitio de la Gloria, Golfo de Uraba. *Revista de la Academia Colombiana de Ciencias Exactas, Fisicas y Naturales* 58:77–82.

Faught, M. K., and J. Dunbar 1997 Paleoindian Archaeology in Two Regions Exhibiting Waisted Lanceolate Projectile Points: Florida and Panama. Paper presented at the 62nd Annual Meeting of the Society for American Archaeology, Nashville.

Hester, T. R. 1979 *The Colha Project, 1979: A Collection of Interim Papers.* Center for Archaeological Research, The University of Texas at San Antonio.

Hester, T. R., H. J. Shafer, T. C. Kelly, and G. Ligabue 1982 Observations on the Patination Process and Context of Antiquity?: A Fluted Projectile Point from Belize, Central America. *Lithic Technology* 11(2):29–34.

Hester, T. R., T. C. Kelly, and G. Ligabue 1986 *A Fluted Paleo-Indian Projectile Point From Belize, Central America.* Working Papers in Archaeology No. 1, Center for Archaeological Research, The University of Texas at San Antonio, San Antonio.

MacNeish, R. S., S. J. K. Wilkerson, and A. Nelken-Terner 1980 *First Annual Report of the Belize Archaic Archaeological Reconnaissance.* Robert F. Peabody Foundation for Archaeology, Andover.

Painter, F. 1983 Two Basic Paleo-Indian Lithic Traditions Evolving from a Southeastern Hearth (A Revolutionary Idea). *Archaeology of Eastern North America,* 11:65–79.

Pendergast, D. M. 1981 Lamanai, Belize: Summary of Excavation Results, 1974–1980. *Journal of Field Archaeology.*

Politis, G. C. 1991 Fishtail Projectile Points in the Southern Cone of South America: An Overview. In *Clovis: Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 287–301. Center for the Study of the First Americans, Oregon State University, Corvallis.

Ranere, A. J., and R. G. Cooke 1991 Paleoindian Occupation in the Central American Tropics. In *Clovis: Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 237–253. Center for the Study of the First Americans, Oregon State University, Corvallis.

Reichel-Dolmatoff, G. 1965 *Colombia: Ancient Peoples and Places.* Frederick A Praeger, New York.

Schobinger, J. 1972 Nuevos Hallazgos de Puntas "Colas de Pescado," y Consideraciones en Torno al Origen y Dispercion de la Cultura de Cazadores Superiores Toldense (Fell I) en Sudamerica. In *Atti del XL Congresso Internazionale Degli Americanist,* Vol. 1, Rome.

The Varney Farm Site: Dating the Late-Paleoindian Period in Northeastern North America

James B. Petersen and Belinda J. Cox

More than 10 years ago a distinctive late-Paleoindian period was postulated in northeastern North America, or the Northeast, and roughly dated to c. 10,000–8,000 B.P. However, this period had not been conclusively dated as of the mid-1980s (Doyle et al. 1985; Keenlyside 1985; Petersen et al. 1986; Tuck 1984; see Wright 1972:13–19). It was first recognized on the basis of a broad but seemingly light distribution of lanceolate projectile points, one recognizable form exhibiting very regular parallel flaking and another form less regularly flaked and more triangular in outline. The first of these point forms

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suggested some sort of relationship to late-Paleoindian forms in the Great Plains (e.g., Frison 1978; Wormington 1957), while the second form seemed more a local phenomenon, perhaps related to earlier fluted points (Keenlyside 1985).

Since the mid-1980s, evidence has steadily accumulated to support the existence of scattered late-Paleoindian occupation across much of the Northeast, at least for the lanceolate, parallel-flaked specimens, along with unequivocal evidence that such remains must predate c. 8,000 B.P. (e.g., Chapdelaine 1994:231–237; Sanger et al. 1992:150–155). Most recently, a presumed single component late-Paleoindian site, the Varney Farm (designated 36-57 ME by the Maine Historic Preservation Commission [MHPC]), was identified near the Nezinscot River in the town of Turner, Androscoggin County, Maine. It was discovered in 1993 during a small consulting archaeology study for what was then the U.S. Soil Conservation Service and the private landowners. In 1994, an extensive volunteer salvage excavation was undertaken at the Varney Farm site with partial support from the MHPC, ultimately covering an area of about 220 m^2, or roughly half the site area. About 120 lithic tools and 2,350 lithic flakes were recovered, nearly all representing two distinctive cherts, perhaps from Maine. The 16 parallel-flaked projectile point fragments are the most diagnostic tools recovered from the Varney Farm, representing nine individual points (Figure 1) (Cox and Petersen 1997: Figures 8 and 9). These points, like others found elsewhere in the Northeast, generally resemble projectile points of the Cody complex in the Plains, but without stemming in

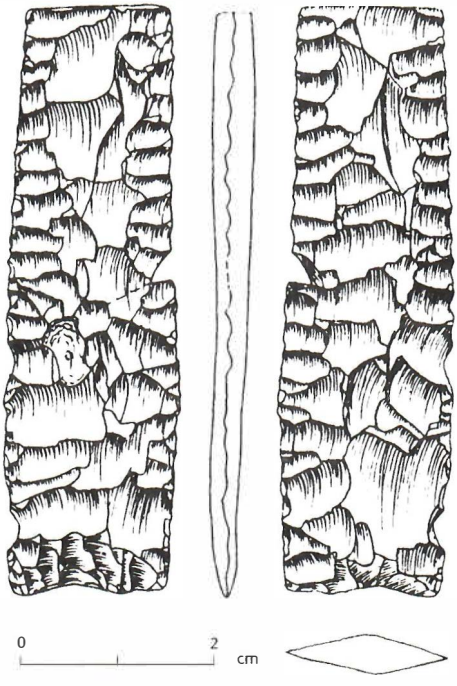

Figure 1. Late-Paleoindian parallel-flaked projectile point from the Varney Farm site, showing obverse and reverse surfaces.

all cases at the Varney Farm, except one. One or more may resemble earlier points of the Agate Basin complex (Frison 1978; Wormington 1957).

Although most of the late-Paleoindian artifacts originated in the shallow plow zone at the Varney Farm, four possible (but equivocal) cultural features were identified below the plow zone and one produced a noncultural conventional ^{14}C date of 2,280 ± 60 B.P. (Beta-73976). One other feature, 3, was conventionally ^{14}C dated to 9,410 ± 190 B.P. (Beta-79658), and later the same feature was assayed using five AMS dates. These additional dates include, from oldest to youngest: 8,700 ± 60 B.P. (Beta-88673), 8,620 ± 60 B.P. (Beta-93001), 8,430 ± 100 B.P. (Beta-81250), 8,420 ± 60 B.P. (Beta-88674), and 8,380 ± 100 B.P. (Beta-81251) (Cox and Petersen 1997:42).

The dating of the late-Paleoindian component at the Varney Farm site thus remains uncertain, but the older date of 9,410 B.P. is perhaps most appropriate for this occupation if a single occupation is represented, at least on the basis of accumulating evidence for the early-Archaic period in local and regional contexts, assuming that the late-Paleoindian and early-Archaic periods did not temporally overlap to any significant degree. Alternatively, the dates from site DcEd-1 in Quebec (Chapdelaine 1994) might suggest that the later cluster of dates at c. 8,700–8,380 B.P. is more appropriate for the Varney Farm, or perhaps they represent a second occupation. In either case, this would certainly mean that this occupation existed contemporaneously with rather different local Archaic period technologies. Dates on the Cody complex in the Plains suggest its duration was c. 9,500–8,500 B.P., or perhaps the latter half of this range; the Agate Basin complex dates back to c. 10,500–10,000 B.P. (Frison 1978; Holliday 1996). Consequently, the dates from the Plains do not help clarify dating of the late-Paleoindian period in the Northeast.

Available evidence nonetheless demonstrates a close contemporaneity and overall similarity between late-Paleoindian manifestations in the Plains and the Northeast, as well as elsewhere. Elucidation of the nature of the long-distance relationship between these and other areas in North America must await further investigation.

References Cited

Chapdelaine, C. (editor) 1994 *Il y a 8000 Ans à Rimouski: Paléoecologie et Archéologie d'un Site de la Culture Plano.* Pàléo-Quebec 22. Recherches Amerindiennes au Québec, Montreal.

Cox, B. J., and J. B. Petersen 1997 The Varney Farm (36-57 ME): A Late Paleoindian Encampment in Western Maine. *Maine Archaeological Society Bulletin* 37(2):25–48.

Doyle, R. A., N. D. Hamilton, J. B. Petersen, and D. Sanger 1985 Late Paleo-Indian Remains from Maine and Their Correlations in North-eastern Prehistory. *Archaeology of Eastern North America* 13:1–34.

Frison, G. C. 1978 *Prehistoric Hunters of the High Plains.* Academic Press, New York.

Holliday, V. T. 1997 *Paleoindian Geoarchaeology of the Southern High Plains.* University of Texas Press, Austin.

Keenlyside, D. L. 1985 Late Palaeo-Indian Evidence from the Southern Gulf of St. Lawrence. *Archaeology of Eastern North America* 13:79–92.

Petersen, J. B., N. D. Hamilton, R. A. Doyle, and D. Sanger 1986 Late Paleoindian Remains from Maine. *Current Research in the Pleistocene* 13:19–21.

Sanger, D., W. R. Belcher, and D. C. Kellogg 1992 Early Holocene Occupation at the Blackman Stream Site, Central Maine. In *Early Holocene Occupation in Northern New England*, edited by B. S. Robinson, J. B. Petersen, and A. K. Robinson, pp. 149–161. Occasional Publications in Maine Archaeology 9. Maine Historic Preservation Commission, Augusta.

Tuck, J. A. 1984 *Maritime Provinces Prehistory*. National Museum of Man, Ottawa.

Wormington, H. M. 1957 *Ancient Man in North America*, 4th edition. Denver Museum of Natural History Popular Series 4. Denver.

Wright, J. V. 1972 *Ontario Prehistory*. National Museums of Canada, Ottawa.

Subsistence and Settlement Patterns during the Pleistocene-Holocene Transition in the Northern Great Basin: The View from Dietz Basin

Ariane Oberling Pinson

Dietz Basin is located at the north end of Alkali Valley, Oregon, within 10 km of higher-elevation upland areas, including Horse Mountain. Although this part of Lake County is semiarid and vegetated with sagebrush steppe communities, during the late Pleistocene a large lake covered the area.

Dietz Basin's surface record consists mainly of Paleoindian (Clovis and Western Stemmed Point Tradition) artifacts that lie unconformably on late-Pleistocene lake deposits exhumed by eolian erosion. This erosion has removed younger Pleistocene-Holocene Transition-age deposits (PHT, 11,500–7,000 yr B.P.) across the basin. The Tucker site (35LK1529/65), located along the eastern basin margin, is an exception.

Based on the distribution of artifacts with respect to shoreline features across Dietz Basin, J. Willig (1989) hypothesized that PHT settlement focused on lake margin locations within the basin. The hypothesis that occupation and permanent lakes were contemporaneous can be tested at the Tucker site because a stratigraphic section spanning the PHT is preserved there. The last lake deposit visible in the section predates the PHT (Pinson n.d.). These lake sediments likely correlate with the lowest shoreline deposits at 1,318 m elevation along the basin margins. The lake sediments are separated from overlying granular silty-clay sediments by an erosional inconformity. The granular silty-clay grays upward. Marsh-dwelling gastropods (*Succinea*) (J. Mead, pers. comm. 7) occur in the lower third but are absent from the upper two-thirds. These data indicate a gradual transition from a marsh to a seasonally wet meadow across the basin. This deposit is overlain by lunette dune sediments deposited downwind of an active playa. Five AMS radiocarbon dates from the lunette deposit cluster between 9,100 and 9,600 yr B.P. Around 9,000 yr B.P., lunette activity ceased and a soil formed in the lunette deposit. Pedogenesis

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ended with the deposition of Mazama pumice and the formation of pumice dunes along the basin margin. The erosional event interpreted by Willig as a mid-Holocene-aged wave-cut scarp truncates the lunette and Mazama dune deposits, and the soils formed in them. This erosional event must be late Holocene in age. Its morphology indicates it is eolian in origin. Stratigraphic trenches in the basin center and along the northern and western basin margins have not provided evidence for lacustrine deposits of PHT age or younger. Trenches dug at shoreline locations proposed by Willig failed to reveal constructional shoreline deposits (e.g., beach sediments). The stratigraphic evidence is clear: throughout occupation terrestrial environments are represented. The occurrence of Clovis and Western Stemmed Tradition artifacts at sites in the middle of Willig's proposed lake beds support this interpretation of the stratigraphy.

Lithic debitage, ground stone, and burned bone were recovered from two blocks excavated at the Tucker site. Charcoal associated with stained sediment produced an AMS date of 9,420 ± 80 yr B.P. (uncorrected, Beta 102259). Burned bone from these assemblages was fragmented; less than five percent could be identified to genus. The genera represented were *Anas* (ducks), *Sylvilagus* (rabbits) and *Lepus* (hares) (Jung n.d.). Charcoal identification by K. Adams, R. Adams and L. Huckell indicates that fuel wood utilized during occupation was mainly sagebrush (*Artemisia*) (Pinson n.d.). Materials recovered in 1997, not reported here, support the 1996 findings.

The stratigraphic evidence does not support Willig's hypothesis that occupation and lakes in Dietz Basin were contemporaneous. PHT-age lacustrine deposits are absent, and shorelines lower than 1,318 m cannot be substantiated. Instead, seasonally wet meadows, playas, and dry basin floors were the dominant environments at this time. In the adjacent portions of Alkali Valley, shoreline deposits occur at elevations below the floor of Dietz Basin, indicating that a shallow, recessional lake may have existed within 1–2 km of Dietz Basin, at least during the early part of the PHT. Discharge from the Butte Creek drainage, 2 km east of the Tucker Site, may have contributed water to this lake. Ducks could have been reliably procured from either locale. Importantly, PHT sites are not known from Alkali Valley away from the Dietz Basin area (W. Cannon, pers. comm. 1997), indicating that the Dietz Basin area was the focus of settlement in this region.

Dietz Basin provided access to a diversity of environments. Upland, lowland dry, palustrine and riverine environments occurred within a 10-km radius from Dietz Basin, within easy foraging range. Comparison with subsistence remains from other sites (Connolly 1995, Mehringer and Cannon 1994, Oetting 1994) suggests that Paleoindian diets in the northern Great Basin were likely diverse, rather than specialized, reflecting a response to the shifting environmental mosaics at local and regional scales that accompanied the increasingly arid climates of the PHT.

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Fellowship. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the National Science Foundation. Barbara J. McKay's assistance with the fieldwork is gratefully acknowledged. As always, this paper benefited from the insightful criticisms of Dr. Bruce Huckell.

References Cited

Connolly, T. J. 1995 Human and Environmental Holocene Chronology in Newberry Crater, Central Oregon. Report to the Oregon Department of Transportation, State Museum of Anthropology, University of Oregon, Eugene.

Jung, S. n.d. Appendix A: Faunal Analysis Sites 35LK1529/Main, 35LK1529/64 and 35LK1529/65. In Further Archaeological Investigations in Dietz Basin, Lake County, Oregon: The Results of the 1996 Field Season, edited by A. O. Pinson, pp. A1–A12. Sundance Archaeological Research Fund Technical Paper, Reno, NV.

Mehringer, P. J., Jr., and W. C. Cannon 1994 Volcaniclastic Dunes of the Fort Rock Valley, Oregon: Stratigraphy, Chronology, and Archaeology. In *Archaeological Researches in the Northern Great Basin: Fort Rock Archaeology Since Cressman,* edited by C. M. Aikens and D. L. Jenkins, pp. 283–327. University of Oregon Anthropological Papers. Vol. 50. University of Oregon, Eugene.

Oetting, A. C. 1994 Early Holocene Rabbit Drives and Prehistoric Land Use Patterns on Buffalo Flat, Christmas Lake Valley, Oregon. In *Archaeological Researches in the Northern Great Basin: Fort Rock Archaeology Since Cressman,* edited by C. M. Aikens and D. L. Jenkins, pp. 155–170. University of Oregon Anthropological Papers. Vol. 50. University of Oregon, Eugene.

Pinson, A. O. n.d. Further Archaeological Investigations in Dietz Basin, Lake County, Oregon: The Results of the 1996 Field Season. Sundance Archaeological Research Fund Technical Paper, Reno.

Willig, J. A. 1989 *Paleo-Archaic Broad Spectrum Adaptations at the Pleistocene-Holocene Boundary in Far Western North America.* Ph.D. dissertation, University of Oregon.

Dating a Cody-complex Occupation in the Knife River Flint Quarries

Matthew J. Root

This paper reports a radiocarbon date on charcoal from a Paleoindian hearth at the Benz site (32DU452A), located in the Knife River flint quarries, North Dakota. The Benz site is a large workshop and camp with Paleoindian through late-Prehistoric components. The University of North Dakota conducted excavations in the northern edge of the site, revealing Cody-complex occupations. Excavations consisted of a 1-by-14-m trench and four isolated 1-by-1-m units. In the trench, we excavated two Scottsbluff points (Figure 1A, B) (Bradley and Frison 1987:219) from the early-Holocene Leonard Paleosol, which is preserved in the western part of excavations. The A-horizon of the paleosol extends from c. 55–95 cm below surface. We also recovered one resharpened Alberta point (Figure 1C) (Agenbroad 1978:67–80) from the eastern end of the trench, but the Leonard Paleosol was not recognized in that location. The

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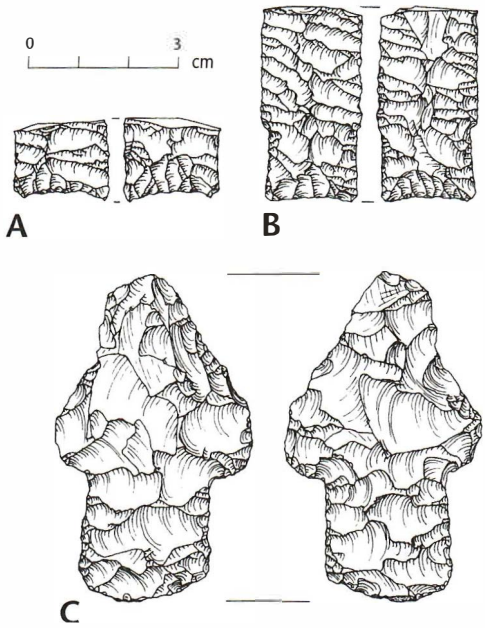

Figure 1. Projectile points from the Benz site. **A, B,** Scottsbluff; **C,** Alberta.

Alberta point was at 64 cm below surface; the lowest Scottsbluff point was at 75 cm below surface. We also excavated a corner-notched dart point 26 cm directly below the Alberta point. These observations suggest that deposits in the eastern part of the trench are disturbed, and that the Alberta point is not in situ. Excavated Cody deposits in the paleosol cover 11 m^2, extending vertically 30 cm (Root 1992:168–199). Seven flake concentrations were exposed in the paleosol in Cody levels at different depths, indicating multiple occupation surfaces. The smallest contains 496 flakes and the largest contains 32,899 flakes, indicating substantial production of tool blanks (Root 1997).

Previous dates on base-soluble humates from the paleosol were stratigraphically inconsistent, ranging from 8,000 ± 80 yr B.P. (SMU-1307) from the middle of the paleosol to 9,320 ± 60 yr B.P. (SMU-1487) at the bottom of the paleosol. A date from the surface of the paleosol was 8,590 ± 55 yr B.P. (SMU-1488). We excavated a small basin-shaped hearth at the bottom of the paleosol in a unit just north of the trench. A base-soluble humate date from the hearth was 8,600 ± 40 yr B.P. (SMU-1390) (Root 1992:181). A 9-mg piece of wood charcoal from the hearth was recently AMS dated to 9,540 ± 50 yr B.P. (UCR-3466). This indicates that the humate date is 1,000 years too young. The hearth is stratigraphically equivalent to the lower Scottsbluff point, suggesting that it dates an initial Cody occupation. The Cody complex, however, generally dates between 8,800 and 9,300 yr B.P. on the Northern Plains (Frison et al. 1996:15). Thus, the date from the hearth is earlier than other Cody occupations, and an association with an Alberta-complex occupation is possible.

I thank Sarah Moore for her excellent illustrations of the points from the Benz site.

References Cited

Agenbroad, L. D. 1978 *The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains.* University Press of America, Washington, D.C.

Bradley, B. A., and G. C. Frison 1987 Projectile Points and Specialized Bifaces from the Horner Site. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by G. C. Frison and L. C. Todd, pp. 199–231. Academic Press, Orlando.

Frison, G. C., D. Schwab, L. A. Hannus, P. Winham, D. Walter, and R. C. Mainfort 1996 Archeology of the Northwestern Plains. In *Archeological and Bioarcheological Resources of the Northern Plains*, edited by G. C. Frison and R. C. Mainfort, pp. 8–40. Arkansas Archeological Survey Research Series 47. Fayetteville.

Root, M. J. 1992 *The Knife River Flint Quarries: The Organization of Stone Tool Production.* Ph.D. dissertation, Washington State University, Pullman. University Microfilms, Ann Arbor.

——— 1997 Production for Exchange at the Knife River Flint Quarries, North Dakota. *Lithic Technology* 21:33–50.

Toward a New Paleoenvironmental Interpretation of the Early-Paleoindian Period in the Southeast

Michael W. Ruddell

The recent acceptance of a 12,500 yr B.P. date for human occupation at Monte Verde (Meltzer et al. 1997) provides incentive to search beyond the previously accepted chronology of Clovis in North America. The often ignored Southeast may hold information for understanding the initial colonization. The paleoenvironment of the southeastern region has been interpreted as essentially modern since 16,000 yr B.P., and subsistence adaptations are thought to have represented a generalized foraging adaptation (Meltzer 1984; Meltzer and Smith 1986). This interpretation is based on lithic assemblages, paleobotanical, and micro-vertebrate records. This contrasts with the idea that the Clovis specialization of hunting extinct megafauna occurred in the Eastern Woodlands. However, fluted point assemblages that compare favorably to other regions of North America in extent and diversity are being studied in the Southeast (Anderson 1995a). The clustering of sites in the Southeastern river valleys has been used to form a hypothetical model of colonization and dispersal routes. The spread of people during the early-Paleoindian period has been described as a "leap frog" mode of colonization, and the major river valleys in the East served as staging areas for the spread of people (Anderson 1990, 1995a, 1995b; Faught and Anderson 1996).

Because of the increasing antiquity of human occupation in America, a reevaluation of the paleoenvironmental record is essential. Many archaeolo-

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gists have used community-scale reconstruction as a model for paleoenvironmental interpretation. The high concentration of arboreal pollen has led to the idea that the southeastern region was essentially a closed woodland environment during the period of the first appearance of humans (Meltzer and Smith 1986). However, the community scale likely represent overgeneralization of past environments (Dincauze 1996). Studies of individualistic species response to climate change over time and space is a more reliable method for reconstructing paleoenvironments (Delcourt and Delcourt 1991). The large vertebrate record has received little attention. This is primarily due to the lack of classic kill sites and the argument that much of the Pleistocene megafauna was already extinct upon the relatively late arrival of humans (Grayson 1991). Both of these concepts require a reassessment in the Southeast and elsewhere due to the paradigm altering discoveries and revelations of the past several years in New World Paleoindian research.

Paleontological collections from major river valleys may help explain the high concentrations of fluted point assemblages in the Eastern river valleys. These river valley faunas contain elements that have an open grassland adaptation. The calculated NISP of the Mississippi Valley Connaway Collection demonstrates a bias for grassland- versus woodland-adapted species (Ruddell et al. 1997). A total NISP of 634 was identified for grassland taxa (*Bison, Equus, Mammuthus, Bootherium bombifrons, Panthera leo atrox, Paramylodon harlani* and *Geochelone crassicutata*) and a NISP of 418 for both woodland and forest edge taxa (*Odocoileius, Cervus canadensis, Mammut americanum, Ursus americanus, Megalonyx jeffersonii, Tapirus, Myohylus nasutus, Dasypus bellas,* and *Meleagris gallopavo*). A similar ratio is found in a fauna from the Black Belt region of Mississippi (Kaye 1972). Evidence of open grassland regions in the Southeast has been documented frequently in the micro-vertebrate record. The occurrence of prairie-adapted species such as the 13-lined ground squirrel and plains pocket gopher has been unequivocally documented in the Southeast during the late Wisconsin (Faunmap 1994). The presence of grassland megafauna may indicate significant patches of open grasslands and the initial attraction for the first colonizers into these valleys. The meandering of the major rivers during past interglacials or interstadials would have produced large terraces which early graminoid colonizers could have exploited. This also may explain the leapfrog colonization behavior. The high concentrations of fluted points are found in the river valleys because of the presence of megafauna in these regions. The record is unfortunately surficial, and the lack of kill sites represents a geoarchaeological bias related to river hydrology. The global climate changes that took place at the end of the Wisconsin caused erosion of sediments laid down during the late Pleistocene, or early cultural period of regions like the Mississippi embayment (Saucier 1994). The potential for buried late-Pleistocene archaeological sites exists in these valleys, but they have not been adequately explored (Dunnell 1990). Until there is a more intensive search for buried sites in these areas, we are left with a mainly surficial archaeological and paleontological record. Although this type of record is inadequate for making unequivocal statements regarding subsistence activities of early human cultures of the region, when lithic studies and

paleoenvironmental studies are considered there is potential for new working hypotheses.

References Cited

Anderson, D. 1990 The Paleoindian Colonization of Eastern North America: A View from the Southeastern United States. *Research in Economic Anthropology*, Supplement 5:163–216.

——— 1995a Recent Advances in Paleoindian and Archaic Period Research in the Southeastern United States. *Archaeology of Eastern North America* 23:145–176.

——— 1995b Paleoindian Interaction Networks in the Eastern Woodlands. In *Native American Interactions*, edited by M. S. Nassaney and K. E. Sassamen, pp. 3–26. The University of Tennessee Press, Knoxville.

Delcourt, H. R., and P. A. Delcourt 1991 *Quaternary Ecology: A Paleoecological Perspective*. Chapman and Hall, New York.

Dincauze, D. 1996 Modeling Communities and Other Thankless Tasks. In *The Paleoindian and Early Archaic Southeast*, edited by D. G. Anderson and K. E. Sassaman pp. 421–424.

Dunnel, R. C. 1990 The Role of the Southeast in American Archaeology. *Southeastern Archaeology* 9(1):11–22.

Faught, M. 1996 *Clovis Origins and Underwater Prehistoric Archaeology in Northwestern Florida*. Ph.D. Dissertation, Department of Anthropology, University of Arizona, Tucson.

Faught, M., and D. Anderson 1996 Across the Straits, Down the Corridor, Around the Bend, and Off the Shelf: An Evaluation of Paleoindian Colonization Models. Paper presented at the 61st Annual Meeting of the Society of American Archaeology.

Faunmap Working Group 1994 *Faunmap*. Illinois State Museum, Scientific Papers, 25:2.

Grayson, D. K. 1991 Late Pleistocene Mammalian Extinctions in North America: Taxonomy, Chronology, and Explanations. *Journal of World Prehistory* 5(3):193–231.

Kaye, J. 1972 *Pleistocene Sediment and Vertebrate Fossil Associations in the Mississippi Black Belt: A Genetic Approach*. Ph D. Dissertation, Louisiana State University, Baton Rouge.

Meltzer, D. 1984 *Late Pleistocene Human Adaptations in Eastern North America*. Ph.D. dissertation, Department of Anthropology, University of Washington, Seattle.

Meltzer, D. J., and B. D. Smith 1986 Paleo-Indian and Early Archaic Subsistence in Eastern North America. In *Foraging, Collecting, and Harvesting: Archaic Period Subsistence and Settlement in the Eastern Woodlands*, edited by S. Neusius, pp. 1–30, Center for Archaeological Investigations, Southern Illinois University, Carbondale.

Meltzer, D., D. Grayson, G. Ardila, A. Barker, D. Dinacauze, C. V. Haynes, F. Mena, L. Núñez, and D. Stanford 1997 On the Pleistocene Antiquity of Monte Verde, Southern Chile. *American Antiquity* 62(4):659–663.

Ruddell, M. W., R. C. Brister, J. M. Conaway, C. Davenport, P. A. Delcourt, and R. T. Saucier 1997 The Conaway Collection: A Late Quaternary Vertebrate Record of the Central Mississippi River Valley. *Current Research in the Pleistocene* 14:151–153.

Saucier, R. 1994 Geomorphology and Quaternary Geologic History of the Lower Mississippi Valley. U.S. Army Corps of Engineers, Vicksburg, Mississippi.

The French Connection: Investigating a Possible Clovis-Solutrean Link

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The recent discovery at Kennewick, Washington, of a Paleoindian skeleton with some Caucasoid features has revived an old controversy about a possible Eurasian origin for the first inhabitants of the New World. The need to find cultural remains that support the apparent paleontological evidence has led to an informal discussion about a possible link between the European Solutrean and the Clovis culture (see Preston 1997). This paper is meant to offer some thoughts on the topic, and possibly to trigger a more thorough debate. Indeed, if proven true, this hypothesis would have a profound impact on the traditional view of a migration of people through the Bering Straits and would unequivocally suggest a North Atlantic route for the first peopling of the New World.

The fluting technique seen on the Clovis points is not found outside the American continents and seems to be indigenous to the New World. This fact alone triggered numerous hypotheses about the origins of the Clovis cultural complex. One of the most recent links Clovis to the Solutrean on the basis of technological similarities. Indeed, like some Solutrean laurel leaves, a few Clovis bifaces and projectile points show a peculiar flaking pattern relying on flakes that dive to the other edge (*outre-passé*). After the removal of such a flake, a platform is prepared on the other edge and the process repeated. This unusual way to thin bifaces, shared by the two traditions, has been advanced as conclusive evidence for a direct migration. To sum up the apparent argument: the tools are made the same way, thus they are made by people *sharing* the same technical knowledge.

The technological argument, however, focuses only on a single aspect of a cultural tradition extracted from its context, in this case, biface manufacture. Solutrean blades, bladelets, burins, or bone artifacts, for instance, have no equivalent in the Paleoindian tool kit. Furthermore, the fact that there is a huge time gap between the two traditions of at least six to seven thousand years (for a list of radiocarbon dates of Solutrean sites see Straus 1990) should itself be sufficient to reject the possibility of a direct migration.

The hypothesis of a close cultural relationship between Europe and North America is not new and has been a recurrent argument in American archaeology. In 1877, Abbott argued that the morphological analogies between some of the artifacts found in North America and Europe implied an identical age. He thus concluded in favor of an American Paleolithic. In 1912, in an important symposium on the origins of the first people in the New World, Holmes, a staunch opponent of Abbott in the American Paleolithic issue, himself pleaded in favor of a possible link between the two continents. Holmes

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described a series of cultural traits shared by North America and the rest of the world, including Europe, and maintained that they represented multiple waves of migration into the New World. More recently, the old ghost resurfaced when Greenman (1963) attempted to make a case for a transatlantic route of migration. Greenman based his demonstration on typological resemblance between Sandia points and Solutrean shouldered points (Renaud [1931] had made a comparable argument).

All these assumptions are very similar in nature. They rest on one or both of the following premises: 1) similar forms imply a similar age; 2) similar forms in two different parts of the world imply a contact or migration. They do not differ significantly from today's assertion of a Clovis-Solutrean link.

The technological argument focuses on an identity in manufacturing process rather than on form, but fails to explain why this would be more significant. Like any of the above hypotheses, it rejects convergence as a possible explanation, and ignores the possibility of independent inventions or similar answers to the same problem or need (whether technical or situational). Placed in a broader context, it raises a series of questions. Is the notion of a techno-complex really useful? What does it mean? How is it different from the typological argument? More specifically, do we base a definition of Clovis on typology, technology, or adaptations? All these questions need to be addressed in order to approach the problem of the origins of the First Americans.

References Cited

Abbott, C. C. 1977 on the Discovery of Supposed Paleolithic Implements from the Glacial Drift in the Valley of the Delaware River, near Trenton, New Jersey. *Peabody Museum Annual Report* 10:30–43.

Greenman, E. F. 1963 The Upper Palaeolithic and the New World. *Current Anthropology* 4:41–66.

Holmes, W. H. 1912 Bearing of Archeological Evidence on the Place of Origin and on the Question of the Unity or Plurality of the American Race. *American Anthropologist* 14(1):30–36.

Preston, D. 1997 The Lost Man, *The New Yorker,* June 16, pp. 70–81.

Renaud, E. B. 1931 *Archaeological Survey of Eastern Colorado,* University of Denver, Denver, Colorado.

Straus, L. G. 1990 The Original Arms Race: Iberian Perspective on the Solutrean Phenomenon. In *Les Industries À Pointes Foliacées du Paléolithique Supérieur Européen.* ERAUL No. 42. pp. 425:447. Liège.

Preservation of the Paleoindian Record in Alluvial Fill, Northeastern Kansas

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As part of a geoarchaeological investigation on the Fort Riley military installation in northeastern Kansas, we are determining the distribution of buried Paleoindian-age surfaces. The potential for preservation of these surfaces has been previously noted for the loess-mantled uplands (Johnson et al. 1997), and herein for the valleys. In the course of describing, ^{14}C dating, and mapping alluvial fills, Paleoindian-age features have not been as common as Archaic-age features, but occur with sufficient frequency to indicate widespread use of alluvial surfaces.

The alluvial stratigraphy of Forsyth Creek, a small tributary of the Kansas River, illustrates the character of late-Pleistocene and Holocene valley fills and presence of Paleoindian activity (Figure 1). Late-Pleistocene deposition of the T2 was characterized by nine identifiable episodes of stability, whereas T1 fill appears to represent one or more periods of relatively rapid deposition until about 3,000 years ago, when an extended period of pedogenesis began. The

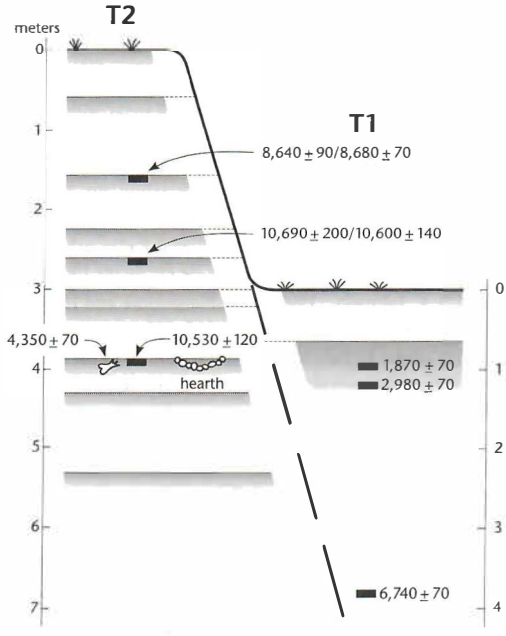

Figure 1. Soil stratigraphy of T1 and T2 fills of lower Forsyth Creek. Total humates were assayed for the ^{14}C ages, which were corrected for the effects of isotopic fractionation. The upper two dated soils in T2 fill were dated twice using two different samples from each.

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break between the two fills corresponds to middle-Holocene erosional phases observed in other stream systems of the central Great Plains (Mandel 1995). Abandonment of the T1 likely occurred about 1,200 years ago, a temporal pattern documented elsewhere in the central Great Plains (Martin 1990).

Soils buried between about 225 and 380 cm in T2 fill indicate a relatively stable flood plain about 11,000 to 10,000 years ago. Three ^{14}C ages obtained on soil humates are within one standard deviation of one another. This time period corresponds to landscape stability recorded in alluvial fills throughout the region (Johnson et al. 1996). Further, contemporaneous stability is well documented for the loess-mantled uplands of the region and was recorded by development of the Brady soil (Schultz and Stout 1948; Johnson 1993).

A corrected, conventional ^{14}C age of 4,350 ± 70 yr B.P. (ISGS-3605) derived from a fractured portion of a *Bison* (sp.) tibia resulted in an age apparently much younger than the soil within which it was located. Because of the stratigraphic consistency and reproducibility of the soil ages, we consider the bone age to be in error. It was not determined if the bone was from a Holocene or late-Pleistocene bison.

The backhoe trench exposure of T2 fill also yielded a burnt limestone hearth in the upper part of the buried soil at 380 cm, providing evidence of Paleoindian-age activity on the valley bottom. The bone fragment was situated about 2 m north of the feature and imbedded in the same buried soil.

References Cited

Johnson, W. C. 1993 Surficial Geology and Stratigraphy of Phillips County, Kansas, with emphasis on the Quaternary Period. *Kansas Geological Survey Technical Series 1.*

Johnson, W. C., and B. Logan 1990 Geoarchaeology of the Kansas River Basin, Central Great Plains. In *Archaeological Geology of North America*, edited by N. Lasca and J. Donahue, pp. 267–299. Geological Society of America Centennial Special Volume 4.

Johnson, W. C., D. W. May, and R. D. Mandel 1996 A Database of Alluvial Radiocarbon Ages from the Central Great Plains (Kansas and Nebraska). *Current Research in the Pleistocene* 13:79–81.

Johnson, W. C., K. Park, J. S. Isaacson, and D. L. Johnson 1997 Late-Pleistocene and Holocene Environments on Fort Riley, Kansas. *Current Research in the Pleistocene* 14:163–165.

Mandel, R. D. 1995 Geomorphic Controls of the Archaic Record in the Central Great Plains of the United States. In *Archaeological Geology of the Archaic period in North America*, edited by E. A. Bettis, III, pp. 37–66. Geological Society of America Special Paper 297.

Martin, C. W. 1990 *Late Quaternary Landform Evolution in the Republican River Basin, Nebraska*: Unpublished Ph.D. dissertation, Department of Geography, University of Kansas, Lawrence.

Schultz, C. D., and T. M. Stout 1948 Pleistocene Mammals and Terraces in the Great Plains. *Geological Society of America Bulletin* 59:553–591.

Physical Anthropology

Direct AMS Radiocarbon Dating on Human Bones from Baño Nuevo, Central Patagonian Andes, Chile

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The re-excavation of Cueva Baño Nuevo (Figure 1)—a site originally excavated by Bate (1979) at the western fringes of the Central Patagonian steppe (present-day Chilean XI Region)—did not confirm his assertions regarding a late-Pleistocene archaeological level associated with the hunting of extinct mylodon and American horse. However, the new excavations revealed a rich archaeological assemblage dating to the early Holocene, including the osteological remains from five human individuals, one of them directly dated to the early ninth millennium B.P. These remains represent the oldest human bones currently known from Patagonia and are one of the most securely dated early human skeletal remains in South America.

The dated remains include a rib fragment and the fragment of an unidentified long bone from a well-preserved adult male skeleton. This individual (#2) was found in a flexed position as if placed on a rocky inflection of the wall with the right side of the body leaning against the eastern wall of the cave, facing west. There is no evidence of underground burial. The corpse was placed in a shallow pit before being covered with pebbles 10–50 cm in diameter and boulder. This burial pattern, along with the intentional association with canid remains and a bundle of plant fibers, resembles much later Tehuelche "chenkes" or funerary cairns, although the latter have never been found inside caves. A charcoal speck found between two cervical vertebrae of this skeleton yielded an AMS ^{14}C date of 8,890 ± 90 yr B.P. (Beta 90889). To eliminate stratigraphic association errors for this feature, which spans 60 cm vertically, we measured two XAD-purified gelatin hydrolyzate AMS ^{14}C dates directly on the human bone. The results of these analyses, 8,850 ± 50 yr B.P. (CAMS-36663) and 8,880 ± 50 yr B.P. (CAMS-36664) confirm that Individual #2 from Baño Nuevo—a young adult male—dates to the early ninth millennium B.P. and

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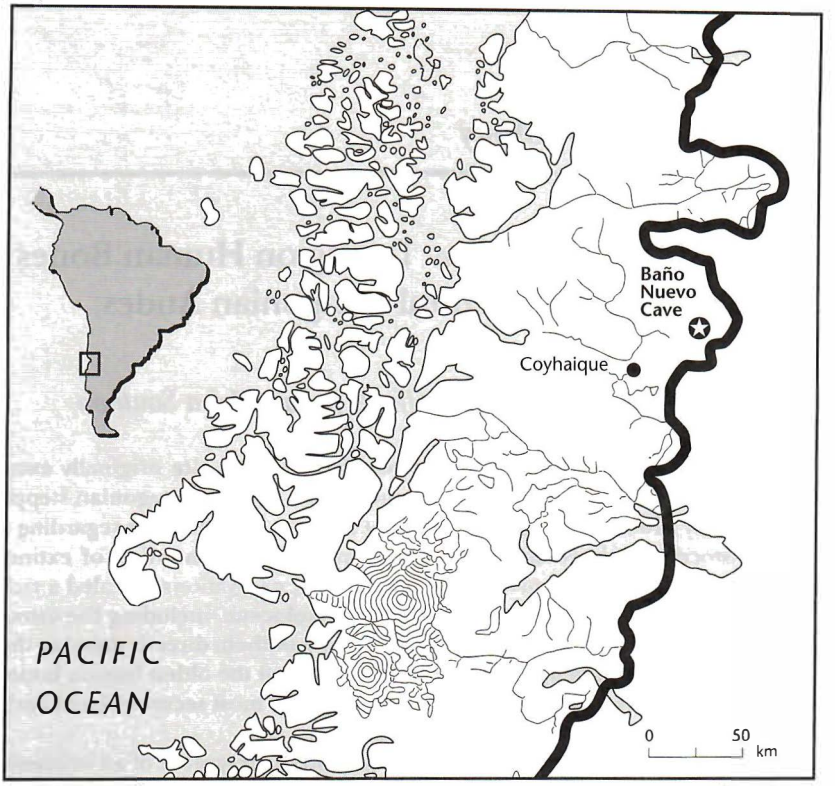

Figure 1. Location of Baño Nuevo Cave in Chile's central Patagonian Andes. (Angel Antonelli)

thus is the earliest well-dated human skeleton from Patagonia. Since the neighboring individual #3 (an old female) exhibits similar preservation conditions and funerary treatment, being associated with a charcoal speck dated by conventional radiometric ^{14}C techniques to 8,530 ± 160 yr B.P. (Beta-90892), we are confident that this is also an early-Holocene specimen. Two of the remaining individuals (young children of unidentified sex) may have the same geologic age, but they are represented by few and heavily fragmented bone pieces. Despite its small size, the early-Holocene human skeletal sample from Baño Nuevo provides a glimpse of an interesting diversity (young male and old female). The earliest human remains found thus far in Patagonia are also providing valuable information on prehistoric activity patterns, diets, disease and population morphology.

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References Cited

Bate, L. F. 1979 Las Investigaciones sobre los Cazadores Tempranos en Chile Austral. *Trapananda* 1(2):14–23.

Lithic Studies

Barton Gulch Paleoindian Alder Complex Functional Analysis

Leslie B. Davis, Marvin Kay, and Sally T. Greiser

The Barton Gulch (24MA171) 9,400-year-old Paleoindian Alder complex (Eighmy and Davis 1997) is defined by the Ruby Valley point type (a small to medium-sized lanceolate) (Davis et al. 1989) and a host of associated biface forms (Greiser n.d.); among the latter are two anomalous "stemmed points." Microscopic use-wear and formal attributes were used to determine function (see Kay 1996, 1997; Semenov 1964 for a general discussion of methodology) of the two "stemmed points" (Figure 1A, B), a Ruby Valley point (Figure 1C), and five other bifacial artifacts (Kay n.d.).

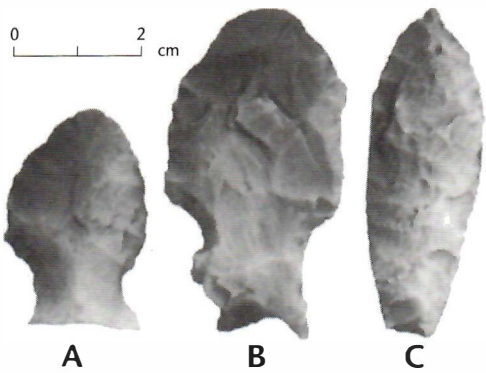

Figure 1. The non-lanceolate "shouldered" bifaces (**A** and **B**) compared with a Ruby Valley lanceolate projectile point (**C**) from Barton Gulch.

Formal attributes and use-wear criteria indicate that the two "stemmed" artifacts had long use-lives and complex use histories, complicating typological assessment. The smaller of the two, a distal fragment (Figure 1A), ultimately was recycled as a bifacial wedge. This fragmentary chert artifact displays wedge-related bipolar flaking on its left edge and complex microwear; the tool was probably first used as a projectile point, followed by invasive cutting from

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either body edge and then recycling as a wedge. The broken proximal end would have provided a convenient hammer surface, but the tip-related wear traces might be attributed to initial projectile point or knife usage. The tool was later rotated about 90 degrees so that the left edge could serve as a wedge. The "stemmed" chert artifact lacks basal grinding (Figure 1B), unlike the Ruby Valley point. Its body edges are roughly parallel, then converging to a rounded and plainly reworked tip. This specimen appears to have been extensively used as a projectile and then as a knife point.

The Ruby Valley point has a razor-sharp, needlelike tip which is emphatic evidence of serviceability as a projectile point. Projectile impact use wear consists of striae obliquely oriented to (or off center from) the long axis. Closer to the tip, but just off the midline, is an extensively polished and abrasively planed area with striae perpendicular to what appears to be a reworked right edge that likely represents invasive cutting use wear subsequent to employment as a projectile point.

Since the anomalous "stemmed" artifacts do not formally resemble the Alder complex Ruby Valley lanceolate point assemblage (n = 95 complete [reworked] and fragmentary), it seems unlikely that they are integral to or contemporary with other elements in the Alder complex bifacial lithic subassemblage. They might be curated artifacts. Results of this pilot application suggest that at least some lithic artifacts in newly recognized Paleoindian tool kits should be subjected to microwear use determination. The inherently limited validity of gross morphology-constructed artifact use classes should be but a preliminary step in artifact function determination.

The Barton Gulch site investigations (1979–1980, 1985, 1987-1988, and 1991–1992) by the Museum of the Rockies were supported by the Kokopelli Archaeological Research Fund.

References Cited

Davis, L. B., S. A. Aaberg, W. P. Eckerle, J. W. Fisher, Jr., and S. T. Greiser 1989 Montane Paleoindian Occupation of the Barton Gulch Site, Ruby Valley, Southwestern Montana. *Current Research in the Pleistocene* 6:5–7.

Eighmy, J. L., and L. B. Davis 1997 Archaeomagnetometry of Paleoindian Alder-Complex Roasting Pits, Barton Gulch, Montana. *Current Research in the Pleistocene* 14:22–24.

Greiser, S. T. n.d. Alder Complex Bifacial and Unifacial Lithic Artifacts. In: Paleoindian Foragers of the Northern Rockies: The Barton Gulch Site, Upper Ruby Valley, Southwest Montana, edited by L. B. Davis. In preparation.

Kay, M. 1996 Microwear Analysis of Some Clovis and Experimental Chipped Stone Tools. In *Stone Tools: Theoretical Insights Into Human Behavior*, edited by G. H. Odell, pp. 315–344. Plenum Press, New York.

——— 1997 Imprints of Ancient Tool Use at Monte Verde. In *Monte Verde: A Late Pleistocene Settlement in Chile, Volume II: The Archaeological Findings*, edited by T. E. Dillehay, pp. 649–660. Smithsonian Institution Press, Washington, D.C.

——— n.d. Microwear Analysis of Barton Gulch (24MA171) Alder Complex Artifacts: A Pilot Study. Ms. on file, Museum of the Rockies, Montana State University-Bozeman, Montana.

Semenov, S. A. 1964 *Prehistoric Technology*. Cory, Adams and MacKay, London.

The Possible Design of Folsom Ultrathin Bifaces as Fillet Knives for Jerky Production

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Remarkably thin, well-crafted bifaces are illustrated from several Folsom sites (Lindenmeier, Wilmsen and Roberts 1978: Fig. 98a; Hanson, Frison and Bradley 1980: Fig. 21a; Stewart's Cattle Guard, Jodry 1987:Fig. 4.4a; Mitchell Locality, Boldurian 1990:Fig. 36a; Bobtail Wolf, Root and Emerson 1991:Fig. 43, 44: and Young-Man-Chief, Shifrin and William 1996:43). Manufacturing debris recovered at the Lake Ilo Folsom sites indicates that ultrathin bifaces did not result from a multi-product-oriented, generalized biface manufacturing process. Rather, the finished form was conceived at the start of production (Williams et al. 1997). Ultrathin bifaces represent a distinct tool type, as deliberately designed as Folsom points, and as demanding of advanced flint-knapping skills.

Key features of their design include an exceptionally thin, nearly flat cross section, with long, precision cutting edges, and an ovate to bipointed outline. Width-thickness ratios of four resharpened ultrathins from Stewart's Cattle Guard (CG) range from 9.5:1 to 13:1, with an average central thickness of 4.3 mm. In comparison, newly made ultrathins from the Lake Ilo Folsom sites have average width:thickness ratios ranging from 15:1 to 20:1, and an average central thickness of 4.0 mm (William et al. 1997). Whether as an element of intentional design or as the inadvertent result of a diving flake thinning technique (Bruce Bradley, pers. comm. 1997), ultrathin bifaces are 1–2 mm thinner near the midline than at their cutting edges (William et al. 1997). Regardless of resharpening, they retain thin cross sections throughout their use lives. Extensive unifacial resharpening results in alternate beveling and a tendency toward differentiation of a strongly pointed and more rounded outline to opposite ends of the tool.

Use-wear traces identified by Kay (100–400X) on an ultrathin of silicified welded tuff from CG, and another of Tecovas from the Mitchell Locality (Boldurian and Hubinsky 1994), are indicative of prolonged and extensive contact of tool edges and bifacially worked faces with soft to medium-hard materials. The evidence is judged consistent with use-wear traces on experimental butchering tools (Marvin Kay, pers. comm. 1996). At what points in butchering activities (cutting hide, dismembering limbs, stripping meat, processing for consumption or storage) might ultrathin knives be routinely employed?

To my knowledge, ultrathins have not been recovered from Folsom kill/initial butchering areas, such as at Folsom, Cooper, Linger, or CG sites. Unifacial knives apparently predominate in these early-stage butchering contexts. In the three late-summer/early-fall bison kill episodes at the Cooper site, all seven of the butchering tools recovered were unifacial (Bement 1995).

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Likewise, of 67 flakes from Cooper with intact platforms, 61 are single-faceted and imply unifacial tool resharpening (Brosowske and Bement 1997). The ultrathin's greater susceptibility to bend and twist breakage during heavy butchering may have influenced the selection of expediently produced, unifacial knives as heavy butchering tools.

Ultrathin bifaces seem to be more closely associated with camps and stone quarries. At CG, no ultrathins were recovered in the bison kill/initial butchering areas. Two broken ultrathins were discarded close together amidst hide-working and other tools in a multipurpose work area that was slightly separated from the kill and the residential portion of the camp. The remaining three knives appear to be associated with domestic activities in the residential area. Ethnographic photographs of campsites associated with large animal kills depict vast quantities of meat shaved into long, wide sheaths for drying. My experiential use of hand-held, replicated ultrathins to produce similar thin sheaths (c. 60–90 cm long by 20 cm wide) from cow meat, and to cut elk meat into thin strips for jerky, emphasizes the remarkable suitability of these tools for such precision cutting tasks.

Hayden (1987:20) observed that "in order to understand why an artifact has specific characteristics, it is necessary not only to understand how it is made, but also how it is used and what was done to it during use." I propose that the design of ultrathins is activity related and largely constrained by the need for an efficient filleting knife with which to process large quantities of bison meat for drying. I do not suggest their exclusive use, *rather their repeated use,* in this context. If jerky production in the context of large kills was gendered Folsom activity, as was common among eighteenth- and nineteenth-century Plains buffalo hunting groups, then ultrathin tool use may have been dominated by a particular sex. I suspect that ultrathin bifaces may represent a woman's knife form analogous to *ulus* in the far north.

I greatly appreciate the interest and support of Bob Patton, Bruce Huckell and Gene Titmus who generously replicated ultrathin bifaces for my experiential use in jerky production, Bruce Bradley who provided elk meat, guidance and friendship during meat-making, Aldan Naranjo and Everett Burch of the Southern Ute Nation for their help and for making me aware of similarly shaped women's knives among their people, and Bertha Grove who shared knowledge of women's work and extended great hospitality at Ignacio. The Smithsonian Institution's Paleoindian/Paleoecology Program supported this research.

References Cited

Bement, L. C. 1995 The Retooling Index, Seasonality, and the Folsom-age Cooper Bison Site Kill. *Current Research in the Pleistocene* 12:61–62.

Boldurian, A. T. 1990 Lithic Technology at the Mitchell Locality of Blackwater Draw. A Stratified Folsom Site in Eastern New Mexico. *Plains Anthropologist* Memoir 24.

Boldurian, A. T., and S. M. Hubinsky 1994 Preforms in Folsom Lithic Technology: A View from Blackwater Draw, New Mexico. *Plains Anthropologist* 39:445–464.

Brosowske, D. D., and L. C. Bement 1997 An Analysis of Resharpening Flakes from the Cooper Site. *Current Research in the Pleistocene* 14:99–101.

Frison, G. C., and B. A. Bradley 1980 *Folsom Tools and Technology at the Hanson Site, Wyoming.* University of New Mexico Press, Albuquerque.

Hayden, B. (editor) 1987 *Lithic Studies Among the Contemporary Highland Maya.* The University of Arizona Press, Tucson.

Jodry, M. A. 1987 Stewart's Cattle Guard Site: A Folsom Site in Southern Colorado, Report of the 1981 and 1983 Field Seasons. Unpublished Master's thesis, Department of Anthropology, University of Texas, Austin.

Kay, M. 1996 Microwear Analysis of Some Clovis and Experimental Chipped Stone Tools. In *Stone Tools: Theoretical Insights into Human Prehistory*, edited by G. H. Odell, pp. 315–344. Plenum Press, New York.

Root, M. J., and A. M. Emerson 1994 *Archaeology of the Bobtail Wolf site (32DU9SSA): 19931994 Progress Report*, Progress Report Number 26, Center for Northwest Anthropology, Washington State University, Pullman.

Shifrin, L. K., and J. D. William 1996 Investigations at Young-Man-Chief, a Folsom Site in western North Dakota. *Current Research in the Pleistocene* 13:42–44.

William, J. D., M. J. Root, and L. K. Shifrin 1997 Lake Ilo Ultrathin Bifaces and Folsom Points: Separate Production Sequences. *Current Research in the Pleistocene* 14:111–112.

Wilmsen, E., and F. H. H. Roberts, Jr. 1978 Lindenmeier, 1934–1974: Concluding Report on Investigations. *Smithsonian Contributions to Anthropology*, No. 24.

Folsom Use of Eastern New Mexico Look-alike Cherts on the Llano Estacado

Philippe D. LeTourneau

In Volume 1 of *Current Research*, Phillip Shelley suggested that the apparent dominance of well-known, non-local Alibates and Edwards cherts in Llano Estacado Paleoindian lithic assemblages needs to be reconsidered because macroscopically identical materials from different geologic sources "exist adjacent to the Llano much closer [to the Paleoindian sites] than previously assumed" (Shelley 1984:35). Shelley hypothesized that these materials may have been used in addition to the non-local materials and that their use would affect conclusions about Paleoindian mobility. Because only limited attempts to test this hypothesis have been published (e.g., Hofman et al. 1991:304), I present the results of such a test with an analysis of Folsom artifacts from the Llano Estacado.

Each of the apparently dominant cherts has "look-alike" sources in eastern New Mexico. The same is true for Tecovas chert, another non-local toolstone identified on Llano Estacado Paleoindian sites (Hester 1972:121, 142). Alibates-like chert occurs in the Ogallala Formation near Yeso and Ragland, in the Baldy Hill Formation along the Dry Cimarron River, and in an unidentified formation near Tucumcari (Banks 1990:89; Boldurian 1991:283; Goldsmith 1990:5, 48–54; Green and Kelley 1960:413; Hillsman 1992:147). Edwards-like chert occurs in the San Andres Formation in the Sacramento Mountains and in the vicinity of Roswell and Carlsbad, and in an unidentified

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formation near Tucumcari (Goldsmith 1990:31–46; Hillsman 1992:148; Shelley 1984:36, pers. comm. 1997). Finally, Tecovas-like material occurs in the Ogallala Formation near Ragland, in the Baldy Hill Formation along the Dry Cimarron River, and in an unidentified formation in the vicinity of Ute Creek (Banks 1984:72; Boldurian 1991:283; Goldsmith 1990:5, 52–54).

Previous analyses of the non-local cherts and their look-alikes conclude that they are difficult to tell apart because they have similar colors, exhibit similar responses to ultraviolet light, and are of similarly high quality (Goldsmith 1990:33–54; Hillsman 1992:69–117; Hofman et al. 1991:304). The cherts differ in several respects, however. The look-alikes tend to occur as relatively small pieces (average size is less than 10 cm and maximum size rarely exceeds 15 cm, although Shelley [pers. comm. 1998] has documented San Andres chert nodules up to 25 cm in size). Their non-local counterparts can all exceed 100 cm in length (Bowers 1975:66; Frederick and Ringstaff 1994:148–154; Mallouf 1989). The San Andres chert is rarely as good as Edwards, and the Edwards-like material from near Tucumcari exhibits a different response to ultraviolet light (Goldsmith 1990:33–46, 71-83; Hillsman 1992:90–101, 119).

My own macroscopic analysis of the cherts and their look-alikes generally agrees with the previously published reports, but indicates that it is possible to distinguish among them with relative certainty. Colors and structures are generally distinct, although there is limited overlap in the ranges of each. Quality of the look-alikes is usually inferior, although rare samples are of equivalent quality. The size difference, which may be the most important factor influencing Paleoindian toolstone use, is unfortunately one that is not directly observable in finished artifacts. The small size of the look-alikes combined with their generally poor quality would have made these a much less desirable alternative. Ultraviolet light is not particularly useful in distinguishing among the sources.

In my study of 1,199 Folsom-Midland artifacts from 188 sites on the Llano Estacado in New Mexico and Texas, I found very little evidence for the use of the look-alike materials; I identified only 5 (0.4%) of the artifacts as the look-alike cherts. Of 662 projectile points and preforms, 3 are Alibates-like chert from the Ogallala Formation (1 each from RO-4-16, RO-2-66, 16/31). Of 384 flakes and retouched flake tools, 1 from Blackwater Draw (29RV3) is Alibates-like chert from the Ogallala Formation, and of 16 cores, 1 from Blackwater Draw is Baldy Hill Formation chert. I identified none of the look-alike cherts among 137 channel flakes. It appears that, in Folsom lithic assemblages at least, these cherts played only a very limited role relative to the better known non-local ones. Because source analysis based on visible criteria is subjective and qualitative (Luedtke 1992:117–122), more definitive tests of Shelley's hypothesis await the development of better source identification techniques.

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References Cited

Banks, L. D. 1984 Lithic Resources and Quarries. In *Prehistory of Oklahoma*, edited by R. E. Bell, pp. 65–95. Academic Press, Orlando.

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

Boldurian, A. T. 1991 Folsom Mobility and Organization of Lithic Technology: A View from Blackwater Draw, New Mexico. *Plains Anthropologist* 36(137):281–295.

Bowers, R. L. 1975 *Petrography and Petrogenesis of the Alibates Dolomite and Chert (Permian), Northern Panhandle of Texas.* Unpublished Master's thesis. Department of Geology, University of Texas, Arlington.

Frederick, C. D., and C. Ringstaff 1994 Lithic Resources at Fort Hood: Further Investigations. In *Archaeological Investigations on 571 Prehistoric Sites at Fort Hood, Bell and Coryell Counties, Texas,* edited by W. N. Trierweiler, pp. 181–255. Archeological Resource Management Series Research Report No. 31. United States Army, Fort Hood.

Goldsmith, W. M. 1990 *Macroscopic Variability in Cherts from Drainages Adjacent to the Western Edge of the Llano Estacado.* Unpublished Master's thesis. Department of Anthropology, Eastern New Mexico University, Portales.

Green, F. E., and J. H. Kelley 1960 Comments on Alibates Flint. *American Antiquity* 25(3):413–414.

Hester, J. J. 1972 *Blackwater Locality No. 1.* Publication No. 8. Fort Burgwin Research Center, Ranchos de Taos.

Hillsman, M. J. 1992 *Evaluation of Visible and Ultraviolet-Excited Attributes of Some Texas and Macroscopically Similar New Mexico Cherts.* Unpublished Master's thesis. Department of Anthropology, Eastern New Mexico University, Portales.

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

Luedtke, B. E. 1992 *An Archaeologist's Guide to Chert and Flint.* Archaeological Research Tools 7. Institute of Archaeology, University of California, Los Angeles.

Mallouf, R. J. 1989 Quarry Hunting with Jack Hughes: Tecovas Jasper in the South Basin of the Canadian River, Oldham County, Texas. In *In the Light of Past Experience: Papers in Honor of Jack T. Hughes,* edited by B. C. Roper, pp. 307–326. Aquamarine Publications, Clarendon.

Shelley, P. H. 1984 Paleoindian Movement on the Southern High Plains: A Re-Evaluation of Inferences Based on the Lithic Evidence from Blackwater Draw. *Current Research* 1:35–36.

Patterns of Breakage and Methods of Fluted Point Manufacture in Northeast Illinois

Thomas J. Loebel and Tim Dillard

Analysis of patterns of breakage in the Hawk's Nest assemblage from northeast Illinois (Amick et. al, 1997), along with studies of fluted point replication, is used to infer a method of fluting using preform restraint and indirect percus-

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sion with a horizontally oriented antler punch. The Hawk's Nest assemblage is possibly diagnostic of the Gainey complex, a Great Lakes Clovis variant (Deller and Ellis, 1988). Several preforms exhibit well-isolated striking platforms for channel flake removal, deep basal concavities, and moderately abraded distal tips. Consistent patterns of breakage observed in the assemblage include lipped bending fractures and unintentional burin-like fractures of the preform ear and lateral edge. We believe that the deep basal concavity produced during the platform preparation for the second channel flake precluded removal by direct percussion. The moderately abraded distal tips of some preforms and lipped bending fractures are indicative of rigid preform restraint, which amplifies the compressive forces generated during fluting. Replicative studies undertaken with professional flintknapper Tim Dillard have produced consistent patterns of breakage similar to that seen in the archaeological assemblage. Replicated preforms were restrained along lateral margins in a vise-like manner and fluted with indirect percussion using a horizontally oriented punch (Figure 1A). The punch was set on the well-prepared and isolated striking platform in a horizontal orientation in order to avoid damage to the punch and the loss of energy transfer as the platform pitted or cracked into the weaker end grain of the moose antler punch. Damage to the punch was reduced with the change of orientation (cross grained), as were problems with unpredictable channel flake removal. Lipped

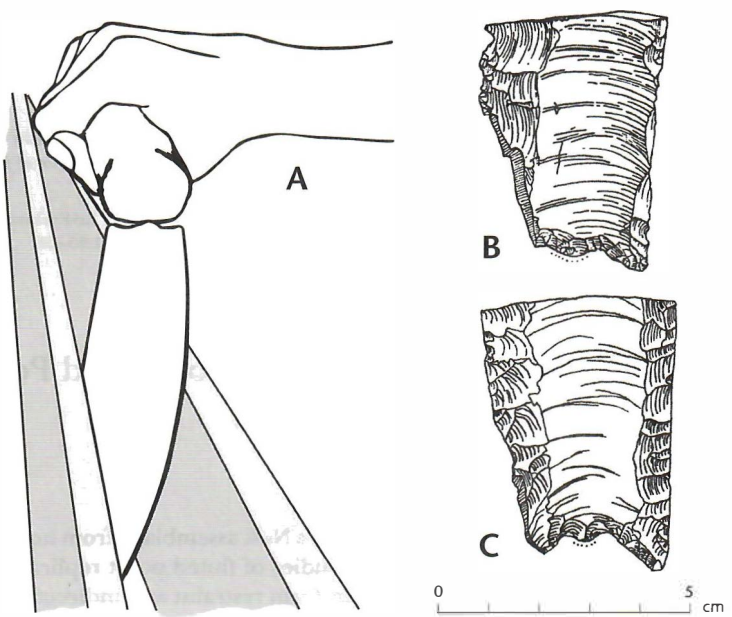

Figure 1. **A,** sketch of restrained preform showing horizontal placement of punch. **B,C,** preform bases broken during fluting (**B,** archaeological specimen; **C,** replica). Platforms failed to release and preforms folded. Note burination-like fractures to left ear and lateral edges caused by errant blow of percussor.

bending fractures were commonly encountered during restrained fluting attempts using the punch. Also associated with attempts at restrained fluting using a horizontally oriented punch was the occurrence of unintentional burin-like fractures to the ear and lateral edge of the preform caused by an unintentional strike during the follow-through stroke of the percussor. This type of fracture was not encountered during fluting attempts using direct percussion or with a vertically oriented punch. Identical patterns of breakage, possibly diagnostic of technique, are seen in three and possibly a fourth preform recovered from the site. Patterns of breakage encountered during replication attempts with laterally restrained preforms and indirect percussion using a horizontally oriented punch were consistent with those seen in the archaeological specimens, suggesting a similar method of manufacture (Figure 1B, C).

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References Cited

Amick, D., T. Loebel, T. Morrow, and J. Morrow 1997 Hawk's Nest: A New Gainey-Clovis Site in Northeastern Illinois. *Current Research in the Pleistocene* 14:4–6.

Deller, D. B., and C. J. Ellis 1988 Early Paleo-Indian Complexes in Southwestern Ontario. In *The Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 251–263. Bulletin of the Buffalo Society of Natural Sciences, Vol. 33.

Technological Observations on the Paleoindian Artifacts from Fell's Cave, Magallanes, Chile

Hugo Gabriel Nami

At the end of the nineteenth century the finding of Pleistocene fauna in Mylodon Cave (Ultima Esperanza, Chile) motivated the search for sites with similar finds in both Chile and Argentina. At the beginning of this century Hauthal, from the La Plata Museum (Buenos Aires, Argentina), recovered paleontological remains in the mentioned Chilean site, and in Markatch Aike Cave (Santa Cruz, Argentina). In the latter he found the remains of *Hippidion* cf. *saldiasi* (horse) (Lehman-Nitsche 1904).

Markatch Aike cave is located in the Río Chico basin, on the Argentine-Chilean border (Nami 1995). In the same basin but on the Chilean side, in Fell's and Pali Aike caves, Junius Bird found in the 1930s a clear association of archaeological remains and Pleistocene fauna, such as *Hippidion saldiasi*

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(horse) and *Mylodon* cf. *listai* (ground sloth). The lithic remains consisted of different artifacts and ecofacts; among the lithic remains, the Fell's cave or "fishtail" projectile points became the best known (Bird 1988).

I had the opportunity to carry out some observations on the Paleoindian lithic and bone materials of the Bird and John Fell's collections curated in the American Museum of Natural History in New York and the Museo Regional de Magallanes in Punta Arenas, Chile.

The observations reported here expand existing knowledge on certain technical aspects from the paleoindian artifacts recovered at Fell's cave.

Although most of Bird's observations have not been substantially modified, some additions to his remarks can be made based on new studies and methodological criteria (e.g., Hedges et al. 1992, Hyslop 1992). In the specific case of the stone artifacts, the knowledge and information produced by lithic research in the last decades allows us to draw the following conclusions.

Four specimens (#41.1 1924) catalogued as scrapers are actually early bifacial manufacturing stages rejected during the manufacturing process. These specimens evidence fractures of different types produced while knapping (see Callahan 1979), which caused their rejection during the reduction process. This agrees with the fact that, although many Fell's cave points were manufactured from flakes (see Bird 1969; Bird and Cook 1970), some of them show clear evidence of bifacial knapping carried out before shaping (Nami 1993–94, 1997). Specimen #41.1 1980G, which is considered a projectile point, is probably a preform fractured during the manufacturing process. The piece only presents evidence of percussion flaking and lacks pressure flaking, the technique used to finish the points. This piece is illustrated in figures 57 and 58 (third specimen, first row) of Bird's book (1988).

Specimen #41.1 1974, which has been referred to as a Clovis-like fluted projectile point (Lynch 1978: 467), actually has no fluting but rather what is commonly called "pseudo-fluting." This consists of remnants of the flake blank faces: the dorsal, or more commonly the smooth ventral face (Wilmsen and Roberts 1978:111). The section of the specimen and the fact that all the projectile points in the assemblage are "fishtails" suggests that it is not a projectile point but rather another kind of stone tool, probably a knife. This piece is illustrated in figures 57 and 58 (first specimen from the left, first row) of Bird's book (1988).

Most of the fishtail projectile points were resharpened during their use-lives. As a result, there are a great variety of blade shapes (see Ahler 1971, Flenniken and Raymond 1986).

Based on experimental studies, it is possible to suggest that the fractures on the projectile points are due to use (Woods 1988), and that the points were probably discarded because the blades were too small to allow resharpening.

The Bird collection curated at the American Museum of Natural History also includes an interesting number of bone artifacts. One of them deserves special attention because it was habitually interpreted as a flaker (Bird 1988 figs. 60 No. 8, 9 and 61). However, this artifact is morphologically different from the flakers recovered in the same level (Bird 1988 fig. 60 No. 4 and 7) and the Paleoindian flakers belonging from Cueva del Medio. There, similar

Fell and Pali Aike's findings were made (Nami 1987 fig. 21). The bone artifact probably is a broken piece of a foreshaft. In fact, it is very similar to the proximal experimental foreshafts employed in experiments with replicated Paleoindian technology (Callahan 1994: fig 7).

Based on these observations it is possible to suggest that weaponry repair and projectile point replacement tasks were carried out at the site. Thus, foreshafts, intermediate bifacial manufacturing stages, lithic debitage, and heavily resharpened and fractured projectile points have remained in the site.

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References Cited

Ahler, S. A. 1971 *Projectile Point Form and Function at Rodgers Shelter, Missouri.* Missouri Archaeological Society, Research Series, 8.

Bird, J. 1969 A Comparison of South Chilean and Equatorial "Fishtail" Projectile Points. *The Kroeber Anthropological Society Papers* 40, California.

——— 1988 *Travels and Archaeology in South Chile*, edited by J. Hyslop, Iowa University Press, Iowa.

Bird, J., and R. Cooke 1977 Los Artefactos Más Antiguos de Panamá. *Revista Nacional de Cultura* 6:7–31.

Callahan, E. 1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition. A Manual for Flintknappers and Lithic Analysts. *Archaeology of Eastern North America* 7(1):1–180.

——— 1994 A Mammoth Undertaking. *Bulletin of Primitive Technology* (1)7:23–39.

Flenniken, J., and A. W. Raymond 1986 Morphological Projectile Point Typology: Replication, Experimentation and Technological Analysis. *American Antiquity* 51(3):603–614.

Hedges, R. E. M., R. A. Housley, C. R. Bonk, and G. J. van Klinken 1992 Radiocarbon Dates from the AMS System: Datelist 15. *Archaeometry* 34(2):337–357

Hyslop, J. 1992 Report on Dating of Cerro Sota Human Remains. Ms on file at American Museum of Natural History.

Lehman-Niestche, R. 1904 Hallazgos Antropológicos en la Caverna Markatsch-Aike (Patagonia Austral). *Revista del Museo de La Plata* 11: 171–176.

Lynch, T. 1978 South American Paleo-Indians. *Ancient Native Americans*, edited by J. D. Jennings, pp. 455–490, W. H. Freeman and Co., San Francisco.

Nami, H. G. 1993–94 Observaciones Sobre Desechos De Talla Procedentes de las Ocupaciones Tempranas de Tres Arroyos (Tierra del Fuego, Chile). *Anales del Instituto de la Patagonia* (Serie Ciencias Humanas) 22:175–180, Punta Arenas.

——— 1995 Archaeological Research in the Argentinian Río Chico Basin. *Current Anthropology* 36 (4):661–664.

——— 1997 Investigaciones Actualísticas para Discutir Aspectos Técnicos de los Cazadores-Recolectores del Tardiglacial: El Problema Clovis-Cueva Fell. *Anales del Instituto de la Patagonia (Serie Ciencias Humanas)* 25:151–186, Punta Arenas, Chile.

Wilmsen, E. N., and F. H. H. Roberts 1978 *Lindenmeier 1934–1974: Concluding Report on Investigations.* Smithsonian Contributions to Anthropology No.24, Washington, D.C.

Woods, J. C. 1988 Projectile Point Fracture Patterns and Inference about Tool Function. *Idaho Archaeologist* 11 (1):3–7.

Reduction Strategy for Secondary Source Lithic Raw Materials at Guardiria (Turrialba), 9-FG-T, Costa Rica

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The debates over the origins of South American fishtail projectile points (FTPPs) and their relationship with Clovis have yet to provide definite answers to some basic questions. For instance, there is still no consensus on whether FTPPs were a technological innovation by Clovis groups moving south (Lynch 1978; Ranere 1997) or an independent invention spreading north with a South American population (Bryan 1973; Mayer-Oaks 1986; Politis 1991). Although some of these questions may eventually be answered by dating future sites, the technological characteristics of these assemblages must be identified and compared if we are to understand this relationship beyond mere chronology. This is important since a "classic Clovis" technological yardstick is often used to determine the degree of cultural affinity between early populations of Central and South America and Northern Paleoindians. This method has both strengths and weaknesses depending on whether archaeologists recognize and factor in important environmental variables that might explain why incongruities appear between some assemblages.

The Guardiria site, situated in the Turrialba Valley of Costa Rica, offers a unique opportunity for archaeologists trying to understand preceramic reduction strategies of Central America. Guardiria functioned as both a campsite and a procurement locality for secondary-source lithic raw materials (Castillo et al. 1987; Snarskis 1979). The site occupies a vast area that includes a point of land at the confluence of the Reventazon and Tuis Rivers where large chert cobbles abound. This material is heterogeneous and does not compare in quality to the better-known lithic sources exploited by North American Clovis groups. Nevertheless, the discovery of 18 fluted bifaces, in different stages of manufacture, attest to substantial workshop activities.

Reduction of the river cobbles started with the creation of a platform with a blow to one of their extremities (Figure 1). If this did not remove enough cortex, the cobbles were struck again, this time detaching a tablet. Blade-like flakes were then removed from the core's periphery to eliminate the surrounding cortex. The production of large flake-blanks for points and other tools followed decortication. Unidirectional flake removals continued until unrecoverable fractures and/or obtuse angles prevented further reduction. At this point, instead of rejuvenating the original platform, the core was turned over and a second platform was created by striking off its distal end. This strategy was observed on many pieces of the collection and is considered a diagnostic aspect of this reduction process. Flake production proceeded, making use of fortuitous

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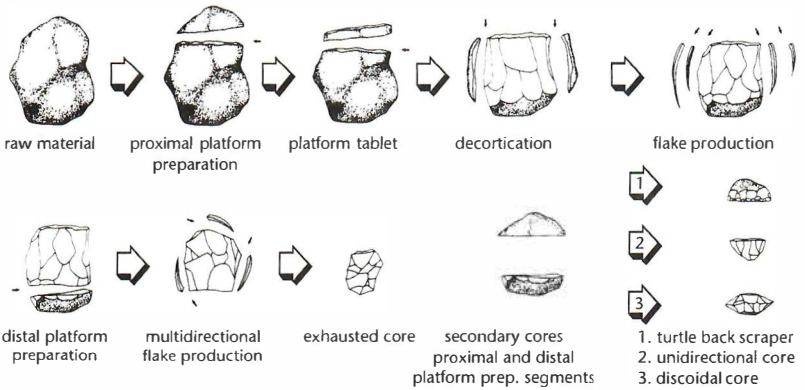

Figure 1. Reduction sequence of secondary-source lithic raw materials at Guardiria, Costa Rica.

angles around the entire core. Both the proximal and distal platform preparation segments were, in turn, used as either secondary flake cores or transformed into turtle-back scrapers/planes. This cobble reduction sequence is but a single aspect of the lithic industry at Guardiria, and an analysis of the tool manufacturing techniques, both bifacial and unifacial, is ongoing.

Since the site remains to be dated, the antiquity of its assemblage can only be evaluated by comparing its technological and typological attributes to firmly dated material. Therefore, additional early-stage Clovis reduction strategies for secondary-source lithic raw materials need to be defined (Mallouf 1989, Sanders 1990). Given that reduction processes are influenced by the types of source exploited and the quality of raw materials, certain hallmarks of North American Clovis technology (Bradley 1982; Morrow 1995; Wilke et al. 1991), dependent on high-quality stones with predictable fractures (Ellis 1989; Goodyear 1979), may not be applicable in areas where such materials were absent (Meltzer 1984). We must, therefore, be cautious and assess the validity of our assumptions when comparing late-Pleistocene assemblages from dramatically different environments.

I would like to extend a debt of gratitude to the archaeologists at the Museo Nacional de Costa Rica whose hospitality and cooperation contributed to the success of this research. Many thanks go to John Hoopes and Jack Hofman for bringing this project to my attention. This research was funded by a Tinker Research Grant from the Center of Latin American Studies of the University of Kansas.

References Cited

Bradley, B. A. 1982 Flake Stone Technology and Typology. In *The Agate Basin Site: A Record of Paleoindian Occupations of the Northwestern Plains*, edited by G. Frison and D. Stanford, pp. 181–208. Academic Press, New York.

Bryan, A. L. 1973 Paleoenvironments and Cultural Diversity in Late Pleistocene South America. *Quaternary Research* 3:237–256.

Castillo, C., D., E. Castillo O., M. Rojas G., and C. Valldeperas A. 1987 Analysis de la Litica Lasqueada del Sitio 9-FG-T. En Turrialba. Tesis de Licenciatura, Escuela de Antropologia y Sociologia, Universidad de Costa Rica.

Ellis, C. J. 1989 The Explanation of Northeastern Paleoindian Lithic Procurement Patterns. In *Eastern Lithic Resources Use*, edited by J. Ellis and J. C. Lothrop, pp. 139–164. Westview Press, Colorado.

Goodyear, A. C. 1979 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleo-Indian Groups of North America. Institute of Archaeology and Anthropology, University of South Carolina, Research Manuscript Series No. 156.

Lynch, T. F. 1978 The South American Paleo-Indians. In *Ancient Native Americans*, edited by J. D. Jennings, pp. 445–490. W. H. Freeman and Co., San Francisco.

Mallouf, R. J. 1989 A Clovis Quarry Workshop in the Callahan Divide: The Yellow Hawk Site, Taylor County, Texas. *Plains Anthropologist* 34(124):81–103.

Mayer-Oakes, W. J. 1986 Early Man Projectile Points and Lithic Technology in the Ecuadorian Sierra. In *New Evidence for the Peopling of the Americas*, edited by A. L. Bryan, pp. 133–156. Center for the Study of Early Man, University of Maine, Orono.

Meltzer, D. J. 1984 On Stone Procurement and Settlement Mobility in Eastern Fluted Point Groups. *North American Archaeologists* 6(1):1–23.

Morrow, J. E. 1995 Clovis Projectile Point Manufacture: A Perspective from the Ready/Lincoln Hills Site, 11JY46, Jersey County, Illinois. *Midcontinental Journal of Archaeology*, 20(2):167–191.

Politis, G. C. 1991 Fishtail Projectile Points in the Southern Cone of South America: An Overview. In *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 287–301. Center for the Study of the First Americans, Oregon State University, Corvallis.

Ranere, A. J. 1997 Paleoindian Expansion into Tropical America: The View from Central Panama. Temple University, Ms. in possession of author.

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

Snarskis, M. J. 1979 Turrialba: A Paleo-Indian Quarry and Workshop Site in Eastern Costa Rica. *American Antiquity* 44:125–138.

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

The Crook County Clovis Cache

Kenneth B. Tankersley

During the summer of 1963, Harold Erickson unearthed a Clovis cache in Crook County, Wyoming (Byrd 1997a). It consisted of red ochre, two cylindrical bone artifacts, and nine flaked-stone bifaces. Contrary to statements made in the popular literature (Byrd 1997b), there was no evidence of mortuary activity.

Eight of the stone artifacts are manufactured from large flakes of a black to brown Eocene, Green River Formation, silicified sediment known as Tiger chert. The principal source of this material is more than 500 km southwest of Crook County, Wyoming (Miller 1991:467). Outlines of the bifaces demonstrate that they originated from a single nodule or several nodules of the same size (Figure 1). Bulls-eye and banding patterns can be matched on some of the artifacts.

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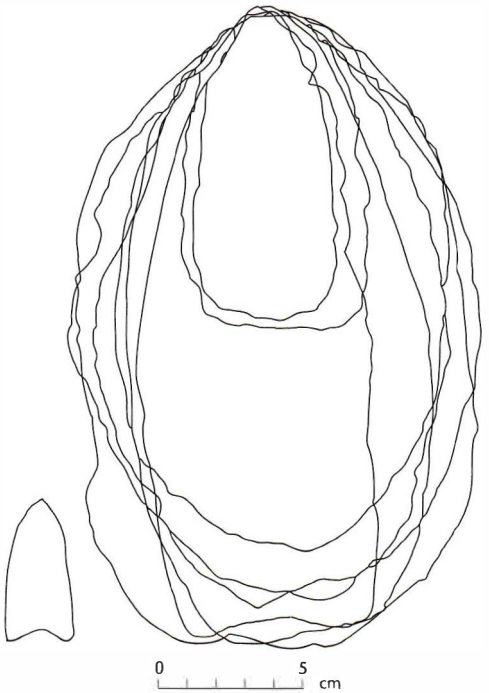

Figure 1. Outlines of the Crook County Clovis cache bifaces. Left, Madison Formation chert. Right, Green River Formation chert.

Seven of the bifaces are Clovis point preforms manufactured by direct soft-hammer percussion. They show pronounced beveled (50°–60°) platforms and long, expansive flake scars. The largest biface is an early-stage preform shaped with slight platform preparation (55°–80°) and few flake removals. Two bifaces exhibit secondary shaping, reduced beveled-edge angles (40°–45°), and bases prepared for fluting.

One of the bifaces is a large fluted knife (215 cm) made from a flake blank struck in the shape of a Clovis point. Aside from the concave base, basal thinning flakes, and retouch along a lateral margin, the biface retains most of the original flake surfaces, including cortex.

The smallest biface is a heavily reworked Clovis point manufactured from an even-colored yellow chert. It compares favorably with Mississippian, Madison Formation cherts exposed in the Hartville Uplift, Black Hills, and Wind River areas of Wyoming (Francis 1991:308). It differs from the other bifaces in stone, near-exhausted state, and sandblasted appearance. Like the other specimens, multicolored fine sand, silt, and red ochre are present in the flake scars.

The red ochre is a hematite that deeply penetrates the chert's microcrystalline texture. This trait is typical of Sunrise red ochre from the Hartville Uplift region of Wyoming (Frison 1991; Stafford 1990; Tankersley et al. 1995). Well-defined diagonal patterns of red ochre occur on two bifaces. These patterns can be enhanced under long-wavelength ultraviolet light. Linear outlines of

red ochre and polish across flake ridges and flake scar interiors suggest that the bifaces were wrapped with multiple strips of rawhide. Similar patterns of red ochre appear on two finished Clovis points from the Fenn Cache.

The Crook County assemblage is the seventh known cache of Clovis bifaces (Frison 1991; Gramly 1993; Hofman 1995; Jones and Bonnichsen 1994; Stanford and Jodry 1988; Woods and Titmus 1985). Differences in manufacture technology between these caches may provide evidence for regional variation in the Clovis culture (Bonnichsen 1977; Haynes 1982).

The author wishes to thank and acknowledge the following for their insightful observations and comments: Daniel Amick, George Frison, Margaret Jodry, Dennis Stanford, and Alice Tratebas. The generous help and cooperation of Pete Bostrom and Forest Fenn were invaluable.

References Cited

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

Byrd, J. 1997a The Crook County Cache. *Indian Artifact Magazine* 11:38.

——— 1997b The Crook County Cache: A Probable Clovis Mortuary Site in Wyoming. *Journal of the American Society for Amateur Archaeology* 4:19–23.

Francis, J. 1991 Lithic Resources on the Northwestern High Plains: Problems and Perspectives in Analysis and Interpretation. In *Raw Material Economies Among Prehistoric Hunter-Gatherers,* edited by A. Montet-White and S. Holen, pp. 321–334, University of Kansas Press, Publications in Anthropology, No. 19, Lawrence.

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

Gramly, R. M. 1993 *The Richey Clovis Cache.* Persimmon Press, Buffalo.

Haynes, C. V. 1982 Were Clovis Progenitors in Beringia? In *Paleoecology of Beringia,* edited by D. M. Hopkins, J. V. Matthews Jr., C. E. Schweger, and S. B. Young, pp. 383–398, Academic Press, New York.

Hofman, J. L. 1995 The Busse Cache: A Clovis-Age Find in Northwestern Kansas. *Current Research in the Pleistocene* 12:17–19.

Jones, S., and R. Bonnichsen 1994 The Anzick Clovis Burial. *Current Research in the Pleistocene* 11:42–44.

Miller, J. C. 1991 Lithic Resources. In *Prehistoric Hunters of the High Plains,* edited by G. C. Frison, pp. 449–476, Academic Press, New York.

Stafford, M. D. 1990 The Powers II Site (48PL330): A Paleoindian Red Ochre Mine in Eastern Wyoming. Unpublished M.A. thesis, Department of Anthropology, University of Wyoming, Laramie.

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

Tankersley, K. B., K. O. Tankersley, N. R. Shaffer, M. D. Hess, J. S. Benz, F. R. Turner, M. D. Stafford, G. M. Zeimens, and G. C. Frison 1995 They Have a Rock that Bleeds: Sunrise Red Ochre and its Early Paleoindian Occurrence at the Hell Gap Site, Wyoming. *Plains Anthropologist* 40:185–194.

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

Use-Wear Evidence from Southern Ontario for Heavy Woodworking during the Early-Paleoindian Period

John Tomenchuk and Peter L. Storck

Four chipped-stone adzes and four other possible adzes were identified recently in the lithic assemblage from the Red Wing site, occupied by early-Paleoindian Parkhill-complex peoples. The site is situated adjacent to a Pleistocene-age bog/shallow body of water and 50 m from a bedrock source of preferred toolstone, Fossil Hill Formation chert, in the Kolapore Uplands in the southern Georgian Bay region of Ontario. During the late Pleistocene in this upland region (today a prominent snowbelt), chert would presumably only have been accessible during the snow-free seasons of the year.

The adzes, like the Red Wing bifacial preforms, manifest variable combinations of biface and core reduction techniques. However, the adzes differ from preforms by exhibiting prominent keels (usually parallel to, but offset from, the longitudinal axis) and a pronounced planar-convex cross section (Figure 1). During preliminary analysis, the adzes were not recognized as such but thought to represent unskilled or rough attempts to produce biface preforms.

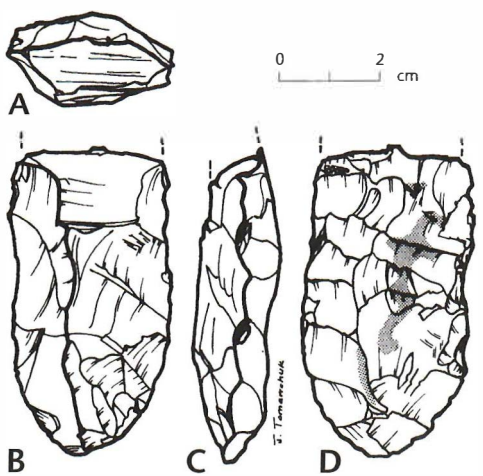

Figure 1. Red Wing adze with broken bit (catalogue number 994.76.277). **A,** distal end showing transversely broken bit; **B,** obverse face, showing keel truncated by step-terminating fracture which removed bit; **C,** lateral view showing localized crushing; **D,** reverse face showing wood polish (heavy shading, near left distal edge) and haft polish (light shading, roughly coincident with position of keel on obverse face).

Usewear studies later identified evidence of woodworking damage/polish and hafting polish indicating use as adzes. Comparable tools have not been reported from other Parkhill-complex sites in southern Ontario.

Average dimensions for the eight Red Wing adzes are: length, 63.5 mm; width, 36.7 mm; thickness, 19.5 mm; and weight, 46.0 gm. The average edge

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angle of the bit is 65.3°, of the poll 71.9°. All specimens lack edge grinding despite microwear evidence that at least five were probably hafted.

The bits on four specimens are damaged and no longer functional because of the presence of broad (>2.0 mm), flat and invasive (>2.0 mm) flake scars produced by impact damage during use. In two instances, transverse breaks perpendicular to the long axis truncate the bit ends and culminate in pronounced step or hinge terminations. These transverse breaks are characterized by bend rather than cone initiations.

Use-wear analysis of the Red Wing adzes was performed employing both low- and high-power optical microscopy. Most complete bits exhibit a wood polish undercut by repeated removals of step-terminating chips. The intensity and invasiveness of the polish (often >10.0 mm) is more pronounced on the convex dorsal surface than on the planar ventral surface. Striations oriented roughly perpendicular to the bit edge are present but rare, suggesting that the tools were used on non-charred wood (cf. Yerkes and Gaertner 1997). This interpretation is supported by an absence of charcoal particles in cracks and recesses of the bits.

If the Red Wing adzes are indeed part of the early-Paleoindian (Parkhill complex) tool kit (see Storck 1997), the absence of hafting-related edge grinding—a common feature on fluted points—suggests that a different mechanism of hafting was used for the adze. It also suggests that the adze was less labor-intensive to manufacture than the heavily ground, chipped-stone late-Paleoindian Dalton adze in the southeastern United States, to which it is most comparable, and ground-stone adzes of later periods. The shorter investment of time required to manufacture the Parkhill-complex adze, and the presumed absence of the adze at other types of sites, suggest that the tool was made specifically for short-term use at chert procurement sites in the Kolapore Uplands where, during spring, summer or fall visits to obtain toolstone, wood may also have been cut for use as handles, spear shafts and other tools. This geographically (and seasonally) restricted pattern of use contrasts strongly with the widespread occurrence (in many different types of sites) of Dalton and later-Archaic adzes, presumably reflecting the year-round use of these artifact types. These contrasting patterns, if verified by future research, may throw new light on the process of early-Paleoindian cultural-ecological adaptation to late glacial environments in the Great Lakes region.

The use-wear analysis was financially supported by research grants to Storck from the Royal Ontario Museum Foundation and the Social Sciences and Humanities Research Council of Canada.

References Cited

Gaertner, L. M. 1990 Determining the Function of Dalton Adzes from Northeast Arkansas. *Lithic Technology* 19(2):97–109.

Storck, P. L. 1997 Exploring Possible Ecological Factors Underlying Early-Paleoindian Lithic Procurement: The 1996 Red Wing Project, Southern Ontario, Canada. *Current Research in the Pleistocene* 14:79–80.

Yerkes, R. W., and L. M. Gaertner 1997 Microwear Analysis of Dalton Artifacts. In *Sloan: A Paleoindian Dalton Cemetery in Arkansas*, edited by D. F. Morse, pp. 58–71. Smithsonian Institution Press, Washington.

Stone Raw Materials of Late-Pleistocene and Early-Holocene Russian Far Eastern Assemblages: Analytical Approach.

Irina Zhushchikhovskaya, Boris Zalishchak, and Vera Pakhomova

Previously the description of stone raw materials used during the Paleolithic and Neolithic in Primorie region was restricted to lithologic identifications. Today the situation has changed, and detailed characterization of rock components has become the goal of research (Popov & Shackly, 1997).

This report presents some results of analysis of stone raw material from late-Pleistocene/early-Holocene sites of the eastern Primorie region of the Russian Far East. These artifacts belong to the late-Paleolithic Ustinovskaya culture, dated from 20,000 to 9,000–8,000 yr B.P. These sites are concentrated in Zerkalnaya River Valley where the deposits of stone raw material identified as siliceous tuff are located. The lithic industry includes a blade technology. (Dyakov, 1997; Kononenko, 1996; Vasil'evsky & Gladyshev, 1989).

Our petrographic analysis of some artifacts from site Ustinovka-3 (dated at 9,000–8,000 yr B.P.) and rock samples from the vicinity of the site identify raw material as cryptocrystalline tuff. It is characterized by exclusively homogenous and fine texture (grain size c. 0.01 mm). The angular grains of quartz, plagioclase, and feldspar occur as rare inclusions. Silicification, zeolitization and kaolinization suggest intensive hydrothermal alteration.

The chemical composition of local tuffs is: 60–73% SiO_2, 13–18% $A_{12}O_3$, 7–12% Na_2O, K_2O, CaO, MgO, Fe_2O_3 in sum, 4–7% H_2O (Popov & Shackly, 1997). This differs strikingly from the predominantly siliceous composition of natural cherts or flints formed by chalcedony or cryptocrystalline quartz and containing 97–99% SiO_2.

The ratio of principal chemical elements in tuffs is similar to that of porcelain, porcelain-like artificial composites and porcelain raw materials. The clasts from Primorie region's deposits contain about 62-77% SiO_2, 12-20% Al_2O_3, 7-10% oxides (Stupatchenko et al., 1965).

Chemical composition, together with mineralogical and structural homogeneity of cryptomere tuffs, cause the resemblance of main technological properties of stone raw materials and porcelain matter—monolithic and isotropic texture, hardness, elasticity. It is likely that these properties especially were most important for the making of tools of high and long-timed workability.

At the same time such properties as hardness and elasticity might cause some difficulties during certain stone-processing operations. Experimental

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research has shown that the tuffs are processed by light-pressure retouching. These data, and the observation of some external features of artifacts from Ustinovka-3 site, have allowed us to infer the use of heat treatment for the facilitating of lithic processing (Kononenko, 1996).

Heat treatment is recognized for the cherts used by stone-age people in various regions of the world. The methods of identifying thermal changes are color analysis, scanning electron microscopy, X-ray diffraction, instrumental measuring of some rock properties, and other methods (Girya, 1994; Collins & Fenwick, 1974; Mandeville, 1973).

The authors suggest using thermobarogeochemistry to solve the problem of heat treatment in our case of study, taking into account the different nature and properties of chert and tuff rocks. Thermobarogeochemistry is a most effective method for the detecting the thermal "history" of minerals and rocks. The essence of this method is identifying melt and fluid individual inclusions in transparent minerals, determining their genesis and reconstructing the thermal process which caused the appearance and kind of inclusions (Roedder, 1983). Thermobarogeochemistry was first used to study archaeological ceramics (Lamina et al., 1995).

The groups of samples studied were stone raw materials from the surroundings of Ustinovka-3 site, and some artifacts with probable evidence of heat treatment from Ustinovka-3 site. Four types of inclusions were identified in transparent minerals as quartz. The first and second types are primary high-temperature melt inclusions, which are characteristic of both sample groups equally and are caused by rock formation processes. The third type is late gas-water and gas-water with solid phase inclusions, which are characteristic mainly of natural rock samples. The fourth type is mostly fluid gas and water-gas inclusions, which are preferable for stone artifact samples. A probable reason for the appearance of the fourth type's inclusions might be thermal processing at temperatures near 200°–300°C.

The next step of our study will be the thermobarogeochemical research of experimental samples of tuff rock heated at precisely fixed temperatures. This research method is preferable for determining the origin of low-temperature fluid inclusions in tuffs and resolving the problem of stone heat treatment during the late Pleistocene/early Holocene in Primorie region.

References Cited

Dyakov V. I. 1997 The Oldest Habitation Site on the West Coast of Japan Sea. *Current Research in the Pleistocene* 14:20–22.

Collins M. B, and J. M. Fenwick 1974 Heat Treatment of Chert: Methods of Interpretation and Their Application. *Plains Anthropologist* 19(64):134–145.

Girya E. Y. 1994 Teplovaya obrabotka kremnistyh porod isposoby eyo opredeleniya v arheologicheskih materialah (The Heat Treatment of Chert Rocks and Methods of its Identification in Archaeological Records). In *Experimental Research and Usewearing Analyses in Archaeology*. St. Petersburg.

Kononenko N. A. 1996 The Site Ustinovka-3 and the Problems of Transition from Paleolithic to Neolithic in Primorie region. In *Late Paleolithic-Early Neolithic (Eastern Asia and Northern America)*. pp. 117–136. Vladivostok.

Kononenko N. A., A. V. Garkovik, and H. Kajiwara 1993 *Issledovanie dokeramicheskoi stoyanki Ustinovka-3 v Primorie* (The Research of Pre-ceramic Site Ustinovka-3 in Primorie Region). Vladivostok.

Lamina E. V., E. V. Lotova, and N. N. Dobretsov 1995 *Mineralogiya drevnei keramiki Baraby* (Mineralogy of Ancient Ceramics of Baraba Region). Novosibirsk.

Mandeville M. O. 1973 A Consideration of the Thermal Pretreatment of Chert. *Plains Anthropologist* 18(61):177–202.

Popov V. K., and S. Shackly 1997 Obsidian Primoria: pervye rezultaty arheologo-geologicheskoi korrelatsii (The Obsidian Rock of Primorie Region: First Results of Archaeological-Geological Correlation. In *Vestnik Dalnevostochnogo Otdeleniya Rossiyskoi Akademm Nauk* (Bulletin of Far Eastern Branch of Russian Academy of Sciences) 3:77–85.

Roedder E. 1984 Fluid inclusions. In *Reviews in Mineralogy* Vol.2. Reston, Virginia.

Stupatchenko P., V. Korenbaum, and I. Svininnikov 1965 *Stroitelnye materialy iz gornyh porod Primoria* (Primorie region's rocks as raw materials for building industry). Vladivostok.

Vasil'evsky R. S., and S. V. Gladyshev 1989 *Verkhnii paleolit yuzhnogo Primoria* (The Upper Paleolithic of Southern Primorie Region). Novosibirsk.

Paleoenvironments: Plants

Phytolith Analysis of Bison Teeth Calculus and Impacta from Sites in Kansas and Oklahoma

Steven Bozarth and Jack Hofman

The purpose of this study was to determine the feasibility of reconstructing the diet of prehistoric bison in the central Great Plains by analyzing opal phytoliths (plant silica bodies) extracted from teeth calculus and impacta. The first study of this type was by Armitage (1975), who demonstrated that phytoliths isolated from the food residue on teeth can be used to investigate the diet of cattle in various archaeological sites. Middleton (1990) reported that analysis of phytoliths isolated from tartar residues on herbivore teeth yielded valuable data on historic livestock management practices. Akersten et al. (1988) reported that "pockets" (fossettes) on teeth of many large herbivores contain impacted plant material which can be classified at various taxonomic levels.

Phytoliths were extracted from five samples of bison teeth calculus and one sample of bison tooth impacta (Table 1). The extraction procedure involved ultrasonically cleaning the material in a solution of distilled water and detergent followed by washing with distilled water. The calculus was then digested with dilute hydrochloric acid. The resulting isolates were washed with distilled water and stored in 1-dram glass vials. Phytoliths were mounted in immersion oil on microscope slides and studied at 625X with a research-grade Zeiss petrographic microscope. At least 100 short cells characteristic of the principal grass subfamilies in the central Great Plains (Twiss 1987) were classified in those samples with significant amounts of phytoliths. Virtually all phytoliths were counted in the other isolates.

Phytolith concentration was adequate for analysis in both the impacta and the calculus samples from the left mandibular ramus in bison #3 collected in Finney County, Kansas. The other four calculus samples contained phytoliths but not in sufficient quantities for a conclusive analysis. The low phytolith concentration in these four samples is presumably due to their much smaller size relative to the calculus sample from Finney County.

The phytolith assemblages from both the impacta and calculus samples

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Table 1. Relative frequency (%) of phytolith types isolated from bison teeth calculus and impacta

sample description	sample wt. (grams)	Chloridoid (short grasses)	Panicoid (tall grasses)	Pooid (cool-moist)	total
impacta from molar fossetts left mandibular ramus (#47)■ Bison #3, Finney Co., KS	0.02	86	5	9	111
calculus from left mandibular ramus (#47)■ Bison # 3, Finney Co., KS	6.01	83	3	14	100
calculus from left mandibular ramus,■ Konza Prairie # 2 Riley Co., KS	0.61	—	100	—	4
calculus, isolated teeth▲ 34HP42 (Waugh site) Harper Co., OK	1.25	25	50	25	4
calculus from mandibular ramus▲ 34CD314 WCT-26 Caddo Co., OK	0.87	—	67	33	3
calculus, isolated teeth▲ 14SC6 (Norton site) Scott Co., KS	0.42	75	25	—	4

note: All specimens were collected in the field. Frequencies in last four samples not statistically significant due to low phytolith count.
■ modern bison control sample
▲ archaeological sample

from the Finney County, Kansas, bison tooth are dominated by Chloridoid short cells, indicating that the animal ate mostly short grasses adapted to warm, dry environments such as buffalo grass (*Buchloe dactyloides*) and blue grama grass (*Bouteloua gracilis*). The phytolith data also show that the bison grazed on Panicoids (warm, humid-type grasses) such as little bluestem (*Andropogon scoparius*) and Pooids (cool, moist-season grasses) like western wheatgrass (*Agropyron smithii*).

This study demonstrates that significant quantities of phytoliths can be extracted from bison teeth calculus and impacta. The classification of these phytoliths can then be used to determine the dietary habits of bison. Relatively large calculus samples (at least 5 g) need to be processed to provide adequate numbers of phytoliths.

This study was partially funded by the Wenner-Gren Foundation for Anthropological Research (Grant #5287) and the University of Kansas General Research Fund.

References Cited

Armitage, P. L. 1975 The Extraction and Identification of Opal Phytoliths from the Teeth of Ungulates. *Journal of Archaeological Science* 2, 187–197.

Akersten, W. A., T. M. Foppe, and G. T. Jefferson 1988 New Source of Dietary Data for Extinct Herbivores. *Quaternary Research* 30, 92–97.

Middleton, W. 1990 An improved Method for Extraction of Opal Phytoliths from Tartar Residues on Herbivore Teeth. *The Phytolitharien,* 6(3):2–5.

Twiss, P. C. 1987 Grass-Opal Phytoliths as Climatic Indicators of the Great Plains Pleistocene. In *Quaternary Environments of Kansas,* edited by W. C. Johnson, pp. 179–188. Kansas Geological Survey Guide Book Series 5, Lawrence, KS.

A Late-Pleistocene/Holocene Transition from the Brule Spillway, Douglas County, Wisconsin

Martin F. Engseth and James K. Huber

The basal portion of a 3-m core from a cedar swamp in the Brule/St. Croix Spillway channel has been analyzed for pollen as part of a multidisciplinary archaeological investigation of Paleoindian settlement patterns in northwestern Wisconsin. The site is in Douglas County, Wisconsin (UTM: N5138150, E594750). Located near the headwaters of the Bois Brule River, in the Brule/St. Croix Spillway channel, the site is on the present-day divide between the Great Lakes/St. Lawrence drainage basin and the Mississippi River/Gulf of Mexico drainage basin. The spillway was abandoned when the Superior Lobe of the Wisconsin Ice Sheet melted back far enough to allow the meltwater ponded behind it to seek a lower outlet east of the Keweenaw Peninsula in Michigan (Farrand and Drexler 1985).

The basal portion of the core is composed of dark brown peat and gray organic silt (Figure 1). An AMS date on charcoal and *Picea* (spruce) needles from 297 cm yielded a date of 9,050 ± 60 yr B.P. (Beta-112985) with a calibrated 2-sigma range of 9,990 to 10,120 yr B.P. The organic material retrieved

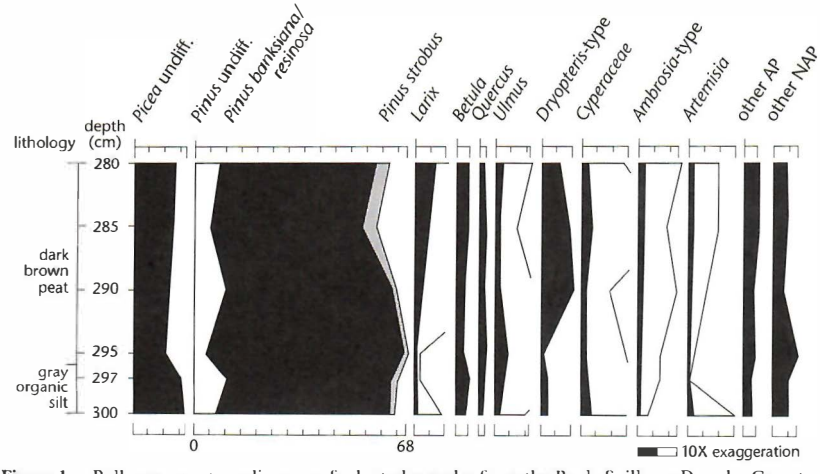

Figure 1. Pollen percentage diagram of selected samples from the Brule Spillway, Douglas County, Wisconsin. AP = arboreal pollen; NAP = Non-arboreal pollen.

from the bottom of the spillway probably began accumulating following the cessation of spillway activity.

The pollen spectrum from the basal portion of the core (Figure 1) is dominated by *Pinus banksiana/resinosa* (jack/red pine), *Picea*, and *Dryopteris*

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(shield fern). Other important taxa include *Larix* (tamarack), *Betula* (birch), *Quercus* (oak), *Ulmus* (elm), Cyperaceae (sedge), *Ambrosia* (ragweed), and *Artemisia* (wormwood). The small *Ulmus* peak (Figure 1) may reflect the postglacial elm maximum dated in the Midwest between 9,000 and 10,000 yr B.P. (Maher 1977). The pollen spectrum from the Brule/St. Croix Spillway channel is similar to Zone 1 at Mary Lake dated to 9,800 to 10,000+ yr B.P. (Webb 1974) and a late-glacial pollen sequence from Lake Superior (Huber 1993).

The results of the analysis tighten the chronology of geological and paleoenvironmental events in and around the Lake Superior Basin at the end of the Pleistocene. The pollen spectra, along with the AMS date, suggest that the Brule/St. Croix Spillway ceased to be active about 10,000 years B.P., and that the local environment consisted of a conifer or conifer-hardwood forest dominated by red and/or jack pine.

References Cited

Farrand, W. R., and C. W. Drexler 1985 Late Wisconsinan and Holocene History of the Lake Superior Basin. In *Quaternary Evolution of the Great Lakes*, edited by P. F. Karrow and P. E. Calkin, Geological Association of Canada Special Paper No. 30, Waterloo, Ontario, pp. 17–32.

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

Webb III, T. 1974 A Vegetational History from Northern Wisconsin: Evidence from Modern and Fossil Pollen. *American Midland Naturalist* 92(1):12–34.

Huber, J. K. 1993 A Late Glacial Pollen Sequence from Lake Superior: Current Research in the Pleistocene 10:89–90.

A Pollen Sequence from Rocky Run Road Channel Lake, Portage County, Wisconsin

James K. Huber

Palynological investigations of a core from an unnamed channel lake (herein referred to as Rocky Run Road Channel Lake) were undertaken to reconstruct a paleoenvironmental setting for prehistoric occupation of the Sandhill site (47Pt42). Situated on a sandy terrace, the Sandhill site is west of the Wisconsin River within the city of Stevens Point, Portage County, Wisconsin. Rocky Run Road Channel Lake (RRRCL) is approximately 0.75 km to the southwest of the Sandhill site (NW ¼, sect. 7, T23N, R8E, Whiting 7.5′ Quadrangle. RRRCL appears to be either an old tributary or an abandoned channel of Rocky Run Creek. The channel lake is on stream sediment of the Love Terrace

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deposited by the Wisconsin River, probably soon after Wisconsin glaciation (Clayton 1986). The 221-cm core recovered RRRCL is composed of two major units (Figure 1).

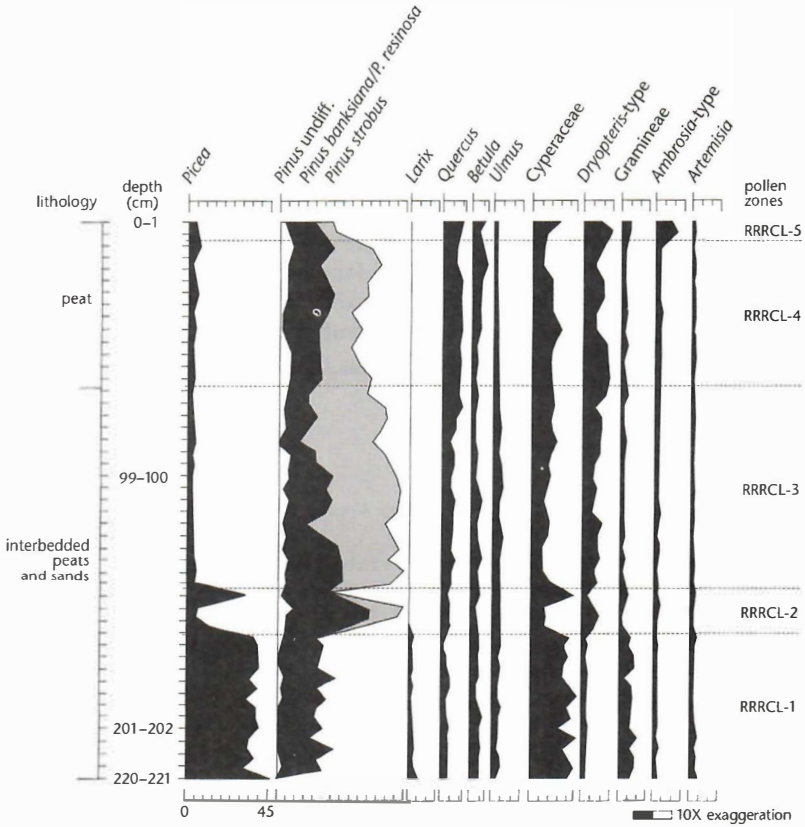

Figure 1. Pollen percentage diagram of selected taxa from Rocky Run Road Channel Lake, Portage County, Wisconsin.

The pollen diagram from RRRCL is divided into five zones (Figure 1). RRRCL-1 is dominated by *Picea* (spruce), *Pinus* (pine), Cyperaceae (sedge), and Gramineae (grass). The high abundance of *Picea* and *Pinus* in this zone does not correlate well with other sequences in the area. Assuming that pollen deposition at the base of the core reflects the initial migration of *Pinus* into this area, the base of the core can be dated to approximately 11,000 yr B.P. by correlation to the Devil's Lake core (Maher 1982). Zone RRRCL-1 may reflect a conifer or conifer-hardwood forest; it is also possible that the high *Picea* values reflect local pollen influx from a black spruce swamp. The abundance of Cyperaceae and Gramineae suggest the presence of moist forest openings or sedge meadows in the vicinity of the lake.

RRRCL-2 is characterized by an overall increase in *Pinus*. At the top of this zone a *Pinus* minimum and *Picea* maximum occur (Figure 1). *Pinus banksiana/*

P. resinosa (Jack/red pine) is the dominant pine although *Pinus strobus* (white pine) is prominent. The *Pinus strobus* rise has been dated at 9,600 yr B.P. at Devil's Lake (Maher 1982) and 8,400 yr B.P. at Mary Lake (Webb 1974). The *Picea* maximum and *Pinus* minimum in RRRCL-2 correlate to the top of Zone 1 at Mary Lake (Webb 1974). The fluctuations between *Picea* and *Pinus* dominance also occur at Gilbert Bog and Birge Bog (Potzger 1942) and Forestry Bog Lake (Potzger and Richards 1942). The second *Picea* peak may indicate a climatic reversal. It is also possible that the *Picea* and Cyperaceae peaks may reflect lowering of lake level and reworking of older sediment. A similar situation was recorded by West (1961) at Seidel Lake. The pollen zone indicates the presence of a mixed pine-hardwood forest.

Pine dominates Zone RRRCL-3, and there is a slight increase in deciduous taxa. In Zone RRRCL-4, pine is less abundant and hardwoods increase. The *Ambrosia* (ragweed) peak in Zone RRRCL-5 reflects the advent of Euro-American settlement and land clearance in the vicinity of the Sandhill site (Figure 1).

I would like to thank Lynn Rusch and Midwest Archaeological Consulting for financial support for this investigation.

References Cited

Clayton, L. 1986 Pleistocene Geology of Portage County, Wisconsin. *Wisconsin Geological and Natural History Survey, Information Circular 56.*

Maher, L. J., Jr. 1982 The Palynology of Devil's Lake, Sauk County, Wisconsin. In *Quaternary history of the Driftless Area: Wisconsin Geological and Natural History Survey Field Trip Guide Book Number 5*, edited by J. C. Knox, L. Clayton, and D. M. Mickelson, pp. 119–135.

Potzger, J. E. 1942 Pollen Spectra from Four Bogs on the Gillen Nature Reserve along the Michigan-Wisconsin State Line. *American Midland Naturalist* 28:501–511.

Potzger, J. E., and R. R. Richards 1942 Forest Succession in the Trout Lake, Vilas County, Wisconsin, Area: a Pollen Study. Butler University Botanical Studies 5:179–189.

Webb III, T. 1974 A Vegetational History from Northern Wisconsin: Evidence from Modern and Fossil pollen. *American Midland Naturalist* 92:12–34.

West, R. G. 1961 Late- and Postglacial Vegetational History in Wisconsin, Particularly Changes Associated with the Valders Readvance. *American Journal of Science* 259:766–783.

Paleoenvironments: Vertebrates

Fauna from Late-Pleistocene Sediments of the Sheriden Cave Site (33WY252), Wyandot County, Ohio

Thomas M. Bills and H. Gregory McDonald

The Sheriden Cave site (33WY252), in the northwestern corner of Wyandot County, Ohio, has proven to be an especially important source of late-Pleistocene sediments containing numerous well-preserved bones, botanical remains, and human artifacts. Fishes, amphibians, reptiles, birds, and mammals representing over 60 species have been identified from this cave, making it the most diverse cave deposit in Ohio (Ford et al. 1996; Holman 1997; McDonald 1994). This paper documents the faunal remains identified to date during the 1997 Kent State Archaeological Field School excavations at Sheriden Cave.

Several bone-yielding layers of late-Pleistocene sediments were excavated in 1-by-1-m units and 10-cm intervals. All excavated cave sediments were subjected to flotation resulting in the recovery of microfaunal bones and animal hair. Sedimentologist Robert Breckenridge of Dartmouth University described these sediments as (from top to bottom) a diamicton layer, a gray- and red-banded rhythmite stratum, another diamicton layer, and a layer of angular dolomite rubble.

Uncorrected ^{14}C dates of the upper diamicton layer are 10,850 ± 60 yr B.P. (CAMS 26783; AMS bone collagen) and 10,680 ± 80 yr B.P. (AA 21710; AMS wood charcoal). This layer yielded a carved and incised bone point and a *Chelydra serpentina* (snapping turtle) cervical vertebra with a distinct cut mark (Tankersley and Landefeld, this volume).

Selected materials from the rhythmite layers yielded these ^{14}C dates, listed by increasing depth: 11,710 ± 220 yr B.P. (PITT 0892; conventional wood charcoal), 13,120 ± 80 yr B.P. (AA21711; AMS wood charcoal), 11,060 ± 60 yr B.P. (CAMS 10349; AMS bone collagen), and 10,470 ± 70 yr B.P. (AA 21712; AMS wood charcoal). Bones from this layer have rounded edges characteristic

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of water movement and sediment abrasion (Lyman 1994). This layer also contained high concentrations of fish and herpetofaunal remains (cf. Ford et al. 1996 and Holman 1997).

Three ^{14}C dates, 11,480 ± 60 yr B.P. (CAMS 12837), 11,570 ± 70 yr B.P. (CAMS 12839), and 11,610 ± 90 yr B.P. (CAMS 12845), all on bone collagen, were recorded for the lower diamicton layer. This layer contained a bone bed consisting mostly of skeletal elements of *Platygonus compressus* (flat-headed peccary).

No ^{14}C dates were available for the angular dolomite rubble stratum. This bottom excavated layer yielded a paucity of bones compared with the other strata. A *P. compressus* (flat-headed peccary) humerus and a *Vulpes vulpes* (red fox) mandible are among the bones collected from this layer.

Excavators recovered several owl pellets of recent origin in situ from units along the north wall of the cave, about 5 m from the entrance. Excavations in these units also revealed a recent *Microtus pennsylvanicus* (meadow vole) skeleton associated with a *P. compressus* premolar in situ. The unit farthest from the cave entrance contained a juvenile *P. compressus* skull containing a *Peromyscus maniculatus* (deer mouse) mandible within one orbit. These associations indicated intrusion of recent animals into older sediment layers. Several *P. compressus* bones showed puncture marks from carnivore canines and rodent gnaw marks.

Extinct mammal taxa identified from Pleistocene sediments were *Castoroides ohioensis* (giant beaver), *Arctodus simus* (short-faced bear), *P. compressus* (flat-headed peccary), and *Cervalces scotti* (elk-moose). Identified extralimital extant mammal taxa included *Sorex hoyi* (pygmy shrew), *Synaptomys borealis* (Northern bog lemming), *Phenacomys intermedius* (heather vole), *Glaucomys sabrinus* (Northern flying squirrel), *Erethizon dorsatum* (porcupine), *Mustela vison* (mink), *Martes americana* (pine marten), *Martes* cf. *M. pennanti* (fisher), *Canis lupus* (gray wolf), *Sorex cinereus* (masked shrew), and *Myotis* cf. *M. septentrionalis* (Northern bat). Local extant mammal taxa included *Blarina brevicauda* (short-tailed shrew), *Lagomorpha* (rabbits or hares), *Microtus pennsylvanicus* (meadow vole), *Peromyscus maniculatus* (deer mouse), *Ondatra zibethicus* (muskrat), *Tamias striatus* (Eastern chipmunk), *Tamiasciurus hudsonicus* (red squirrel), *Sciurus carolinensis* (Eastern gray squirrel), *Sciurus* sp. (tree squirrel), *Marmota monax* (woodchuck), *Castor canadensis* (beaver), *Procyon lotor* (raccoon), *Vulpes vulpes* (red fox), and *Odocoileus virginianus* (white-tailed deer). These sediments also yielded remains of bird, reptiles (including snake, lizard, turtle, and *Chelydra serpentina*), amphibians (including *Rana* sp., *Bufo* sp., and salamander), and fish.

Because of the presence of sediment-filled rodent burrows, owl pellets, and rodents currently living in the cave, we were uncertain of the contemporaneity of the animal bones in this sample. Hence, we will obtain direct chronometrical and relative dates from a sample of bones in this assemblage, including AMS ^{14}C, fluorine, and geomagnetism. These dates will be used to determine time relationships of bones from the cave.

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Natural History and the Kent State University Department of Anthropology for access to their comparative faunal collections.

References Cited

Ford, K. M., A. R. Bair, and J. A. Holman 1996 Late Pleistocene fishes from Sheriden Pit, Northwestern Ohio. *Michigan Academician.* 28:135–145.

Holman, J. A. 1997 Amphibians and Reptiles from the Pleistocene (Late Wisconsinan) of Sheriden Pit Cave, Northwestern Ohio. *Michigan Academician.* 29:1–20.

Lyman, R. L. 1994 *Vertebrate Taphonomy.* Cambridge University Press, Cambridge.

McDonald, H. G. 1994 the Late Pleistocene Vertebrate Fauna in Ohio: Coinhabitants with Ohio's Paleoindians. In *The First Discovery of America,* edited by W. S. Dancey, pp. 23–41. Ohio Archaeological Council, Columbus.

Tankersley, K. B., and C. S. Landefeld 1998 Geochronology of Sheriden Cave, Ohio: the 1997 Field Season. *Current Research in the Pleistocene* (this volume).

Fossil Birds of Tunica Hills and First Record of Ruffed Grouse (*Bonasa umbellus*) for Louisiana

Robert M. Chandler

The record for fossil birds from Louisiana is sparse to say the least. Known fossil birds from the state are a *Pterodroma*-like tubenose (Procellariiformes) from the late Eocene Yazoo Formation, reported by Feduccia and McPherson (1993), and a set of footprints of a medium-sized bird (vulture or crane size) from the Miocene of Grant Parish, reported by Wetmore (1956). Therefore, the addition of a small late-Pleistocene/Holocene avifauna is of interest.

Dr. A. Bradley McPherson, Bill Lee, and others collected bird fossils while screen-washing for microfossils in loess and associated gravel beds. Collections were made between January 1983 and September 1991 in the Tunica Hills area in western Feliciana Parish, along Tunica Bayou and Kimball Creek (McPherson, pers. comm.). Three taxa are represented by the following Centenary College Vertebrate Collection (CCVC) specimens: ruffed grouse (*Bonasa umbellus*) complete left humerus (CCVC 563) and a left ulna (CCVC 1557); wild turkey (*Meleagris gallopavo*): left femur shaft (CCVC 222), right tibiotarsus distal end (CCVC 337), left ulna shaft (CCVC 1075), left coracoid (CCVC 1339), right tibiotarsus distal shaft (CCVC 3321); and a perching bird identifiable only to the level of Passeriformes, right tibiotarsus distal end (CCVC no number, "J's Site/Top/87").

The fossils identified herein as wild turkey fit within the size range given by Steadman (1980) for late-Pleistocene turkeys. The distal end of a tibiotarsus

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identified as from a perching bird cannot be identified with confidence to any lower taxonomic category than Passeriformes. However, the leg bone is from an individual about the size of an American robin (*Turdus migratorius*).

The ruffed grouse is only the second Gulf Coastal Plain record for this boreal species. Brodkorb (1959) first identified ruffed grouse from the late Pleistocene of Arredondo, Florida. A population of ruffed grouse closest to the Tunica Hills area today would be in northern Georgia (AOU 1983). Brodkorb (1964) lists 11 Pleistocene or prehistoric records for this species from 7 states from Idaho to Florida and Virginia to California. The Tunica Hills and Arredondo records support the hypothesis proposed by Givens and Givens (1987) and others (see References in Givens and Givens) that during the late Quaternary the Gulf Coast was much cooler than at present.

I thank A. Bradley McPherson, Department of Biology, Centenary College of Louisiana for allowing me to study these fossils and for providing essential collecting data and relevant literature. Identifications were made while I was a Visiting Research Assistant in the Division of Vertebrate Paleontology, Florida Museum of Natural History, University of Florida, Gainesville. Drs. S. David Webb and Bruce J. MacFadden, curators, and Gary S. Morgan, Collection Manager, in the Division of Vertebrate Paleontology allowed access to the fossil collections (especially bird fossils) in their care and Dr. Tom Webber, Collection Manager in the Division of Ornithology, for access to the modern bird osteological collection. I thank Linda D. Chandler, William P. Wall, and an anonymous reviewer for critically reading and improving this paper.

References Cited

American Ornithologist's Union 1983 *Check-list of North American Birds,* 6th edition. American Ornithologist's Union, Lawrence, Kansas.

Brodkorb, P. 1959 The Pleistocene Avifauna of Arredondo, Florida. *Bulletin of the Florida State Museum, Biological Sciences* 4(9):269–291.

——— 1964 Catalogue of Fossil Birds, Part 2 (Anseriformes through Galliformes). *Bulletin of the Florida State Museum, Biological Sciences* 8(3):195–335.

Feduccia, A., and A. B. McPherson 1993 A Petrel-like Bird from the Late Eocene of Louisiana: Earliest Record for the Order Procellariiformes. *Proceedings of the Biological Society of Washington* 106(4):749–751.

Givens, R. C., and F. M. Givens 1987 Age and Significance of Fossil White Spruce (*Picea Glauca*), Tunica Hills, Louisiana-Mississippi. *Quaternary Research* 27:283–296.

Steadman, D. W. 1980 A Review of the Osteology and Paleontology of Turkeys (Aves: *Meleagridinae*). *Contributions in Science, Natural History Museum of Los Angeles County* 330:131–207.

Wetmore, A. 1956 Footprint of a Bird from the Miocene of Louisiana. *Condor* 58(5):389–390.

Schreger Angles in Mammoth and Mastodon Tusk Dentin

Daniel C. Fisher, Josh Trapani, Jeheskel Shoshani, and Michael S. Woodford

One of the most distinctive features of proboscidean dentin is the "Schreger pattern" (Espinoza and Mann 1993) seen on transverse cross-sections of tusks and cheek teeth. Schreger patterns consist of intersecting spiral alignments (Schreger lines; Obermayer 1881) of alternating dark and light regions forming outwardly convex, curvilinear tracts through the dentin (Owen 1845). These patterns reflect complex spatial modulation of the undulatory pathways followed by dentinal tubules within radial planes (Miles and Boyde 1961; Miles and White 1960). Detailed manifestation of the pattern varies, but one of its more easily quantified aspects is the angle of intersection of dextral and sinistral spirals. Espinoza and Mann (1992) used this aspect of Schreger patterns to distinguish "modern" ivory—tusk dentin of African elephants (*Loxodonta africana*) and Asian elephants (*Elephas maximus*)—from "extinct" ivory—represented mostly by tusk dentin of woolly mammoths (*Mammuthus primigenius*). We present evidence that Schreger angles also can be used to distinguish tusks of mammoths from those of the American mastodon (*Mammut americanum*).

Espinoza et al. (1990) and Espinoza and Mann (1992) measured "concave" Schreger angles (straddling radii and opening toward the tusk axis) and "convex" Schreger angles (straddling radii and opening outward), but later argued that no statistically significant quantitative difference separated these two categories (Espinoza and Mann 1993). Additional discussion of measurement protocols is warranted, but on balance their procedure may be more rigorously described as construction of tangents to dextral and sinistral Schreger lines at a point of intersection and measurement of either of the opposite (and equal) radius-straddling intertangent angles. DCF and JT measure Schreger angles on cut and polished transverse cross-sections, using a graduated, rotating stage centered under a stereomicroscope with ocular cross hairs. We center the point at which Schreger angle is to be assessed and measure the angle through which the stage must be rotated to bring each of the two Schreger lines successively into tangency with the same cross hair. Total range of repeated measures of the same angle is usually less than 4°. JS and MSW measure Schreger angles by construction of tangent lines on photocopies or photographs of transverse views of specimens.

Specimens sampled at multiple points throughout the length and thickness of a tusk (by DCF and JT; e.g., Fisher 1990) demonstrate that Schreger angles

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generally increase with increasing distance from the tusk axis and that maximum Schreger angle achieved within a given radial transect also increases proximally, at least within the distal meter of tusk length. This is not surprising, given the outwardly convex curvature of Schreger lines and the conical form of tusks, but Schreger patterns also exhibit features not directly determined by gross morphology. For example, mastodon tusks commonly show an outermost zone of lower Schreger angles associated with a change in the number of Schreger lines. To better represent broad trends, we avoid measuring angles in areas where the Schreger pattern is conspicuously disrupted. Following Espinoza and Mann (1992), our observations focus on outer portions of tusks (near, but not necessarily at, the dentin-cementum junction), and most sampling sites are more than a meter from the tusk tip. These Schreger angles are intended to represent maximal values on their respective specimens.

We measured Schreger angles on tusk specimens of 38 American mastodons and 44 mammoths (*M. primigenius*, *M. columbi*, and *Mammuthus* sp.), independently identified by dental or skeletal evidence. Mastodon values ($\bar{x}$, 124.7°; s.d., 8.8°; range, 113°–149°) differed significantly ($p<0.001$) from mammoth values ($\bar{x}$, 87.1°; s.d., 12.4°; range, 62°–105°), with no overlap between the two distributions. This result differs from that of Espinoza and Mann (1993), who stated (without accompanying data) that three mastodon samples they examined were indistinguishable from mammoths. Espinoza and Mann may have been measuring outermost, rather than maximal, Schreger angles, but even compared on this basis, mastodons in our sample usually show higher values than mammoths.

Espinoza and Mann's (1992, 1993) data suffice to distinguish tusks of mammoths from those of extant proboscideans, but comparison of our data with theirs suggests that these approaches do not readily separate mastodons from extant proboscideans. In this sense, Schreger angles do not directly reflect the extinct-extant dichotomy. However, this does not compromise use of Schreger angle distributions to characterize phylogenetically distinct lineages of proboscideans. Schreger patterns may be especially useful for identifying isolated tusk specimens, which are known from many Pleistocene localities and have often been considered generically indeterminate.

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References Cited

Espinoza, E. O. and M. J. Mann 1992 *Identification Guide for Ivory and Ivory Substitutes.* Second Edition. World Wildlife Fund, Washington, D.C.

——— 1993 The History and Significance of the Schreger Pattern in Proboscidean Ivory Characterization. *Journal of the American Institute for Conservation* 32:241–248.

Espinoza, E. O., M. J. Mann, J. P. LeMay, and K. A. Oakes 1990 A Method for Differentiating Modern from Ancient Proboscidean Ivory in Worked Objects. *Current Research in the Pleistocene* 7:81–83.

Fisher, D. C. 1990 Age, Sex, and Season of Death of Thegrandville Mastodont. *Michigan Archaeologist* 36(3,4):141–160.

Miles, A. E. W., and A. Boyde 1961 Observations on the Structure of Elephant Ivory. *Journal of Anatomy* 95:450 (abstract).

Miles, A. E. W., and J. W. White 1960 Ivory. *Proceedings of the Royal Society of Medicine* 53:775–780.

Obermayer, F. 1881 Beitrag zur kenntnis des zahnbeines vom elefanten, nilpferd, walross und narwal. *Verlag des Vereines der Weiner Handels-Akademie* 1881:102–113.

Owen, R. 1845 *Odontography*. Hippolyte Bailliere, London.

Evidence of Paleoenvironmental Change from Muskrat Dental Microwear Patterns

María Gutierrez, Patrick Lewis, and Eileen Johnson

Lubbock Lake Landmark is a well-stratified late-Quaternary site in Yellowhouse Draw on the Southern High Plains of Texas. Muskrats (*Ondatra zibethicus*) are prevalent at Lubbock Lake during the late Pleistocene and early Holocene, but declined as the paleoclimate became warmer and drier and surface water became less available (Lewis and Johnson, 1997). By 8,500 yr B.P., muskrats are no longer present on the Southern High Plains and do not inhabit the region today (Davis and Schmidly, 1994; Johnson, 1987a). The detailed information on stratigraphy (Holliday, 1982; Holiday and Allen, 1987) and paleoenvironment (Johnson, 1987b) available from Lubbock Lake allow for an excellent opportunity to view muskrat response to environmental change. Current research focuses on dental microwear patterns of the lower first molar (M_1) and how patterns vary with a changing diet.

Muskrat populations are found in three well-dated substrata: 1B, that dates to c. 11,100 yr B.P.; 2A, from 10,800 to 10,200 B.P.; and 2B, from c. 10,000 to 8,600 B.P. (Johnson and Holliday, 1989). As an initial test of the hypothesis that microwear patterns vary with environments, two specimens from the oldest population (1B) and the most recent population (2B) have been examined. These two populations are the most distant temporally and are representative of greatly differing environments.

Stratum 1 represents a cool and humid climate in which a meandering stream dominated the environment. As the climate began to warm and dry, the stream gave way to a ponded environment. In substrata 2A and 2B, the climate continued to become warmer and drier, and by 2B times the ponds changed to an extensive freshwater marsh. The mean annual temperature rose from c. 13° C (55° F) to c. 19° C (66° F) during the period of known muskrat occupation while the mean annual rainfall fell from c. 75 cm to c. 40 cm (Johnson, 1987a). This drastic change in environment caused changes in the flora at Lubbock Lake (Thompson, 1987). As muskrats are mainly herbivo-

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rous, this change in flora should be accompanied by changes in microwear on the enamel of muskrat molars.

Suitable adult muskrat molars were chosen. These molars were analyzed with a scanning electron microscope (SEM) that allows for superior depth of field and resolution of detail compared with standard light microscopes. Although SEM specimens generally are coated with a conductive material (such as gold or palladium) that allows dissipation of the electrons (Teaford, 1991), coating was not possible for the Lubbock Lake molars. Museum policy does not allow coating original objects, as removal of the coating may damage fragile specimens. While lack of coating affects the quality of the image because of charging, the results obtained still were suitable for dental microwear analysis.

Both quantitative and qualitative methods are used in microwear analysis (Teaford, 1991; Strait, 1993). Due to the small sample size of this preliminary analysis, qualitative methods are used with the Lubbock Lake specimens. Qualitative methods focus on the differences in abundance, size, and shape of microwear features and are most reliable when marked differences occur in wear patterns (Teaford, 1991).

Microwear patterns associated with molars from substratum 1B show signs of heavy pitting. Few striations are visible at any magnification. Hard food items tend to leave pitting rather than scratches (Teaford 1991; Strait, 1993). Substratum 1B is representative of a stream habitat where woody plants generally would grow on the bank (King, 1997; Kozlowski et al., 1991) and likely serve as the primary food source of the muskrat (Errington, 1963).

Microwear patterns from upper substratum 2B exhibit fine scratches and a lack of noticeable pitting at all magnification levels. Soft material has been found to leave scratches rather than pits (Teaford, 1991). Substratum 2B represents a marsh habitat, where plants are emergent and submergent. These plants are softer, as hard structures are not required for water-dwelling flora (King, 1997; Larcher, 1980).

The working hypothesis of differential wear between populations is accepted conditionally based on the preliminary qualitative data gathered. These data will form the basis for an expanded study of muskrat molars from all the appropriate substrata at Lubbock Lake. A changing plant community during the late Pleistocene and early Holocene suggests that muskrats adapted their diets to remain in the area, a trend found in modern populations subjected to similar conditions (Errington, 1963). The change in flora was forced by an environment undergoing transition from stream to pond to marsh. This transformation in habitat apparently is reflected by a shift from pitting to scratching in the enamel of muskrat molars. Data collected from microwear research provide independent evidence that supports previous interpretations of the environment and paleoclimate from Lubbock Lake, and demonstrate that tooth wear analysis is not limited to dietary studies.

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specimens and documentation are held in trust for the People of the State of Texas at the Museum of Texas Tech University. This work is part of the ongoing Lubbock Lake Landmark regional research program in late-Quaternary climatic and environmental change on the Southern High Plains.

References Cited

Davis, W. B., and D. J. Schmidly 1994 *The Mammals of Texas.* Texas Parks and Wildlife Department, Austin.

Errington, P. L. 1963 *Muskrat Populations.* Iowa State University Press, Ames.

Holliday, V. T. 1982 Morphological and Chemical Trends in Holocene Soils, Lubbock Lake Site, Texas. Ph.D. dissertation, University of Colorado.

Holliday, V. T., and B. L. Allen 1987 Geology and Soils. In *Lubbock Lake: Late Quaternary Studies on the Southern High Plains,* edited by E. Johnson. pp. 14–21. Texas A&M Press, College Station, Texas.

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

——— 1987a Paleoenvironmental Overview. In *Lubbock Lake: Late Quaternary Studies on the Southern High Plains,* edited by E. Johnson. pp. 90–99. Texas A&M Press, College Station.

Johnson, E., and V. T. Holliday 1989 Lubbock Lake: Late Quaternary Cultural and Environmental Change on the Southern High Plains, USA. *Journal of Quaternary Science,* 4(2):145–165.

King, J. 1997 *Reaching for the Sun: How Plants Work.* Cambridge University Press, Cambridge.

Kozlowski, T. T., P. J. Kramer, and S. G. Pallardy 1991 *The Physiological Ecology of Woody Plants.* Academic Press, Inc., San Diego.

Larcher, W. 1980 *Physiological Plant Ecology.* Second edition. Springer-Verlag, Berlin.

Lewis, P., and E. Johnson 1997 Climate and Muskrats at Lubbock Lake. *Current Research in the Pleistocene,* 14:145–146.

Strait, S. G. 1993 Molar Microwear in Extant Small-Bodied Faunivorous Mammals: An Analysis of Feature Density and Pit Frequency. *American Journal of Physical Anthropology* 92:63–79.

Teaford, M. F. 1991 Dental Microwear: What Can It Tell Us About Diet and Dental Function? In *Advances in Dental Anthropology* edited by M. A. Kelly and C. S. Larsen. pp. 341–356. Wiley-Liss, New York.

Stratigraphy, AMS Radiocarbon Age, and Stable Isotope Biogeochemistry of the Lindsay Mammoth, Eastern Montana

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The Lindsay mammoth was discovered in 1966 and excavated in 1967 (Davis 1971, 1986, 1993; Davis and Wilson 1985). The specimen had been previously referred to *Mammuthus* cf. *M. imperator* (see Davis and Wilson 1985), but

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measurements by Hill indicate a possible closer affinity to *M. columbi*. The nearly complete skeleton was found northeast of Lindsay, Dawson County (Deer Creek Church USGS 7.5-minute quadrangle), about 12.4 km northwest of Glendive, in eastern Montana. Previously reported radiocarbon dates range from about 11,925 to 9,490 yr B.P. (uncalibrated, Davis 1982). Fossil remains, sediments, and associated field records are curated at the Museum of the Rockies, Montana State University-Bozeman (specimen accession number 91.72, previously Geo-67-17). In 1997, geomorphic mapping and stratigraphic studies were conducted at the site by Hill and a new topographic map was produced by Davis and Troy Helmick. Here, we summarize the stratigraphic context based on these field investigations and present the results of AMS radiocarbon and stable isotope analyses of the mammoth remains.

The present-day geomorphic setting is an upland divide between the drainage of the South Fork of Deer Creek to the north and the Spring Creek drainage to the south. Both systems flow generally to the southeast, forming a NW-SE trending upland with sedimentary bedrock composed of the Tongue Member of the Fort Union Formation (Paleocene). In the upland area, this bedrock is sometimes overlain by Quaternary "silts" (very fine sands, silt, clay) containing paleosols. The mammoth remains were found imbedded in these upland silts on a surface sloping toward the east. Mammoth remains were exposed at or close to the present-day surface on the north side of the bone scatter, partly as a result of removal of some of the late-Holocene surface by road grading.

The mammoth remains were recovered over a distance of about 17 m along a NW-SE trend. The deepest stratigraphic exposures were along the south side of the excavations. Toward the southwest, bedrock is very close to the surface. Generally, the Quaternary deposits overlying the Fort Union become increasingly thick toward the north and the east. The mammoth bones were recovered within silts directly overlying the Paleocene sediments. In places the sedimentary matrix enclosing the top of the mammoth bones is more calcareous. The bones and the zone higher in carbonate were overlain by a buried soil A-horizon. The 1997 stratigraphic trench along the south side of the site revealed that this buried A-horizon, interpreted as an indicator of the latest Pleistocene landscape surface, is overlain by more silts toward the east and rises to merge with the present-day surface to the west.

There is some resemblance between the stratigraphy of the Lindsay mammoth discovery and the Oahe Formation (the Aggie Brown member, associated with the "Leonard Paleosol") as well as upland stratigraphies associated with the Brady buried soil (Artz 1995; Clayton et al. 1976; Kuehen 1993, 1996). The Lindsay mammoth fossils appear to have accumulated after the initial deposition of late-Wisconsinan upland silt (presumably as loess) and prior to an interval of landscape stability associated with the development of the now-buried A-horizon connected with perhaps wetter and cooler paleoclimatic conditions. The carbonates may be a local representation of a younger, perhaps dryer or warmer regional climatic interval (Albanese 1996; Haynes and Grey 1965; Leopold and Miller 1954; Reider 1983, 1990, 1996).

Fragments of one tibia were pretreated with HCl and NaOH and the remaining material ("bone collagen") was submitted for AMS analysis. The

conventional radiocarbon age obtained was 11,500 ± 80 yr B.P. (Beta-102031). It is possible that the age of the mammoth is actually slightly older (cf. Stafford 1988; Stafford 1990; Overstreet and Stafford 1997), but probably still late Pleistocene and post–last glacial maximum. The $^{13}C/^{12}C$ ratio is -21.7 per mil. This is a value within the range typically associated with a C^3 plant photosynthetic pathway-group (Bochrens et al. 1994, 1996, 1997; Koch 1991) possibly indicating paleoclimatic conditions with a growing season too short or too cool for C^4 graminoids (Bombin and Muehlenbachs 1985).

The stratigraphy, chronometric measurements, and isotope biogeochemistry associated with the Lindsay mammoth seem to provide indications regarding changing post-last glacial maximum environmental conditions on the North American Plains. Eolian silts appear to have been deposited starting before c. 12,000 yr B.P. The mammoth remains were enclosed in a silt apparently first altered by pedogenic processes resulting in the formation of a buried A-horizon, perhaps during an interval of cooler or possibly wetter climatic conditions. Carbonates superimposed on the silts within the lower part of the A-horizon, which sometimes enclose the mammoth bones, may indicate secondary enrichment resulting from dryer or warmer conditions after the Pleistocene.

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References Cited

Albanese, J. 1996 Geology of the Mill Iron Site. In *The Mill Iron Site,* edited by G. C. Frison, pp. 1–13. University of New Mexico Press, Albuquerque, New Mexico.

Artz, J. A. 1995 Geological Contexts of the Early and Middle Holocene Archaeological Record in North Dakota and Adjoining Areas of the Northern Plains. In *Archaeological Geology of the Archaic Period in North America,* edited by E. A. Bettis III, pp. 67–86. Geological Society of America Special Paper 297, Geological Society of America, Boulder.

Bombin, M., and K. Muehlenbachs 1985 $^{13}C/^{12}C$ Ratios of Pleistocene Mummified Remains in Beringia. *Quaternary Research* 23:123–129.

Bochrens, H., D. Billiou, M. Patou-Mathis, D. Bonjean, M. Otte, and A. Mariotti 1997 Paleobiological Implications of the Isotopic Signatures (^{13}C, ^{15}N) of Fossil Mammal Collagen in Scladina Cave (Sclayn, Belgium). *Quaternary Research* 48:370–380.

Bochrens, H., M. Fizet, A. Mariotti, R. A. Gangloff, and J. A. Burns 1994 Contribution of Biogeochemistry (^{13}C, ^{15}N, ^{18}O) to the Paleoecology of Mammoths *(Mammuthus primigenius). Historical Biology* 7:187–202.

Bochrens, G. P., P. Lazarev, and A. Mariott 1996 Stable Isotope Abundances (^{13}C, ^{15}N) in Collagen and Soft Tissues from Pleistocene Mammals from Yakutia. Implications for the Paleobiology of the Mammoth Steppe. *Paleogeography, Palaeoclimatology, Palaeoecology* 126:31–44.

Clayton, L., S. R. Moran, and W. B. Bickley, Jr. 1976 *Stratigraphy, Chronology, and Climatic Interpretations of Late Quaternary Upland Silt in North Dakota.* North Dakota Geological Survey Miscellaneous Series 54.

Davis, L. B. 1971 The Lindsay Mammoth Site (24DW501): Paleontology, Paleoecology and Prehistory. *Abstracts of the 36th Annual Meeting Society for American Archaeology.* University of Oklahoma, Norman, Oklahoma.

——— 1982 *Montana Archaeology and Radiocarbon Chronology: 1962–1981.* Archaeology in Montana, Special Issue No. 3.

——— 1986 In Search of Early Elephants. *Montana Outdoors* November/December: 27–31.

——— 1993 Paleoindian Archaeology in the High Plains and Rocky Mountains of Montana. In *From Kostenki to Clovis: Upper Paleolithic-Paleoindian Adaptations,* edited by O. Soffer and N. D. Praslov, pp. 273–277. Plenum Publishing Corporation, New York, New York

Davis, L. B., and M. C. Wilson 1985 The Late Pleistocene Lindsay Mammoth (24DW501), Eastern Montana: Possible Man-Mammoth Association. *Current Research in the Pleistocene* 2:97–98.

Haynes, C. V., Jr., and D. C. Grey 1965 The Sister's Hill Site and Its Bearing on Wyoming Postglacial Alluvial Chronology. *Plains Anthropology* 10:196–217.

Kuehen, D. D. 1993 Landforms and Archaeological Site Location in the Little Missouri Badlands: A New Look at Some Well-established Patterns. *Geoarchaeology* 8:313–323.

——— 1996 The Aggie Brown Member of the Oahe Formation: A Late Pleistocene/Early Holocene Marker Horizon in Western North Dakota. *Current Research in the Pleistocene* 13:121–123.

Koch, P. L. 1991 The Isotopic Ecology of Pleistocene Proboscideans. *Journal of Vertebrate Paleontology Abstracts* 11(3):40A.

Leopold, L. B., and J. P. Miller 1954 *A Postglacial Chronology of Some Alluvial Valleys in Wyoming.* USGS Water Supply Paper No. 1261.

Overstreet, D. F., and T. Stafford, Jr. 1997 Additions to a Revised Chronology for Cultural and Non-Cultural Mammoth and Mastodon Fossils in the Southwestern Lake Michigan Basin, *Current Research in the Pleistocene* 14:70–71.

Reider, R. G. 1983 Soils and Late Pleistocene-Holocene Environments of the Sister's Hill Archaeological Site Near Buffalo, Wyoming. *Contributions to Geology, University of Wyoming* 22(2):117–127.

——— 1990 Late Pleistocene and Holocene Pedogenic and Environmental Trends at Archaeological Sites in Plains and Mountain Areas of Colorado and Wyoming. *Archaeological Geology of North America,* edited by N. P. Lasca and J. Donahue, pp. 335–360. Geological Society of America, Boulder.

——— 1996 Soils and Geomorphic Surfaces of the Mill Iron Site. *The Mill Iron Site,* edited by G. C. Frison, pp. 195–204. University of New Mexico Press, Albuquerque.

Stafford, T. W., Jr. 1988 Accelerator ^{14}C Dating of Late Pleistocene Megafauna. *Current Research in the Pleistocene* 5:41–43.

——— 1990 Late Pleistocene Megafauna Extinctions and the Clovis Culture: Absolute Ages Based on Accelerator ^{14}C Dating of Skeletal Materials. *Megafauna and Man,* L. D. Agenbroad, J. I. Mead, L. W. Nelson, eds., pp. 118–122. The Mammoth Site of Hot Spring, South Dakota, Inc., Scientific Papers, Volume 1., Hot Springs.

Late-Pleistocene Fauna and Flora from the Loess of Central Nebraska

Larry D. Martin and Richard Rogers

In 1964 a partial mammoth skull was reported by M. Tinquist to the University of Nebraska State Museum as eroding out of a road cut on State Highway 22 just one-half mile west of the small town of Wolbach, Greely County, Nebraska. A field party consisting of L. D. Martin, J. Emmons, and A. Johnson was sent to

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investigate this find, and they were joined later by L. G. Tanner. The site proved to be of unusual interest, as the mammoth remains lay some 3 m beneath the Sangamon soil in a sandy facies (local channel) of the Gothenburg member of the Loveland Loess formation (see Schultz et al., 1994 for a discussion of the members of the Loveland Loess). This channel lies in superposition above another soil (Buzzard's Roost Paleosol), and dates the mammoth remains quite firmly as late Illinoian. Additional fauna was collected from the sand lens, including *Spermophilus kimballensis* (extinct ground squirrel related to *S. elegans*), *Cynomys* sp. (extinct prairie dog), *Equus* sp. (extinct horse), and a partial humerus of an unidentified passeriform bird.

The Gilman Canyon formation (Wisconsinan) is developed just above the Sangamon soil at this locality, and at its contact with the Peoria Loess it contains a number of irregularly shaped calcareous nodules, some of which formed around fossil bones. Fauna recovered from these nodules include *Geomys* sp. (pocket gopher), *Lepus americanus* (snowshoe hare), and *Microtus montanus* (montane vole). There is also a large gastropod (snail) fauna that has not been studied. The main body of the Peoria Loess at this site does not appear to contain vertebrate fossils.

Matrix collected with vertebrate fossils from the same level as the mammoth partial skull (Gothenburg member of the Loveland Loess) was analyzed for contained pollen, and 125 grains were identified giving the following percentages: *Pinus* (pine), 25.6; *Celtis* (hackberry), 2.4; *Quercus* (oak), 0.8; *Maclura pomifera* (osage orange), 0.8; *Juglans* sp. (walnut), 0.8; *Ulmus* (elm), 0.8; *Gramineae* (grass), 18.4; *Compositae* (primarily ragweed), 28.8; *Chenopodiaceae-Amaranthaceae,* 18.4; *Tradescantia* sp. (spiderwort), 1.6; *Trillium* sp. (trillium), 0.8; *Smilax* sp. (carrion flower), 0.8.

The pollen percentages from the Wolbach locality resemble the modern pollen rain described by Kapp (1965) for the central prairie in the percentages of *Compositae, Gramineae,* and *Chenopodiaceae-Amaranthaceae* pollen. This suggests the presence of open country. The prairie dog, *Cynomys,* is not compatible with either tall grass or forest.

The arboreal pollen is clearly dominated by *Pinus.* The percentage of pine pollen is much greater than any of the cattle-watering tank localities reported by Kapp (1965) for the central prairie region. The pine pollen percentage suggests at least two possible interpretations: 1) the area was a prairie with pine forests of the Rocky Mountains extending far enough into the plains to increase the pine pollen rain on the site; or 2) the area of the site was a pine parkland (open country interspersed with pine trees).

Although the data are not sufficient to decide the question conclusively, we favor the pine parkland hypothesis. The deposition of loess in western Nebraska suggests a northwest wind not greatly different from the prevailing winds in the area today. North of Wolbach, the modern pine pollen rain drops from 70% in the Black Hills to 5% in a distance of only 150 km (McAndrews and Wright, 1969). The percentage of pine pollen in the Wolbach site would suggest a pine forest within a very short distance if the environment was a prairie and the pine pollen was being brought in by the wind. If a pine forest had extended that far into the plains, the authors find themselves at a loss to

explain why it would not have spread to the Wolbach locality. The pine parkland hypothesis would explain the percentage of pine pollen without this difficulty. The small percentages of deciduous taxa may suggest some riparian forest in the area.

The pollen spectrum at the Wolbach site is not analogous to the modern pollen rain in the central prairie region. This suggests a different climate than at present. The higher than present representation of arboreal pollen may indicate moister conditions, due to either or both increased rainfall or other climatic conditions that favor increased availability of moisture for trees (such as less extreme heat in the summer than at present).

It is possible that the locality was a watering area for mammoths. Some pollen grains of opportunistic weeds at the site may represent local vegetation in a frequently trampled area.

References Cited

Fredlund, G. G., and P. J. Jaumann 1987 Late Quaternary Palynological and Paleobotanical Records from the Central Great Plains. In. *Quaternary Environments of Kansas*, edited by W. Johnson, pp. 167–178. Kansas Geological Survey Guidebook Series, 5. Kansas Geological Survey, Lawrence.

Kapp, R. O. 1965 Illinoian and Sangamon Vegetation in Southwestern Kansas and Adjacent Oklahoma. *Contributions of the Museum of Paleontology, University of Michigan* 9:167–255.

McAndrews, J. H., and H. E. Wright 1969 Modern Pollen Rain Across the Wyoming Basins and the Northern Great Plains (U.S.A.). *Review of Palaeobotany Palynology* 9:17–43.

Schultz, C. B., L. D. Martin, and W. Dort 1994 Stratigraphic Nomenclature and Depositional Environment of the Loess in Nebraska. *TER-QUA Symposium Series*, 2:147–154.

A Preliminary Report on the Dry Gulch Mammoth Site, Lincoln County, New Mexico

Raymond Mauldin, Jeff D. Leach, H. Curtis Monger, Arthur H. Harris, and David Johnson

In 1989, two local New Mexico residents noted a section of elephant tusk exposed at the base of a 3.5-m-deep arroyo. Recognizing the potential significance of the find, they reported the discovery to personnel from the Lincoln National Forest. The tusk is located on United States Forest Service (USFS) land, termed the Dry Gulch site, at an elevation of 2,072 m (6,800 ft) AMSL. In

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1990, a team of USFS archaeologists conducted work at the location. The USFS team placed a 2-by-4-m excavation block over the find and ultimately excavated a 2-by-2-m block down to the level containing remains of what appeared to be a mammoth (*Mammuthus* sp.). A substantial portion of the elephant appeared to be present. However, because of funding and personnel limitations, the USFS curtailed their excavation.

In September of 1997, a research team from the Center for Indigenous Research (CIR) conducted additional investigations at the site. CIR researchers reopened a single 1-by-1-m unit, initially excavated in 1990, and placed six more 1-by-1-m units away from the known location of the elephant in order to determine the horizontal extent of the animal and gather data on site stratigraphy. Of the six new units, only one contained bone.

Based on this new excavation and the original USFS work, it appears that the elephant lies in sediments that are late Pleistocene in age (Monger 1998). While several high-energy stream deposits are present above the elephant, sediments that contain the animal reflect a low-energy environment. They are clayey, with an angular blocky structure, a range of color typical of gleyed sediments, and frequently contain small gypsum crystals. Iron and manganese staining and the overall characteristics of the sediments suggest that they may have been saturated with water during much of their history. The site appears to have been the location of a seep or spring that, at various times, may have formed a small pond.

While both excavations were limited, the remains are probably those of a single Columbian mammoth (*Mammuthus columbi*), rather than a mastodon (*Mammut*) or an Imperial mammoth (*M. imperator*). This determination is based on both the suspected late-Pleistocene age of the animal and the southern location of the site (Harris 1993; Lucas and Effinger 1991; Lucas and Morgan 1997) rather than on observed skeletal morphology. A substantial portion of the elephant has not yet been located and may remain buried. Between the two projects, more than 2 m of one tusk has been exposed, along with many rib fragments and a substantial portion of the cranium. However, the work has yet to uncover any diagnostic morphological characteristics that would allow an unambiguous identification.

Neither of the excavations recovered any artifacts associated with the mammoth. However, CIR researchers did locate three small boulders, ranging in maximum length up to 30 cm, at the same level and in association with the elephant. These boulders were the only large-sized clasts (>3 cm) found in the low-energy pond setting. Similar finds have been reported associated with the remains of elephants by Hansen (1993) and Fisher (1987). Hansen (1993:66) speculates that such boulders "may have been used as hand-thrown missiles to help dispatch" an elephant mired in sediment. While it is unclear in the Dry Gulch case if the presence of these boulders reflects some sort of human involvement with the death of the animal, these large items are anomalous in the clayey sediments.

In 1990, a single rib fragment was submitted for radiocarbon dating by the USFS. However, the specimen was depleted of bone collagen, and no date was obtained. From our recent work, we obtained a single radiocarbon date of

8,850 ± 50 yr B.P. (Beta-110110) from soil humus located about 75 cm above the deposit that contains the animal. The 2-sigma calibrated age range provided by Beta Analytic is from 9,445 to 9,535 yr B.P. This supports a late-Pleistocene age for the elephant.

While we currently have no direct evidence of cultural activity, the depositional context, the Holocene-age radiocarbon date above the elephant, and the presence of the anomalous boulders in the deposit all hint at possible human association with the elephant. A substantial Clovis occupation is documented at Mockingbird Gap, located roughly 70 km to the west of the site (see Weber 1963), and isolated Clovis points have been reported from the region. CIR researchers plan to return to the Dry Gulch site to conduct additional investigations.

References Cited

Fisher, D. C. 1987 Mastodon Procurement by Paleoindians of the Great Lakes Region: Hunting or Scavenging. In *The Evolution of Human Hunting*, edited by M. H. Nitecki and D. V. Nitecki, pp. 389–421. Plenum Press.

Hansen, M. C. 1993 The Hallsville Mastodon: Evidence for Possible Human Association. *Current Research in the Pleistocene* 10:65–66.

Harris, A. H. 1993 Quaternary Vertebrates of New Mexico. In *Vertebrate Paleontology in New Mexico*, edited by in S. G. Lucas and J. Zidek, pp. 179–197. New Mexico Museum of Natural History and Science, Bulletin 2.

Lucas, S. G., and J. A. Effinger 1991 Mammuthus *from Lincoln County and a Review of the Mammoths from the Pleistocene of New Mexico*, pp. 277–282. New Mexico Geological Society, Guidebook 42.

Lucas, S. G., and G. S. Morgan 1997 The American Mastodon (*Mammut americanum*) in New Mexico. *The Southwestern Naturalist* 42(3):312–317.

Monger, H. C. 1998 Observations on the Stratigraphic Context of Dry Gulch Paleontological Site. Manuscript on file, Center for Indigenous Research, El Paso, Texas.

Weber, R. H. 1963 Human Prehistory of Socorro County. In *Guidebook of the Socorro Region, New Mexico*, edited by F. Kuellmer, pp. 225–233. New Mexico Geological Society, Socorro.

Late-Pleistocene Mastodon and Digesta from Little River, North Florida

Matthew C. Mihlbachler

The tusks and limb elements of a semi-articulated sub-adult mastodon (*Mammut americanum*) were discovered at the Latvis/Simpson site in the Little River section of the Aucilla River in the Big Bend region of Florida. The remains were covered with a sandy peat consisting mainly of material interpreted as

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herbivore dung filling the bottom of a sinkhole now submerged by the modern river channel.

The Aucilla River Prehistory Project collected an assemblage of exposed Pleistocene faunal material from the surface of the dung deposits. The assemblage contained at least 20 mammal species with large numbers of raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*) and beaver (*Castor canadensis*) and assorted elements of extinct herbivores including Jefferson's ground sloth (*Megalonyx jeffersoni*), mastodon (*Mammut americanum*), tapir (*Tapirus veroensis*), horse (*Equus* sp.) and deer (*Odocoileus virginianus*).

A number of large ivory fragments from the surface assemblage fit onto a pair of in situ tusk tips (UF180221, UF180222) that jutted vertically into the dung matrix. The paired tusks were similarly oriented and about 75 cm apart, suggesting they belong to a single individual. The immediate proximity of the ivory fragments to the in situ tusks suggests that the bone assemblage has deflated directly from overlying sediment and has not experienced horizontal transport. Other vertically oriented bones of a mastodon were recovered from the dung stratum, including a rib, a right tibia and a metatarsal (UF180220). These elements all have unfused epiphyses and evidently belong to the same sub-adult individual.

The herbivore digesta consists of cut and torn woody twigs 2–3 mm in diameter and 6–12 mm in length, with occasional seeds. Based on comparison with dung from African elephant and horse, the size of these digesta particles suggests that they are of proboscidean origin. The browsing content suggests that they were produced by the mastodon (*Mammut americanum*). The absence of grass particles probably rules out the mammoth (*Mammuthus columbi*) and other grazers as contributors to the Latvis/Simpson dung deposit; however, the feces of other browsers such as tapir (*Tapirus veroensis*) and ground sloth (*Megalonyx jeffersoni*) may be present.

The most common woody plant taxon is cypress (*Taxodium* sp.), but woody material from other species is certainly present. Many of the seeds recovered from the deposit represent the local riparian habitat; however, there is a conspicuous presence of plant materials that do not normally appear in peat samples from this region, including grape (*Vitus* sp.) tendrils, fruits of elderberry (*Sambucus* sp.) and the seeds of cocklebur (*Xanthium* sp.), creeping cucumber (*Melothria pendulata*) and gourd (*Cucurbita pepo*). These plants were possibly transported to the sinkhole in the digestive systems of mastodons. The absence of gourd rind, which is more durable than the seeds, suggests that mastodons may have preferred to eat the tender insides but not the bitter rind.

The Latvis/Simpson deposit is nearly identical to the mastodon dung material from the Page/Ladson site, located 2 km upstream (Webb et al. 1992). While the age of the Page/Ladson material is constrained by numerous dates to about 12,500 yr B.P., the Latvis/Simpson digesta dates yield much older ages. A standard radiocarbon date on the dung material at the surface of the deposit yielded a date of 32,740 ± 800 yr B.P. (Beta-64724), and an AMS ^{14}C date on a gourd seed located near one of the proboscidean tusks yielded a date of 31,610 ± 240 yr B.P. (Beta-85549). The presence of two nearly identical deposits of late summer mastodon dung provides a unique opportunity to

compare the diets of mastodons from the mid-Wisconsinan with those of the late Wisconsinan just preceding the Pleistocene extinctions.

While more field excavations are planned, I offer these preliminary conclusions: 1) mastodons and other Pleistocene herbivores utilized this area as a wallow or a drinking hole; 2) they transported plant materials from non-riparian environments and deposited them as fecal material into the local aquatic setting; 3) the presence of grape, cocklebur and gourd seeds indicates summer browse; 4) the semi-articulated arrangement of the sub-adult mastodon suggests that this animal died in or very near the wallow; 5) scratch marks on in situ bone in an otherwise soft matrix and the vertical position of some of the bones suggest that the carcass may have been trampled into the dung deposits by other proboscideans utilizing the sinkhole.

This research is sponsored by the Florida Department of State's Bureau of Historic Preservation. I acknowledge Lee Newsom for identification and interpretation of plant remains.

References Cited

Webb, S. D, J. Dunbar, and L. Newsom 1992 Mastodon Digesta from North Florida. *Current Research in the Pleistocene* 9:114–116.

Tocuila, a Remarkable Mammoth Site in the Basin of Mexico

Luis Morett A., Joaquín Arroyo-Cabrales and Oscar J. Polaco

The Tocuila paleontological site is in the downtown area of the village of San Miguel Tocuila, Municipality of Texcoco, State of Mexico. In July 1996, while a cafeteria was being built, remains of mammoth bones were found. The owners discovered one of the most important late-Pleistocene and early-Holocene paleontological sites in the Basin of Mexico (Morett et al., 1998). The site is situated at the coordinates 19° 31′ 11″ N latitude and 98° 54′ 31″ W longitude, slightly below an altitude of 2,240 m.

The excavated area extends over 28 m^2 in a 5-by-6-m pit that has yielded approximately 800 bones, mostly of plains mammoth (*Mammuthus columbi*). This productivity suggests that the site still has enormous fossiliferous potential. Excavated remains included three skulls that are almost complete, two

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other incomplete skulls, and four mandibles; these represent at least five individuals ranging in age from young to adult stages. Besides the mammoth bones, there were remains of horse (*Equus* sp.), bison (*Bison* sp.), camel (*Camelops hesternus*), rabbits (*Sylvilagus cunicularius*), and on the top layers fish, turtles (*Kinosternon* sp.), and aquatic birds like the flamingo (*Phoenicopterus* cf. *P. ruber*) (Corona M. and Arroyo-Cabrales, 1997). In addition, some bone fragments show evidence of modification by flaking, suggesting association of humans with this faunal assemblage.

The fossiliferous deposit has an average depth of 2 m and has been dated at c. 11,188 ± 76 yr B.P. based on five radiocarbon dates. The deposit is located in a thick unit representing a mud flow or lahar (Figure 1). Above this is a sandy soil layer and two layers of tepetate or attle, different from each other and possibly derived from other lahars of lesser magnitude and more recent deposition. Sealing all these is a plowed soil containing Aztec and modern ceramic fragments. Below the mammoth bone bed is a layer of volcanic ash, the study of which could explain how the fossil deposit was formed; still further below is a thick clayey layer corresponding to the pre-disturbance horizon where most of the species identified at Tocuila had their natural habitat.

The research developed as an interdisciplinary and inter-institutional project (sedimentology, palynology, geophysics, volcanology, geomorphology, radiometric dating, paleontology, and molecular biology), allowing us to generate an explanatory hypothesis regarding two possible regional events of catastrophic nature that formed the deposit. The first was a very sudden and voluminous deposit of volcanic ash, which could have severely restricted the

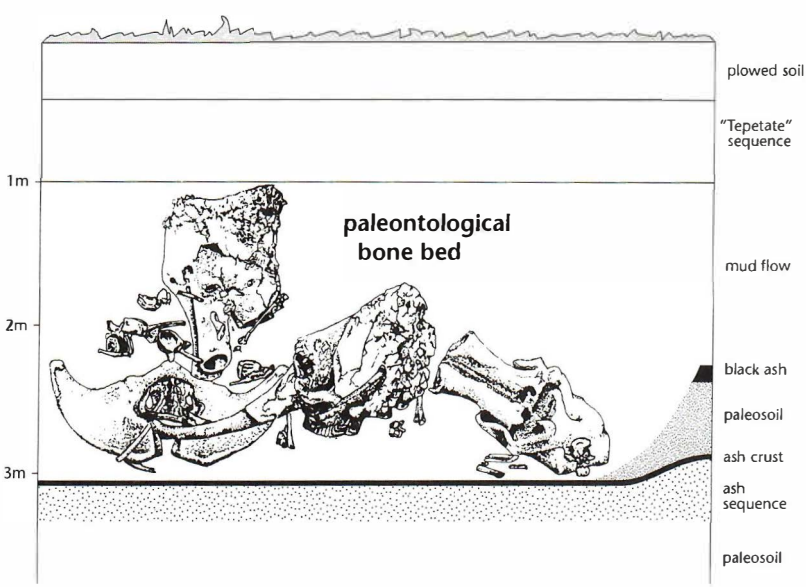

Figure 1. General stratigraphic profile of the excavated pit at the paleontological site of Tocuila in the Basin of Mexico. Re-drawing by Guillermo Herrera, after Leticia Arango and Gabino Salinas.

growth of local vegetation, causing extirpation of populations of herbivorous animals such as mammoths, camels, bison, and horses.

The second large event occurred shortly after the first and was characterized by a sequence of mud flows or lahars that came down from the nearby mountains into the floodplains, transporting and mixing skeletons that had been spread over the land, perhaps trapping and killing some other animals, and eventually burying the entire assemblage with a 1.5-m-thick deposit of mud. The catastrophic character of both events produced an exceptional image-rich flora and fauna in the Basin of Mexico at the end of the Pleistocene.

The excavated area has been enclosed into a small museum, which holds in situ the recovered bone remains. Although the formal displays are not yet finished, the site can be visited. Future studies will search for the spatial limits of the fossiliferous deposits, and that will help to build a framework for undertaking more extensive excavations to answer specific questions we have developed regarding the processes that formed the deposit, the existence of cultural evidence associated with the bones, and osteological issues that relate to the causes of Pleistocene extinctions of species like the mammoths.

The Museo Nacional de Agricultura, Universidad Autónoma Chapingo, and the Paleozoology Laboratory at the Instituto Nacional de Antropología e Historia have sponsored most of the work done at the site, as well as some of the analyses. Personnel of the Instituto de Geofisica from the Universidad Nacional Autónoma de Mexico, Oxford Radiocarbon Lab, and University of Arizona Radiocarbon Facility have done other analyses.

References Cited

Corona-M., E., and J. Arroyo-Cabrales 1997 New Record for the Flamingo (*Phoenicopterus* cf. *P. ruber* Linnaeus) from Pleistocene-Holocene Transition Sediments in Mexico. *Current Research in the Pleistocene* 14:137–139.

Morett, L., J. Arroyo-Cabrales, and O. J. Polaco 1998 El Sitio Paleontológico de Tocuila. *Arqueología Mexicana* 5(30):57.

A Late-Pleistocene/Early-Holocene Faunal Assemblage from the Page/Ladson Site (8JE591), Jefferson County, Florida

Tanya M. Peres

Page/Ladson (8JE591), an inundated site in the Aucilla River in Jefferson County, Florida, has yielded Paleoindian artifacts in stratified sediments ranging in age from before 12,000 to about 8,000 yr B.P. In the October 1995 field season, crew members excavated strata that dated from 10,280 to 9,930 yr B.P., and collected material from an area of 11 m^2. A rich array of worked wood,

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lithic, and bone artifacts, as well as faunal material was recovered. The faunal assemblage is the focus of this report.

In identifying and interpreting the latest Pleistocene fauna from the Page/Ladson site, I developed a scoring system to aid in recording the incidence of features suggestive of human association (Table 1). The main research question I asked when assaying this assemblage was whether it was deposited as a result of human intervention or by natural occurrences (these may vary) in the environment. This question is appropriate to this material, since oftentimes faunal assemblages are assumed to be cultural in origin if they are archaeologically recovered. Criteria to determine if this assemblage had been manipulated by humans include the following: presence of butchering marks, evidence of working or use-wear, presence of possible "exotic" taxa, thermal alteration, and its relationship to features and artifacts (Peres 1997). Using these criteria, archaeologists can determine if faunal assemblages are culturally associated with the archaeological deposit.

Table 1. Scoring system for faunal assemblages.

criteria	points assigned yes	no
presence of butchering marks	2	0
presence of worked bone	2	0
association with features/artifacts	2	0
evidence of thermal alteration	1	0
presence of "exotic" taxa	1	0
environmental deposit	0–2	
indeterminate deposit	3–5	
cultural deposit	6–8	

After all 1,516 elements of the sample were identified, I scored the assemblage using this system to summarize its overall depositional nature. The assemblage from Page/Ladson had an overall score indicative of a non-cultural assemblage characterized by aquatic and terrestrial fauna, such as mud/musk turtles (*Kinosternidae*), sunfish, and basses (*Centrarchidae*). Three bone "pins" in the sample were most likely out of cultural context due to the dynamic nature of river environments. Little can be said about subsistence practices, but we do know that the identified taxa were present in the environment and thus available for selection by humans.

This sample is the first to be analyzed and quantified from this site and time period (c. 10,000 yr B.P.) in particular, and along the Aucilla River in general. The species list derived from this collection will aid in future analysis of additional samples from the project's excavations. The excellent preservation of faunal remains allowed for identification of individuals to the species level, which is important in determining the type of environment that would have existed to support such faunas.

As a result of this study, some questions have been answered, but many remain for future research. Since this is an isolated study for this time frame, more faunal collections, pollen analysis, and hydrological studies are needed

to refine our knowledge of this area during the Paleoindian/Archaic transition. The Page/Ladson site has afforded a unique opportunity to recover, document, and study the presence of the earliest occupation of Florida by humans, as well as the environment that shaped and supported their subsistence practices.

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Reference Cited

Peres, T. M. 1997 Analysis of a Late Pleistocene-Early Holocene Assemblage from the Page/Ladson Site (8JE591), Jefferson County, Florida. Unpublished Master's Thesis, Department of Anthropology, Florida State University, Tallahassee.

The American Mastodon in Mexico

Oscar J. Polaco, Joaquín Arroyo-Cabrales, and Baudelina García-Uranga

The American mastodon (*Mammut americanum*) (Kerr, 1792) is a mammutid with a wide distribution in North America, from Alaska to central Mexico (Tobien, 1996; Shoshani, 1990); however, very little is known about its occurrences in the southern part of its range, especially in Mexico, because its remains are scarce (Miller, 1987). The finding of a mandible pertaining to this species in the Mexican state of Zacatecas required a review of earlier records to clarify its distribution in Mexico.

The Zacatecan specimen is a left mandible fragment with a complete third molar, slightly worn on the pretrite and posttrite cusps of the first crest. This tooth lacks a cingulum, has small cusps in the external side of the valleys, and pertains a smooth morphotype. The tooth is composed of four lophids and a poorly developed fifth lophid. Its measurements are: maximum length, 176 mm; maximum width (2nd lophid), 83.4 mm. These measurements are similar to those provided by Miller (1987) and Laub (1992) for lower third molars.

The fragment was found in lacustrine sediments from Laguna de El Salitre (presently dry), approximately 6 km northwest of Villa Hidalgo, at an altitude of 2,100 m. Other bone fragments from the site pertained to *Mammuthus*, *Equus*, and *Camelops*, so this assemblage suggests a late-Pleistocene fauna.

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Former records include an upper third molar reported by Hibbard (1955), but without locality data. Pichardo del Barrio (1961) mentioned a lower molar from San Pedro Candelaria, Cd. Serdán, Puebla; however, the figure in the publication shows a 5-lophid molar and a talonid that probably represents another taxon. From Valsequillo, Puebla (written as "Pueblo" by some authors), Irwin-Williams (1967) reported several taxa by common names, including mastodon, but such identifications are ambiguous, as other authors used the term "mastodon" to designate both gomphotheres and the species *M. americanum*. Alvarez (1983) documented tooth fragments from Loltun Cave in Yucatán, but those pertain to a gomphothere.

After a thorough review of literature and verification of the specimens where possible, we can confirm remains of *M. americanum* from only six localities, other than the Zacatecan mandible. From Zacualtipan, Hidalgo, there is an isolated molar recorded by Freudenberg (1922), and assigned to this species by Hay (1925). The second specimen is also an isolated tooth from Tequixquiac, Mexico (Pichardo del Barrio, 1961). Mooser and Dalquest (1975) recorded a well-preserved mandible from 3.5 km south of Aguascalientes. Miller (1987) mentions records from Río de Virgenes (Nuevo León), and arroyo Amajac (location not certain). Most recently, Castillo C. et al. (1996) illustrate a mandible and an upper molar from Minas Anaya, 15 km northwest of Actopan, Hidalgo.

All these localities are situated in the Mexican Plateau at altitudes above 1,500 m. Most of them, except for those reported by Miller (1987), are concentrated in central Mexico, with the record from Tequixquiac as the southernmost for *M. americanum*. Given this small number of occurrences, the American mastodon seems to be even more rare in Mexico than a cursory reading of the literature might suggest.

References Cited

Alvarez, T. 1982 Restos de mamíferos recientes y pleistocénicos procedentes de las grutas de Loltún, Yucatán, México. Instituto Nacional de Antropología e Historia, Departamento de Prehistoria, *Cuadernos de Trabajo* 26:7–35.

Castillo C., J. M., M. A. Cabral P., and O. Carranza C. 1996 *Fossil Vertebrates from the State of Hidalgo*. Universidad Autónoma del Estado de Hidalgo, Pachuca, 127 pp.

Freudenberg, W. 1922 Die säugetierfauna des Pliocäns und Postpliocäns von Mexiko. II. Teil: Mastodonten und Elefanten. *Geologische und Palaentologische Abhandlungen* 14:103–176.

Hibbard, C. W. 1955 Pleistocene Vertebrates from the Upper Becerra (Becerra Superior) Formation, Valley of Tequixquiac, Mexico, with Notes on Other Pleistocene Forms. *Contributions from the Museum of Paleontology, University of Michigan* 12:47–96.

Irwin-Williams, C. 1967 Associations of Early Man with Horse, Camel, and Mastodon at Hueyatlaco, Valsequillo (Puebla, Mexico). In *Pleistocene Extinctions: The Search for a Cause*, edited by P. S. Martin and H. E. Wright, Jr., pp. 337–347. Yale University Press, New Haven and London.

Laub, R. S. 1992 Positional and Ordinal Identification of the Teeth of *Mammut Americanum*. *Current Research in the Pleistocene* 9:105–108.

Miller, W. E. 1987 *Mammut Americanum*, Utah's First Record of the American Mastodon. *Journal of Paleontology* 61:168–183.

Mooser, O., and W. W. Dalquest 1975 Pleistocene Mammals from Aguascalientes, Central Mexico. *Journal of Mammalogy* 56:781–820.

Pichardo del Barrio, M. 1960(1961) Proboscídeos Fósiles De México, Una Revisión. Instituto Nacional de Antropología e Historia, *Investigaciones* 4:1–63.

Shoshani, J. 1990 Distribution of *Mammut Americanum* in the New World. *Current Research in the Pleistocene* 7:124–126.

Tobien, H. 1996 Evolution of Zygodons with Emphasis on Dentition. In *The Proboscidea. Evolution and Palaeoecology of Elephants and Their Relatives*, edited by J. Shoshani and P. Tassy, pp. 76–85. Oxford University Press, Oxford.

Paleoenvironments, Cave Faunas, and Human Migration in Late-Pleistocene Beringia: A Comparison of Calibrated Age Ranges.

Robert A. Sattler and Thomas E. Gillispie

The timing and environmental circumstances of human colonization of Beringia during the late Pleistocene remains central to research about the origins of North American natives (Hoffecker et al. 1993; Greenberg et al. 1986). Of great importance are the timing of: 1) late-glacial paleoclimatic changes; 2) late-glacial megafaunal extinction; and 3) the earliest undoubted human occupation of eastern Beringia (Hoffecker et al. 1993; Yesner 1996). Understanding these events requires that the various records all be placed on the same calibrated radiocarbon time scale (Bartlein et al. 1995).

Building on previous work by Kunz and Reanier (1994), we have calibrated two key radiocarbon date lists (Figure 1), and illustrated them in relationship to the calibrated age ranges of the major paleoenvironmental events. One date list consists of radiocarbon ages on Beringian cave faunas (Sattler 1997, Sattler et al. in preparation); the other list consists of the earliest dated human occupations of eastern Beringia. These data support Yesner's (1996) assertion that disintegration of the full-glacial "mammoth steppe" community (Guthrie 1995) antedates human colonization of eastern Beringia.

Mammoth, saiga, and horse are the common indicator species for the mammoth steppe (Guthrie 1995). Calibrated (Stuvier and Reimer 1993) radiocarbon dates from the known cave faunas that include these species virtually all fall within the last glacial maximum, which is called the Duvanny Yar Interval in Beringia (Hopkins 1982). Our dating of the Duvanny Yar Interval is based on Bigelow's (1997) central Alaskan pollen cores, and on analysis of the GISP2 ^{18}O climate record by Stuvier et al. (1995). The earliest undoubted human occupations of eastern Beringia, now central and northern Alaska, are the Nenana complex (Powers and Hoffecker 1989), the Mesa complex (Kunz and Reanier 1994), and earliest phases of the Chindadn

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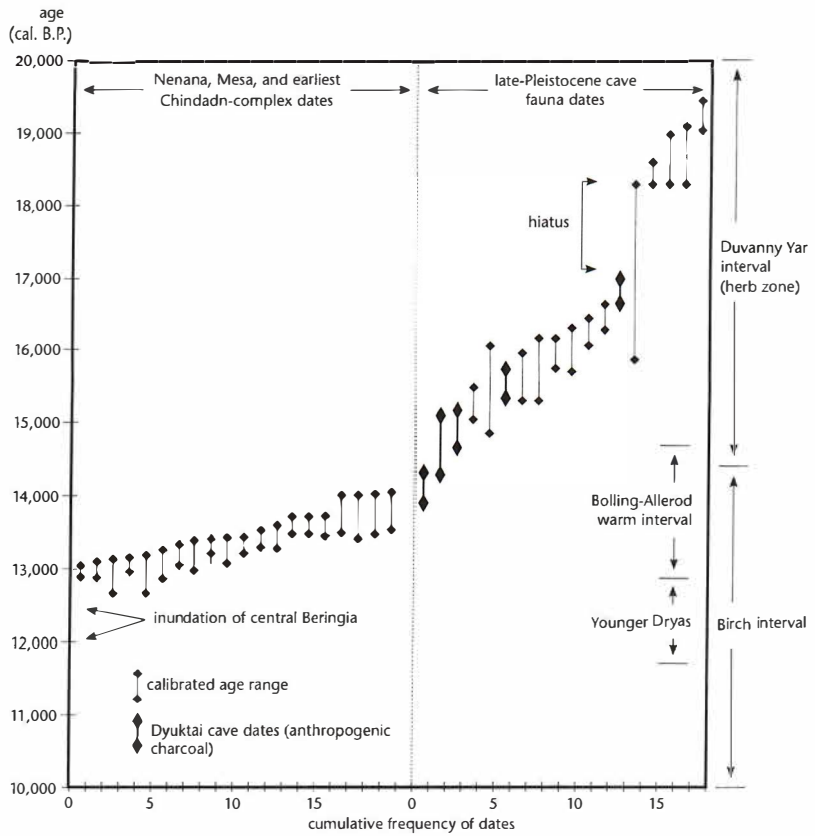

Figure 1. Calibrated radiocarbon ages of late-Pleistocene cave fauna, earliest certain archaeological cultures, and key paleoenvironmental events in east-central Beringia.

complex. We regard early Chindadn to include Component IV at Broken Mammoth (Homes 1996), Component SP-7 at Swan Point (Holmes et al. 1996), and the pre-11,000 B.P. activity areas at Healy Lake Village (Cook 1996 and pers. comm.).

These occupations occurred during the initial climatic warming of the late glacial Birch Interval (Hopkins 1982; dating again based on Bigelow 1997), an interval that appears to be correlative to the European Bolling and Allerod pollen zones (Stuvier et al. 1995). Faunas associated with these open-air sites (Dry Creek and Broken Mammoth) exclude the mammoth and horse diagnostic of the Duvanny Yar Interval mammoth steppe. Instead, the large mammals associated with these occupations are typically wapiti, bison, mountain sheep, and caribou. In contrast, the association of the presumed western Beringian antecedents of the Nenana, Mesa, and Chindadn complexes with the mammoth steppe fauna has been firmly established, as exemplified by the upper-Paleolithic occupation of Dyuktai Cave (Mochanov and Fedoseeva 1996).

References Cited

Bartlein, B. J., M. E. Edwards, S. L. Shafer, and E. D. Barker Jr. 1995 Calibration of Radiocarbon Ages and the Interpretation of Paleoenvironmental Records. *Quaternary Research* 44:417–424.

Bigelow, N. H. 1997 *Late Quaternary Vegetation and Lake Level Changes in Central Alaska.* Unpublished Doctoral Dissertation. Department of Anthropology, University of Alaska Fairbanks, Fairbanks, AK.

Cook, J. P. 1996 Healy Lake. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West. pp. 323–328. University of Chicago Press, Chicago.

Greenberg, J. H., C. G. Turner II, and S. L. Zegura 1986 The Settlement of the Americas: A Comparison of the Liguistic, Dental, and Genetic Evidence. *Current Anthropology* 27:477–497.

Guthrie, R. D. 1995 Mammalian Evolution in Response to the Pleistocene-Holocene Transition and the Break-up of the Mammoth Steppe: Two Case Studies. *Acta Zool. Cracov.* 38:139–154.

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

Holmes, C. E. 1996 Broken Mammoth. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West. pp. 312–318. University of Chicago Press, Chicago.

Holmes, C. E., R. Vanderhoek, and T. E. Dilley 1996 Swan Point. *American Beginnings: The Prehistory and Paleoecology of Beringia* edited by F. H. West. pp. 319–322. University of Chicago Press, Chicago.

Hopkins, D. M. 1982 Aspects of Paleogeography of Beringia during the Late Pleistocene. In *Paleoecology of Beringia,* edited by D. M. Hopkins, C. V. Matthews, Jr., C. E. Schweger, and S. B. Young. pp. 3–28. Academic Press, New York.

Kunz, M. L., and R. E. Reanier 1994 Paleoindians in Beringia: Evidence from Arctic Alaska. *Science* 263:660–662.

Mochanov, Y. A., and S. A. Fedoseeva 1996 Dyuktai Cave. In *American Beginnings: The prehistory and Paleoecology of Beringia,* edited by F. H. West. pp. 312–318. University of Chicago Press, Chicago.

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

Sattler, R. A. 1997 Large Mammals in Lower Rampart Cave 1, Alaska: Interspecific Utilization of an Eastern Beringian Cave. *Geoarchaeology* 12:657–688.

Sattler, R. A., D. M. Vinson, and T. E. Gillispie in preparation Eastern Beringian Cave Faunas during the Demise of the Mammoth Steppe.

Stuiver, M., P. M. Grootes, and T. F. Braziunas 1995 The GISP2 ^{18}O Climate Record of the Past 16,500 Years and the Role of the Sun, Ocean, and Volcanoes. *Quaternary Research* 44:341–354.

Stuiver, M., and P. J. Reimer 1993 Extended ^{14}C Database and Revised CALIB 3.0 14C Age Calibration Program. *Radiocarbon* 35(1) 215–230.

Yesner, D. 1996 Human Adaptation at the Pleistocene-Holocene Boundary (circa. 13,000 to 8,000 BP) in Eastern Beringia. In *Humans at the End of the Ice Age: The Archaeology of the Pleistocene-Holocene Transition,* L. G. Straus, B. V. Ericksen, J. M. Erlandson, and D. R. Yesner editors, pp. 255–272. Plenum, New York.

New Radiocarbon Dates for Vero Tapir and Stout-legged Llama from Florida

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In 1997 a SCUBA-diving team from the Florida Museum of Natural History excavating submerged sediments of the Aucilla River, north-central Florida, recovered new specimens and organic samples that provide some of the youngest known radiocarbon dates for *Tapirus veroensis* and *Palaeolama mirifica*. Three sites produced samples of these extinct ungulate taxa which were dated either by wood or by collagen.

In the northwest corner of Little River Rapids, where the river rises from its subterranean course in the Suwannee Limestone of Oligocene age, we excavated a 2-by-2-m pit 5.25 m below mean river level. We recovered vertebrates from the lowest few centimeters of Zone 4, a sandy gray clay, and on the surface of the underlying paleosol. A left mandible with p4-m3 (UF 180216) of *Tapirus veroensis* was associated with four characteristic Florida late-Pleistocene species: *Megalonyx jeffersoni, Mammuthus columbi, Equus fraternus*, and *Ondatra zibethicus*. Two radiocarbon dates from wood associated with these vertebrates are 11,450 ± 90 yr B.P. (Beta-107296) and 12,130 ± 70 yr B.P. (Beta-111675), the latter apparently representing wood reworked from the underlying paleosol during deposition of the sandy clay (all dates reported in uncalibrated radiocarbon years). Another wood sample from 10–15 cm below the paleosol returned a date of 13,130 ± 230 yr B.P. (Beta-107295).

In the northwest corner of the Page-Ladson Site (Test F 97-1 eastern extension) at the confluence of the northern branch of the Wacissa River with the Aucilla River, a 1-by-2-m excavation in the lower half of the section produced bones near the base of a clayey peat immediately overlying a calcareous sand. Vertebrates were mainly modern aquatic species including fishes, alligator, and *Pseudemys*. There were also two light tan, fresh-looking bones of extinct terrestrial species, namely a skull fragment (right jugal and maxillary) bearing three molars of *Palaeolama mirifica* (UF 180214) and a posterior thoracic vertebra of *Tapirus veroensis* (UF 180215). A small piece of the *Palaeolama* jugal bone was submitted for a collagen date. Pretreatment consisted of repeatedly applying dilute cold HCl to remove bone apatite and then treating with NaOH to remove secondary organic acids. Graphitization and ^{14}C content measurement went normally and the resulting AMS date was 12,350 ± 50 yr B.P. (Beta-112236).

Sloth Hole, four miles downstream in the Aucilla's final run to the Gulf of Mexico, produced from excavation block A two isolated teeth of *Palaeolama*. A right upper P4 (UF 180218) came from shelly, sandy gray clay in level 6 about 120 cm below the excavation datum, and a right lower dp4 (UF 180217) was collected at the interface between level 6 and underlying level 7, another

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sandy clay, 123 cm below datum. A wood sample from level 8, a tan peaty sand 170 cm below datum, was AMS dated at 12,300 ± 50 yr B.P. (Beta-95341).

Combining these occurrences and associated dates, the new evidence shows that *Tapirus veroensis* lived in north Florida 11,450 radiocarbon years ago, and that *Palaeolama mirifica* survived in Florida beyond 12,300 radiocarbon years ago. Graham (1992) reported a partial skeleton of *Palaeolama mirifica* which gave "a terminal Pleistocene date," but no precise numbers were reported. At present the Florida dates provide the best available terminal records of these two extinct species.

Although we collected these taxa in deposits that produce Paleoindian artifacts, we found no discernible evidence of their being hunted or butchered. Furthermore, sister species of these extinct tapirs, as well as sister genera of these llamas, persist in South America in areas that were surely inhabited by late-Pleistocene humans. This suggests that the effects of climate change, such as the sudden severe cooling of the Younger Dryas, did more to devastate temperate tapirs and llamas than humans did.

References Cited

Graham, R. W. 1992 *Palaeolama mirifica* from the Central Mississippi River Valley: Paleoecological and Evolutionary Implications. *Journal of Vertebrate Paleontology* 12(3):31A.

Paleoenvironments: Geosciences

Late-Pleistocene and Holocene Paleoclimate Records from the Badain Jaran Desert, China

Li Baosheng, Yan Mancun, Barry B. Miller, and Michael J. S. Tevesz

Impressive paleoclimate records have begun to be assembled from Pleistocene and Holocene lake deposits throughout China (e.g., van Campo and Gasse, 1993; Fang, 1991, 1993; Lister et al., 1991). Recently, attention has been focused on one of the least-studied areas where extensive records exit. This is the desert region of northwestern China near the border with Mongolia (Pachur et al, 1995). Preliminary work has indicated that fossiliferous lacustrine sediments of the Badain Jaran Desert are particularly rich sources of paleoclimatic information.

The Badain Jaran Desert is located in north central China between 39° 20′ and 41° 30′ N and 100° and 104° E. The area is bounded on the west by the Ruoshui River, on the east by the Yabulai Mountains, on the north by the Muji and Guaizi playas, and on the south by the Beida Mountains. This desert has an extensive cover of high, active dunes, some exceeding 500 m in height. Overall, the desert covers an area of approximately 44,300 km^2.

About a third of the area covered by the dunes and sand belts of this desert is vegetated because of the presence of locally abundant water. Over 140 lakes occupy depressions between dunes in an area of approximately 685 km^2 in the southeastern part of the desert. The water level in the lakes is controlled mainly by groundwater seepage. Although high rates of evaporation have made some of these lakes saline, the desert is also characterized by a large number of fresh water springs that may be recharged from orographic rainfall on mountains immediately to the south and southeast.

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Preliminary field work in the southeastern Badain Jaran Desert by Dr. Li Baosheng, while he was still associated with the Institute of Desert Research, Chinese Academy of Sciences, revealed that surface sediments exposed around the periphery of at least eight of the lakes contain a fossil record of both mollusks and ostracodes (Figure 1). The deposits range in age from late Pleistocene to Holocene. One radiocarbon date on shell carbonate of 5,190 ± 85 yr B.P. (Ld 102696) from locality 2 (Figure 1) has been determined for an assemblage of gastropods that includes five species, *Radix cuconorica, Succinea erythoiphava, Gyraulus sibericus, Radix lagotis,* and *Lymnaea stagnalis.* These fossil mollusks provide evidence of higher lake levels in this area of the Badain Jaran Desert during the Holocene thermal maximum. Additional preserved invertebrate fossils from the other seven sites also include the gastropod *Gyraulus albus,* the bivalve *Corbicula* sp., and the ostracode *Limnocythere* sp.

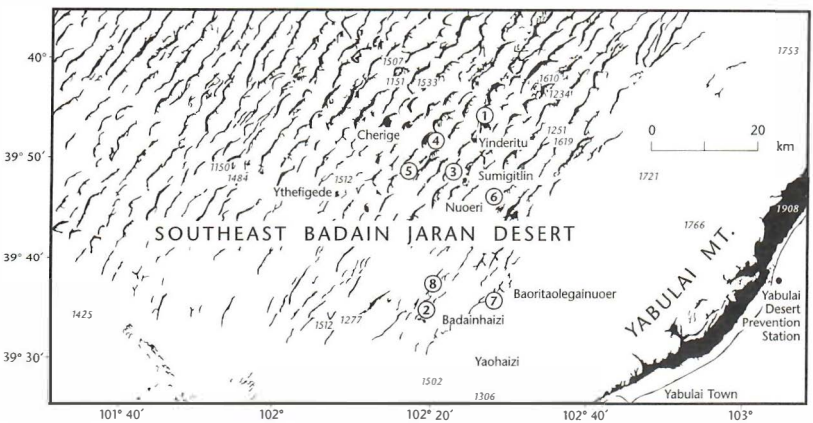

Figure 1. Map showing location of eight study sites (circled numerals) in the southeastern part of the Badain Jaran Desert.

Wet meadowlands surrounding some of the lakes should be suitable for obtaining vibracore samples of sufficient length for detailed paleoclimatic studies of the Holocene and late-Pleistocene sediment record of this area. The diagenetically unaltered and abundant biogenic carbonate should provide suitable material for anticipated future detailed oxygen and carbon isotope analyses that will supplement the biotic studies.

We wish to thank Dr. Cheng Deniou, Institute of Animal Research, Academia Sinica, for most of the molluscan identifications; Mr. Hu Zhiyu, Institute of Desert Research, Academia Sinica, for providing the radiocarbon date (Ld 102696); and Dr. Alison J. Smith, Kent State University, for the ostracode identification.

References Cited

Campo van, E., and F. Gasse 1993 Pollen-and-Diatoms-Inferred Climatic and Hydrological Changes in Sumxi Co Basin (western Tibet) since 13,000 yr B.P. *Quaternary Research* 39:300–313.

Fang, J.-Q. 1991 Lake Evolution during the Past 30,000 Years in China, and Its Implication for Environmental Changes. *Quaternary Research* 36:37–69.

——— 1993 Lake Evolution during the Last 3000 Years in China and Its Implications for Environmental Change. *Quaternary Research* 39:175–185.

Lister, G. S., K. Kelts, C. K. Zao, J. U. Yu, and F. Niessem 1991 Lake Qinghai, China: Closed-basin Lake Levels and the Oxygen Isotope Record for Ostracoda since the Latest Pleistocene. *Paleogeography, Paleoclimatology, Paleoecology* 84:141–162.

Pachur, H-J., B. Wunnemann, and H. Zhang 1995 Lake Evolution in the Tengger Desert, Northwestern China during the Last 40,000 Years. *Quaternary Research* 44:171–180.

Pocket Beaches and Oregon Coastal Prehistory

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Recent studies of the geology of the Oregon coast have shown that there was a fundamental change in the landforms that form the beach zone starting about 7,000 years ago. Before the sea level rise began to stabilize at its current levels, the coast was primarily a wide sandy shelf with meandering rivers. The large flat coastal plain was probably reflective of the remnant coastal plains of today. Komar (1992:10) indicates that the headlands of Oregon segmented the formerly continuous shoreline and extended into sufficiently deep water to hinder coastal transport of beach sands. A study of the mineralogy of sand found on the present-day beaches supports this pattern and is represented by a series of pocket beaches separated by headlands. Lyman (1991:7) noted that at the present time 40% of beaches consists of rocky sea cliffs and headlands. The data suggest that the current pocket beaches separated by rocky headlands formed around 7,000 to 5,000 years ago.

Current estuaries were deeply cut riverine canyons that opened up onto the flat plain. As the sea levels buried these canyons, the drop in water speed deposited sediments that produced estuaries. George Priest (pers. comm.) indicates that he obtained a radiocarbon date of 9,500 yr B.P. on a peaty sample from a drill hole into the base of a Holocene channel at Siletz Bay. This peaty sample resembles current salt marsh deposits in the area but is about 150 feet below sea level. This indicates that sea level had reached the coast at the bottoms of Pleistocene valleys by this time. How far seaward headlands reached and how much headland habitat existed before or after are not known. He cautions that in his opinion although the amount of lithification *decreases* to the west, the relative amount of lithification may not drop significantly enough to make a difference until it was close to the lowest sea levels in the Pleistocene.

The stabilization of increasing rocky habitat, however, may have resulted in shellfish population increases along the Oregon coast. Before the establishment of large-scale rocky headlands and sea cliffs, there may not have been sufficient habitat to support an economy that emphasized littoral resource

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exploitation. The key is the relative amount of lithification exposed at various sea levels.

Additionally, with the submergence of the down-cutting riverine valleys came the emergence of estuaries as the outflow energy dropped and sand began to be deposited by the rivers. Lyman (1991:7) suggested that the size of estuaries is causally related to their biological productivity and that the ecological evolution and size of the estuary and human ecology probably relate to each other in some manner. In addition, the productivity of rocky habitat is obvious in the archaeological record along the Oregon coast. The vast majority of sites are found in such habitat and relate to shellfish, sea mammal and rocky habitat fish exploitation.

It is possible, indeed probable, that the basic patterns in ecology were quite different prior to 7,000–5,000 years ago for the Oregon coast. It is therefore not surprising that the archaeological record reflects a terrestrial economy in the lowest deposits found in coastal archaeological sites. The changing location, changing relative size, and evolutionary development of rocky habitat, sea cliffs, estuaries and dune lakes need to be studied throughout sea level changes during the Holocene.

References Cited

Komar, P. D. 1992 Ocean Processes and Hazards along the Oregon Coast. *Oregon Geology* 54(1)3–19.

Lyman, L. 1991 *Prehistory of the Oregon Coast: The Effects of Excavation Strategies and Assemblage Size on Archaeological Inquiry*. Academic Press, Boston.

Priest, G. 1996 Personal Communication, Department of Geology and Mineral Industries Letter on file at Oregon State Historic Preservation Office, Salem. (DOGAMI Open-File Report O-95-5)

Geoarchaeological Variability between Two Central Iowa Drainage Basins

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Investigations of the alluvial stratigraphy, chronology and archaeology of two small, closely spaced drainage basins near the southern margin of the late-Wisconsinan Des Moines Lobe in central Iowa have revealed considerable variability between the records (Krieg et al. 1997; Van Nest and Bettis 1990). The Buchanan Drainage is a short, narrow, steep-sided third-order tributary of the South Skunk River. Initial entrenchment and headward expansion oc-

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curred in response to entrenchment and valley widening of the South Skunk River valley (Van Nest and Bettis 1990). Episodic headward expansion occurred in the Holocene by seepage and mass wasting processes (Van Nest and Bettis 1990). Alluvial fans are absent from the basin, and Holocene alluvial and colluvial deposits are stored along the valley margins beneath a single low terrace. Buchanan Drainage's archaeological record is dominated by middle- to late-Archaic artifact types (c. 7,500–3,000 yr B.P.). No late-Paleoindian or early-Archaic (c. 10,000–7,500 yr B.P.) artifacts have been recovered during archaeological excavations, and few have been identified from collections within the valley.

Erickson Creek, a small fourth-order tributary of the South Skunk River, is located approximately 15 km southeast of the Buchanan Drainage. This valley is significantly wider and more open than the Buchanan Drainage, and contains several terraces and alluvial fans. Downstream events in the South Skunk River valley, more or less contemporaneous with those further upstream in the vicinity of Buchanan Drainage, also initiated development of the Erickson Creek basin. However, unlike the Buchanan Drainage, initial entrenchment occurred within a linked depression (Bettis et al. 1996), and episodic headward expansion widened and deepened this preexisting system (Krieg et al. 1997). Artifact collections from the Erickson Creek basin contain numerous late-Paleoindian and early-Archaic artifact types. Although present, middle- and late-Archaic artifacts are less common than at the Buchanan Drainage (Krieg et al. 1997).

Does this reflect a shift in prehistoric use of these two valleys during various periods of the Holocene, or a difference in geological factors that control preservation and exposure of the archaeological record? The variability between the archaeological records is at least partially attributable to geologic factors such as deep burial and erosion. Deposits dating to the late Paleoindian and early Archaic are present beneath the modern water table within the Buchanan Drainage, suggesting that archaeological deposits dating to these periods may be present in deeply buried contexts within the basin but have not been discovered using traditional archaeological survey methods. In contrast, deposits of this age are currently exposed in cutbanks within the Erickson Creek basin. Emplacement of culverts near the mouth of the valley in the late 1960s initiated an entrenchment episode that progressed up-valley and exposed early- and mid-Holocene deposits containing late-Paleoindian and early-Archaic cultural horizons. A widespread erosion episode in the late Holocene removed much of the mid-Holocene deposits and the middle- and late-Archaic artifacts they contained within the lower portion of the Erickson Creek valley (Krieg, 1997). During this period aggradation in the lower portions of Buchanan Drainage buried and preserved deposits dating to these time periods (Van Nest and Bettis 1990).

Geologic processes cannot be utilized to fully explain all the variability between the records preserved within the two valleys. Although much of the mid-Holocene stream deposits was eroded from the Erickson Creek basin during the late Holocene, alluvial fans within the valley preserve a record of episodic alluviation and periods of stability and soil formation throughout the

entire Holocene (Bettis, 1990; Krieg et al. 1997). This suggests that middle- and late-Archaic groups may have favored smaller valleys such as the Buchanan Drainage over larger basins such as Erickson Creek during the middle and late Holocene (Krieg et al., 1997). However, the projectile point typology and chronologic relationships of the Archaic period in central Iowa is not well known, and many of the side-notched points tentatively identified as early Archaic may in fact be middle- and late-Archaic artifacts (Toby Morrow and Dave Benn, pers. comm.). Future archaeological investigations within the two basins should address this issue to broaden our understanding of this important period in Iowa's history.

We thank the Erickson, Sesker, Harker, and Griffith families of Cambridge, Iowa, who allowed us to conduct investigations on their property. Harold Erickson deserves special thanks for providing us with a base of operations, and important background information. We are grateful to Don Erickson for loaning his artifact collection for study. Funding for radiocarbon dates was provided by research grants from the Geological Society of America; the Littlefield and Geology Endowment Funds, Department of Geology, University of Iowa; the Iowa Geological Survey Bureau; and NSF Grant EAR 93-16391.

References Cited

Bettis III, E. A. 1990 Holocene Stratigraphy and Chronology of the Cambridge Locality, Story County, IA. Ms. on file with the author, Iowa City. Submitted to the Iowa Science Foundation.

Bettis III, E. A., D. J. Quade, and T. J. Kemmis 1996 *Hogs, Bogs, & Logs: Quaternary Deposits and Environmental Geology of the Des Moines Lobe.* Iowa Geological Survey Bureau Guidebook 18, Iowa City.

Krieg, J. R., E. A. Bettis III, and R. G. Baker 1997 The Role of Potential in the Geoarchaeological Variability between Two Central Iowa Drainage basins. Paper presented at the 55th Annual Plains Conference, Boulder.

Van Nest, J., and E. A. Bettis III 1990 Postglacial Response of a Stream in Central Iowa to Changes in Climate and Drainage Basin Factors. *Quaternary Research* 33:73–85.

The Age and Environment of the Paleolithic Occupation of Sakhalin Island, the Russian Far East

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In 1994–1996, we conducted geoarchaeological research on ancient sites on southern Sakhalin Island. The first Paleolithic cultural layer found in situ at

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the Ogonki 5 site, 46° 46′ N, 142° 30′ E (Vasilevsky 1997), made it possible for us to obtain samples of charcoal from a primary sedimentary context. This will establish the timing of initial peopling of Sakhalin Island, an important step for studying human colonization of all insular Northeast Asia, including Hokkaido, Honshyu, Kyushu, Shikoku, and the Kuril Islands.

Previously, no radiocarbon or paleoenvironmental data had been available for the Paleolithic of Sakhalin. Golubev (1983) associated the earliest traces of human occupation here with the Ado-Tyimovo site, based on artifact typology. Using a stratigraphic correlation with the Japanese Paleolithic, the age of the site was provisionally estimated at c. 30,000 yr B.P. (Golubev and Lavrov 1984). Later, additional excavations on Ado-Tyimovo revealed a mixture of Paleolithic and Neolithic artifacts (Vasilevsky 1996). All other Paleolithic sites, such as Takoe 2 and Sokol, were apparently redeposited and already in secondary context.

Prior to 1993, when the Ogonki 5 site was discovered, no solid evidence for a Paleolithic occupation of Sakhalin was known. In 1997, we obtained four AMS radiocarbon dates for the lower cultural layers (# 2 and 3) of the Ogonki 5 site. From layer 2b, two ^{14}C values of 19,320 ± 145 yr B.P. (AA-20864) and 18,920 ± 150 yr B.P. (AA-25434) are in good agreement with each other. For layer 3, the ^{14}C dates are 17,860 ± 120 yr B.P. (AA-23137) and 31,130 ± 440 yr B.P. (AA-23138). The oldest value in this series, c. 31,000 B.P., is of doubtful utility. Both layers 2 and 3 contain very similar artifacts (Vasilevsky 1997), and such a large difference in age, about 12,000 ^{14}C years, without significant changes in the artifact typology is unlikely. Thus we can estimate the age of the oldest Paleolithic layers at the Ogonki 5 site at c. 17,900–19,300 yr B.P..

This time interval corresponds to the Last Glacial Maximum in Northern Hemisphere. The environment of southern Sakhalin at that time was represented by open birch-larch forests (Kuzmin 1996). On the adjacent territory of the Hokkaido, the eastern part of this island had similar vegetation cover (Tsukada 1985: 378), and the western part was covered by dark coniferous forests (in original paper by M. Tsukada, by boreal conifer forests). The La Perouse (Soya) Strait did not exist at this time, and Sakhalin and Hokkaido were connected by a land bridge. This allowed ancient people to migrate from the mainland territories such as the Amur River basin, connected with Sakhalin by another land bridge at the Tatar Strait, toward the Northeast Asian islands.

During the period 18,000–20,000 yr B.P., several upper-Paleolithic sites, such as Kamishihoro-Shimagi and Shukubai-Sankakuyama, existed on Hokkaido (Aikens and Higuchi 1982: 59-63). This may show the intensive human migration from the Asian mainland through Sakhalin to the Japanese Islands during the Last Glacial Maximum. As for earlier contacts, we do not have strong evidence of human movement throughout these territories before this time.

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References Cited

Aikens, C. M., and T. Higuchi 1982 *Prehistory of Japan*. Academic Press, New York.

Golubev, V. A. 1983 About the Initial Peopling of the Sakhalin Island. In *Late Pleistocene and Early Holocene Cultural Links between Asia and America*, edited by R. S. Vasilievsky. Nauka Publishers, Novosibirsk, pp. 41–49 (in Russian).

Golubev, V. A., and E. L. Lavrov 1984 *Sakhalin in the Stone Age*. Nauka Publishers, Novosibirsk (in Russian).

Kuzmin, Y. V. 1996 Palaeoecology of the Palaeolithic of the Russian Far East. In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by F. H. West. The University of Chicago Press, Chicago, pp. 136–146.

Tsukada, M. 1985 Map of Vegetation during the Last Glacial Maximum in Japan. *Quaternary Research* 23(2):369–381.

Vasilevsky, A. A. 1996 Notes about the Protohistory and Prehistory of the Sakhalin Island. *Bulletin of the Society of Study of Sakhalin and Kuril Islands (Yuzhno-Sakhalinsk)* 6(1):54–79 (in Russian).

——— 1997 The Archaeological Sites of the Lutoga River Basin and Their Significance for the Paleolithic Studies on the Far East. In *Problems of the Stone Age Archaeology*, edited by A. M. Kuznetsov. Ussuriisk Teacher's Training College Press, Ussuriisk, pp. 107–125 (in Russian).

Geochronology of Sheriden Cave, Ohio: The 1997 Field Season

Kenneth B. Tankersley and Carol S. Landefeld

In 1997, a second season of geoarchaeological field work was conducted at Sheriden Cave, a Paleoindian site located in the Erie Basin of northwestern Ohio. The cave contains a deep stratigraphic sequence of unconsolidated early-Holocene and late-Pleistocene deposits (Ford et al. 1996; Hansen 1992a, 1992b; Holman 1997; McDonald 1992, 1994). As stated earlier in this publication series (Tankersley et al. 1997:82), the primary research focus at Sheriden Cave is to provide a temporal framework for the archaeological record, distinguish between natural sedimentary and biological processes and those that resulted from human behavior, and determine what human behavior left artifacts behind at the site (after Waters 1992). Given the rich stratigraphic record, plethora of well-preserved vertebrate skeletal and carbonized plant remains, and presence of flaked-stone and bone artifacts, the senior author argued that these research objectives were achievable.

In 1997, an interdisciplinary team exposed and systematically mapped a 2-m standing profile in Sheriden Cave in order to sample, assess, and radiocarbon date the stratigraphy and material remains laid open in the profile. Trenches were also hand-excavated to a depth of more than 2 m in the area around the cave entrance to permit stratigraphic correlations, identification of facies relationships, and help determine the timing and duration of episodes of deposition, erosion, and stability inside the cave.

The unconsolidated late-Pleistocene cave sediments resulted from se-

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quences of ponding, drainage, drying, freeze-thaw, ceiling and wall collapse, slope wash, and flooding. In contrast, the early-Holocene sediments are exclusively the result of ponding. Four uncalibrated radiocarbon dates have been obtained on wood charcoal from the early-Holocene cave ponded sediments: 9,170 ± 60 yr B.P. (CAMS-24126), 9,190 ± 60 yr B.P. (CAMS-24127), 9,775 ± 70 yr B.P. (AA-21705), and 10,020 ± 115 yr B.P. (AA-21706). Nine uncalibrated radiocarbon dates have been obtained from the late-Pleistocene strata: 10,470 ± 70 yr B.P. (AA-21712), 10,680 ± 80 yr B.P. (AA-21710), 11,710 ± 220 yr B.P. (PITT-0892), and 13,120 ± 80 yr B.P. (AA-21711) on wood charcoal; and 10,850 ± 60 yr B.P. (CAMS-26783), 11,060 ± 60 yr B.P. (CAMS-10349), 11,480 ± 60 yr B.P. (CAMS-12837), 11,570 ± 70 yr B.P. (CAMS-12839), and 11,610 ± 90 yr B.P. (CAMS-12845) on selected amino acids extracted from bone collagen.

All the excavated cave sediments were subjected to flotation. This procedure resulted in the recovery of burned and calcined bone, a compass graver and biface fragment manufactured from Flint Ridge chert, a distal portion of an end scraper manufactured from Pipe Creek chert, and a mixture of local and non-local microdebitage including flakes of Wyandotte, Upper Mercer, Flint Ridge, Pipe Creek, and Delaware cherts. The microdebitage are of the same raw materials used in the manufacture of the formal tools documented during the 1996 and 1997 field seasons. They were produced from tool edge damage, resharpening dulled edges, and tool manufacture. A cervical vertebra of a snapping turtle (*Chelydra serpentina*) displaying distinctive cutmarks was exposed in situ in the same location that produced a carved, incised, beveled, and cross-hachured bone point (Bowen 1995; Tankersley 1997).

The radiocarbon age determination 10,680 ± 80 yr B.P. (AA-21710) was obtained on wood charcoal from the stratum containing the bone point and cut turtle vertebra. Presently, it is the single best age estimation for the late-Pleistocene culture-bearing cave deposits in Sheriden Cave. Radiocarbon samples from the underlying stratum suggest that it is also possible that the Paleoindian component dates as early as 10,900 and as late as 10,400 uncalibrated radiocarbon years B.P. Future geochronological data will be obtained through a detailed analysis of the sediments, additional radiocarbon dating of species-identified wood charcoal, and fluoride dating of bone and teeth by ion selective electrode.

Excavations in the cave also revealed a number of natural pedoturbation processes including aquaturbation (inundation and drainage), cryoturbation (freezing and thawing), faunalturbation (burrowing rodents, carnivores, and owls), floralturbation (fungal growth), and graviturbation (breakdown of the cave ceiling and walls). The destruction and removal of sediments in 1990 prevented investigations of residential space use or general location of activity areas in and around the cave (Tankersley 1997). Sheriden and its artifact assemblage is, however, geologically similar to sinkhole and cave sites that have been investigated in northern Florida (Dunbar 1991; Dunbar and Waller 1992; Dunbar and Webb 1996). It is quite likely that Paleoindian activity and land use options in the karstic regions of the Great Lakes were comparable to those in northern Florida during the late Pleistocene.

The interdisciplinary team includes Robert Brackenridge (Dartmouth College, geologist), Francis King (Cleveland Museum of Natural History, paleobotanist), Brian Redmond (Cleveland Museum of Natural History, archaeologist), Donald Stierman (University of Toledo, geophysicist), Greg McDonald (National Park Service, paleontologist), and Lucinda McWheeny (Yale University, paleoecologist). The 1997 field work at Sheriden Cave was funded by a research grant to the senior author from the National Science Foundation.

References Cited

Bowen, J. E. 1995 *Terminal Pleistocene Fluted Knife/Spearpoints from an 18,000 Square Kilometer Portion of North-Central and West Central Ohio: 9000 BC.* Sandusky Valley Chapter, Archaeological Society of Ohio, Upper Sandusky.

Dunbar, J. S. 1991 Resource Orientation of Clovis and Suwannee Age Paleoindian Sites in Florida. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 185–213, Center for the Study of the First Americans, Corvallis.

Dunbar, J. S., and B. I. Waller 1992 Resource Orientation of Clovis, Suwannee, and Simpson Age Paleoindian Sites in Florida. In *Paleoindian and Early Archaic Period Research in the Lower Southeast: A South Carolina Perspective*, edited by D. G. Anderson, K. E. Sassaman, and C. Judge, pp. 279–295, Council of South Carolina Professional Archaeologists, Columbia.

Dunbar, J. S., and S. D. Webb 1996 Bone and Ivory Tools from Submerged Paleoindian Sites in Florida. In *The Paleoindian and Early Archaic Southeast*, edited by D. G. Anderson and K. E. Sassaman, pp. 331–353, University of Alabama Press, Tuscaloosa.

Ford, K. M., A. R. Bair, and J. A. Holman 1996 Late Pleistocene Fishes from Sheriden Pit, Northwestern Ohio. *Michigan Academician* 28:135–145.

Hansen, M. C. 1992a Indian Trail Caverns—A Window on Ohio's Pleistocene Bestiary. *Ohio Geology* Spring, pp. 1–3.

——— 1992b Bestiary of Pleistocene Vertebrates of Ohio. *Ohio Geology* Winter, pp. 1–6.

Holman, J. A. 1997 Amphibians and Reptiles from the Pleistocene (Late Wisconsinan) of Sheriden Pit Cave, Northwestern Ohio. *Michigan Academician* 29:1–20.

McDonald, H. G. 1992 A Pleistocene Fauna from the Sheriden Pit, Indian Trail Caverns, Wyandot County, Ohio and its Relationship to the Late Wisconsinan Deglaciation of Ohio. *Rocky Mountain Section of the Geological Society of America Abstracts with Programs* No. 16284.

——— 1994 Late Pleistocene Vertebrate Fauna of Ohio: Coinhabitants with Ohio's Paleoindians. In *The First Discovery of America*, edited by W. S. Dancey, pp. 23–42, The Ohio Archaeological Council, Columbus.

Tankersley, K. B. 1997 Sheriden: A Clovis Site in Eastern North America. *Geoarchaeology: An International Journal* 12:1–12.

Tankersley, K. B., K. M. Ford, H. G. McDonald, R. A. Genheimer, and R. Hendricks 1997 Late-Pleistocene Archaeology of Sheriden Cave, Wyandot County, Ohio. *Current Research in the Pleistocene* 14:81–83.

Waters, M. R. 1992 *Principles of Geoarchaeology: A North American Perspective.* The University of Arizona Press, Tucson.

Late-Pleistocene Dunes along the Dempsey Divide, Roger Mills County, Oklahoma

J. Peter Thurmond and Don G. Wyckoff

Extensive sand sheets and associated dune fields are common along the major braided streams crossing the Great Plains and cover much of the northern half of Nebraska. These dunes are mostly of middle- to late-Holocene age (e.g., Ahlbrandt et al. 1983; Arbogast 1995; Ferring 1995; Holliday 1985, 1989; Madole 1995; May et al. 1994; Muhs and Holliday 1995; Muhs et al. 1997; Swinehart et al. 1988; Wright et al. 1985). Since 1994, we have been studying a dune field in far western Oklahoma that has proven to be considerably more ancient.

The Dempsey Divide is the high interfluve between the North Fork of the Red and the Washita rivers in Beckham and Roger Mills counties, Oklahoma. A narrow east-west peninsula of basal Tertiary Ogallala Formation, averaging 8–10 km in width, occupies the crest of the divide in southern Roger Mills County. The Ogallala Formation outcrop is underlain unconformably by Permian Period redbeds. The sandy Ogallala clastics have been extensively reworked into an aeolian landscape of scattered dunes, which vary widely in size and shape, and internally drained deflation basins. Tributaries of the North Fork and Washita are actively eroding the edges of this Ogallala outlier, particularly the steep-gradient Washita tributaries to the north.

A remarkable concentration of late-Paleoindian, late-Archaic and Woodland archaeological sites occurs along the divide, particularly along the outcrop boundary between the Ogallala and the Permian redbeds (Bement and Buehler 1994; Buehler 1997; Thurmond 1990, 1991a, 1991b, 1991c, 1997; Wyckoff 1992). The contrasting lithology of the Tertiary and Permian units produces two distinct landscapes, with different soils, plants and animals. The deep, sandy, mollic soils and gentle relief of the Ogallala outcrop support a mosaic of forest, brush and tall grass, with a diverse assemblage of small game and wild plant foods. The Permian outcrops are characterized by thin, fine-textured soils under a much lower biomass of short to mid-height grasses, with narrow riparian belts of limited species diversity. Shortgrass attractive to bison dominates the Permian outcrops. Nearly every stream valley transecting the Tertiary/Permian outcrop boundary is spring-fed, as groundwater flows from the base of the Ogallala aquifer. Archaeological sites are concentrated along the ecotonal edge associated with this outcrop boundary, in proximity to the ubiquitous spring-fed streams. Knappable stone is available in gravels lagged by the westward erosional recession of the Ogallala Formation. Finally, the divide afforded pedestrian hunter-gatherers a ready "gangplank" for travel between the Llano Estacado to the west and the Rolling Plains to the east.

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In hopes of obtaining data pertinent to a reconstruction of Quaternary geomorphic and climatic change on the Dempsey Divide, since 1994 we have been documenting and dating paleosols in dunes, upland valley fills and pond deposits from the crest of the divide northward to the Washita floodplain. We have dated late-Holocene valley fill paleosols in eight locations which superficially replicate the bimodal Copan/Delaware Canyon paleosol sequence (Ferring 1982; Hall 1982, 1990; Hall and Lintz 1984). However, we have also documented multiple paleosols at five exposures dating 50 B.C. to A.D. 1,680 which manifest a roughly 400-year mesic/xeric cycle, with the mesic intervals lasting 195 years on average, and the xeric intervals 213 years. Our ongoing analysis of marsh, stream and pond deposits dating 9–28 ka B.P., which are now 30 m above the modern streams and as much as 2 km beyond the modern Ogallala Formation erosion front, indicate the Ogallala boundary on the north side of the divide has receded at a remarkable average rate of some 8 m per century over the past 28 millennia, and that the landscape immediately beyond the erosion front has lowered an average of 15 cm per century.

The first dune we dated (Trammell Dune #1) is a large linear one (12 m high, covering 4 ha, oriented NW-SE) on the Washita floodplain at Cheyenne, adjacent to the north bank of the modern river channel. We documented a mollic paleosol at the base of the dune, at the same elevation as the modern floodplain surface, and three melanized horizons within the dune. We expected the subdune soil to be early Holocene, and the soils within the dune to be late Holocene. The subdune soil dated 22,850 ± 290 yr B.P. (NZA-4069). The soils within the dune, representing mesic intervals of dune vegetation and stability, dated 18,870 ± 230 yr B.P. (NZA-4081, 1.5 m above dune base), 14,120 ± 190 yr B.P. (NZA-4082, 2 m above dune base) and 4,670 ± 150 yr B.P. (NZA-4083, 2.4 m above dune base).

Surprised by these dates, we shifted our focus some 15 km to the southwest to the crest of the Dempsey Divide to see how the dunes atop the divide compared in age. We had also assumed these dunes to be largely of Altithermal origin. Olson Dune #1, a linear dune 6 m high, 1.8 ha, oriented SSW-NNE, yielded a date of 25,970 ± 270 yr B.P. (NZA-5739) from a melanized horizon 3 m above the dune base. A date of 9,371 ± 97 yr B.P. (NZA-5738) was obtained from a second paleosol 4.6 m above the dune base. Next we cored Olson Dune #2 (a round dune 4.5 m, 0.4 ha,), 2 km southwest of Olson #1, and sampled three melanized epipedons within the dune. The lowest paleosol, 0.6 m above the base, dated 20,070 ± 340 yr B.P. (NZA-6183). The next one up, 2.8 m above the dune base, dated 17,520 ± 180 yr B.P. (NZA-6182). The uppermost soil, 3.7 m above dune base, dated 10,750 ± 120 yr B.P. (NZA-6181). We cored an interdune basin 100 m to the southeast of Olson Dune #2, and assayed a date of 21,970 ± 210 yr B.P. (NZA-5799) on a melanized silt loam 4 m below the modern surface. Finally, at Olson Dune #4, a linear dune 1.6 km northwest of Olson #1, 3.5 m high, 0.4 ha, oriented SSW-NNE, we dated a paleosol 0.7 m above the dune base at 17,930 ± 180 yr B.P. (NZA-6198).

These are not ordinary Great Plains dunes by any measure. The dunes atop the divide are quite variable in size, shape and orientation. They tend to be widely scattered. Most interesting to us is the fact that the dunes we have dated

appear to have been fixed in place for up to 26 millennia, accumulating during xeric episodes and stabilizing under vegetation during mesic times, but not appreciably moving. There is considerable cementation of the sand by carbonates in these dunes, which is not surprising given the Ogallala Formation origin of the sand. Carbonate consolidation during mesic climatic intervals is probably responsible for the locational stability of the dunes. Analogous carbonate cementation of the soils in the broad areas between the dunes, and the patchy distribution of sandy parent material characteristic of the Ogallala, are presumably responsible for the wide separation of the dunes.

The dunes we have radiocarbon dated on and adjacent to the Dempsey Divide are far more ancient than prior work on the Great Plains had led us to expect. The dune dates are remarkably consistent within our study area, and correlate well with the dates for black mat formation in the Trans-Pecos Glacial Lake King, east of El Paso (Wilkins and Currey 1997), with highstands at Glacial Lake San Augustin, west of Socorro (Phillips et al. 1992) and with stream discharge peaks into Glacial Lake Estancia southeast of Albuquerque (Allen 1993; Allen and Anderson 1993, 1995). We believe we are seeing western Oklahoma expressions of the glacial climatic oscillation well known in the north Atlantic (Bond et al. 1997; Dansgaard et al. 1993; Oppo et al. 1998), expressed in the southwestern United States as pluvial maxima in the El Niño-Southern Oscillation (Benson et al. 1996; Heusser and Sirocko 1997; Oviatt 1997) within an overall pattern of a southward displacement of the southern branch of the jet stream (Kutzbach and Guetter 1986; Hostetler at al. 1994, Benson et al. 1998). A comparison of the Lake King, Lake Estancia, and Dempsey Dune dates (Table 1) appears to support the inference of a 400-year pluvial cycle for the region during the Last Glacial Maximum proposed by

Table 1. Comparison of dates of Lake King black mat, Dempsey Dune LGM paleosol, and Estancia basin stream discharge peaks.

Lake King	Dempsey Dunes	Estancia Basin
17.2 ka	—	17.2 ka
—	17.5 ka	17.6 ka
—	17.9 ka	18.0 ka
19.0 ka	18.9 ka	—
—	—	19.8 ka
—	20.1 ka	20.1 ka
—	—	21.7 ka
—	21.9 ka	21.9 ka
22.6 ka	—	—
—	22.8 ka	—
—	—	23.2 ka
24.7 ka	—	—
—	26.0 ka	—

Phillips et al. (1992). The fact that we see the same 400-year mesic/xeric cycle in the late-Holocene paleosols of the last two millennia within our study area is intriguing and suggests a persistent periodicity in the regional climate that manifests itself in both glacial and interglacial times.

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References Cited

Ahlbrandt, T. S., J. B. Swinehart, and D. G. Maroney 1983 The Dynamic Holocene Dune Fields of the Great Plains and Rocky Mountain Basins, U.S.A. In *Eolian Sediments and Processes*, pp. 379–406. M. E. Brookfield and T. S. Ahlbrandt, editors. Elsevier, New York.

Allen, B. D. 1993 Late Quaternary Lacustrine Record of Paleoclimate from Estancia Basin, Central New Mexico, U.S.A. Ph.D. Dissertation, University of New Mexico, Albuquerque.

Allen, B. D., and R. Y. Anderson 1993 Evidence from Western North America for Rapid Shifts in Climate during the Last Glacial Maximum. *Science* 260:1920–1923.

——— 1995 Field Guide to Estancia Basin, New Mexico. Compiled for PAGES, PEP-1 (Americas) Transect Science Meeting. Albuquerque.

Arbogast, A. F. 1995 Paleoenvironments and Desertification on the Great Bend Sand Prairie in Kansas. *Kansas Geological Survey Open File Report* 95-33. Lawrence.

Bement, L. C., and K. J. Buehler 1994 Preliminary Results from the Certain Site: A Late Archaic Bison Kill in Western Oklahoma. *Plains Anthropologist* 39(148):173–183.

Benson, L. V. , J. W. Burdett, M. Kashgarian, S. P. Lund, F. M. Phillips, and R. O. Rye 1996 Climatic and Hydrologic Oscillations in the Owens Lake Basin and Adjacent Sierra Nevada, California. *Science* 274:746–749.

Benson, L. V., S. P. Lund, J. W. Burdett, M. Kashgarian, T. P. Rose, J. P. Smoot, and M. Schwartz 1998 Correlation of Late Pleistocene Lake-Level Oscillations in Mono Lake, California, with North Atlantic Climate Events. *Quaternary Research* 49(1):1–10.

Bond, G., W. Showers, M. Cheseby, R. Lotti, P. Almasi, P. deMenocal, P. Priore, H. Cullen, I. Hajdas, and G. Bonani 1997 A Pervasive Millennial-Scale Cycle in North Atlantic Holocene and Glacial Climates. *Science* 278:1257–1266.

Buehler, K. J. 1997 Where's the Cliff? Late Archaic Bison Kills in the Southern Plains. *Plains Anthropologist Memoir* 29:135–144.

Dansgaard, W., S. J. Johnsen, H. B. Clausen, D. Dahl-Jensen, N. S. Gundestrop, C. U. Hammer, C. S. Hvidberg, J. P. Steffensen, A. E. Sveinbjornsdottir, J. Jouzel, and G. Bond 1993 Evidence for General Instability of Past Climate from a 250-k yr Ice Core Record. *Nature* 364:218–220.

Ferring, C. R. 1982 The Late Holocene Prehistory of Delaware Canyon, Oklahoma. *North Texas State University Contributions in Archaeology* .

——— 1995 Middle Holocene Environments, Geology, and Archaeology in the Southern Plains. *Geological Society of America Special Paper* 297:21–66.

Hall, S. A. 1982 Late Holocene Paleoecology of the Southern Plains. *Quaternary Research* 17:391–407.

——— 1990 Channel Trenching and Climatic Change in the Southern U.S. Great Plains. *Geology* 18:342–345.

Hall, S. A., and C. Lintz 1984 Buried Trees, Water Table Fluctuations, and 3,000 Years of Changing Climate in West-Central Oklahoma. *Quaternary Research* 22:129–133.

Heusser, L. E., and F. Sirocko 1997 Millennial Pulsing of Environmental Change in Southern California from the Past 24 ky: A Record of Indo-Pacific ENSO Events? *Geology* 25(3):243–246.

Holliday, V. T. 1985 Holocene Soil-Geomorphological Relations in a Semi-Arid Environment: The Southern High Plains of Texas. In *Soils and Quaternary Landscape Evolution*, edited by J. Boardman, pp. 325–357. John Wiley and Sons, Ltd. New York.

——— 1989 Middle Holocene Drought on the Southern High Plains. *Quaternary Research* 31(1):74–82.

Hostetler, S. W., F. Giorgi, G. T. Bates, and P. J. Bartlein 1994 Lake-Atmosphere Feedbacks Associated with Paleolakes Bonneville and Lahontan. *Science* 263:665–668.

Kutzbach, J. E., and P. J. Guetter 1986 The Influence of Changing Orbital Parameters and Surface Boundary Conditions on Climate Simulations for the Past 18,000 Years. *Journal of Atmospheric Science* 435:1726–1759.

Madole, R. F. 1995 Spatial and Temporal Patterns of Late Quaternary Eolian Deposition, Eastern Colorado, U.S.A. *Quaternary Science Reviews* 14:155–177.

May, D., J. B. Swinehart, D. Loope, and V. Souders 1994 Late Quaternary Fluvial and Eolian Sediments: Loup River Basin and the Nebraska Sand Hills. *Guidebook, Friends of the Pleistocene Field Trip*, 13–31.

Muhs, D. R., and V. T. Holliday 1995 Evidence of Active Dune Sand on the Great Plains in the 19th Century from Accounts of Early Explorers. *Quaternary Research* 43(2):198–208.

Muhs, D. R., T. W. Stafford, J. B. Swinehart, S. D. Cowherd, S. A. Mahan, C. A. Bush, R. F. Madole, and P. B. Maat 1997 Late Holocene Eolian Activity in the Mineralogically Mature Nebraska Sandhills. *Quaternary Research* 48(2):162–176.

Oppo, D. W., J. F. McManus, and J. L. Cullen 1998 Abrupt Climate Events 500,000 to 340,000 Years Ago: Evidence from Subpolar North Atlantic Sediments. *Science* 279:1335–1338.

Oviatt, C. G. 1997 Lake Bonneville Fluctuations and Global Climate Change. *Geology* 25(2):155–158.

Phillips, F. M., A. R. Campbell, C. Kruger, P. Johnson, R. Roberts, and E. Keyes 1992 A Reconstruction of the Response of the Water Balance in Western United States Lake Basins to Climatic Change. *New Mexico Water Resources Research Institute Report* 269.

Swinehart, J. B., J. Goeke, and T. C. Winter 1988 Field Guide to Geology and Hydrology of the Nebraska Sand Hills. *Colorado School of Mines, Professional Contributions* 9.

Thurmond, J. P. 1990 Late Paleoindian Utilization of the Dempsey Divide on the Southern Plains. *Plains Anthropologist Memoir* 25.

——— 1991a A Late Archaic/Woodland Lunate Stone Burial from Far Western Oklahoma. *Bulletin of the Texas Archeological Society* 60:241–255.

——— 1991b Archaeology of the Dempsey Divide, a Late Archaic/Woodland Hotspot on the Southern Plains. *Bulletin of the Oklahoma Anthropological Society* 39:103–157.

——— 1991c An Additional Late Paleoindian Component on the Dempsey Divide. *Bulletin of the Oklahoma Anthropological Society* 39:159–169.

——— 1997 A Recently Recorded Late Woodland Campsite on the Dempsey Divide: Thurmond Ranch #112. *Newsletter of the Oklahoma Anthropological Society* 45(4):9–11.

Wilkins, D. E., and D. R. Currey 1997 Timing and Extent of Late Quaternary Paleolakes in the Trans-Pecos Closed Basin, West Texas and South-Central New Mexico. *Quaternary Research* 47(3):306–315.

Wright, H. E., J. C. Almendinger, and J. Gruger 1985 Pollen Diagram from the Nebraska Sandhills, and the Age of the Dunes. *Quaternary Research* 24:115–120.

Wyckoff, D. G. 1992 Archaic Cultural Manifestations on the Southern Plains. *Revista de Arqueologia Americana* 5:167–199.

Information for Contributors

GENERAL INFORMATION

Categories of notes are: 1) Archaeology, 2) Physical Anthropology, 3) Lithic Studies, 4) Taphonomy–Bone Modification, 5) Methods, 6) Paleoenvironments (with subsections: Plants, Invertebrates, Vertebrates and Geosciences), and 7) Special Focus. The last category is reserved for a pre-selected topic for which **CSFA** solicits manuscripts. No more than 65 papers will be accepted for each issue. Each contributor will have no more than two papers published in each issue, and only one paper as senior author.

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The following are some preferred abbreviations, words and spellings: Paleoindian

(or Paleoamerican), archaeology, ca. (circa), yr B.P. (years before present), early-, mid-, late- (i.e., early-Holocene), ^{14}C (radiocarbon 14; ^{16}C, etc.), in situ, et al., pers. comm., CRM (cultural resource management), and AMS or TAMS (accelerator mass spectrometer technique of radiocarbon dating). Metric units should be used and abbreviated throughout: mm, cm, m, km, ha, m^2, etc.

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