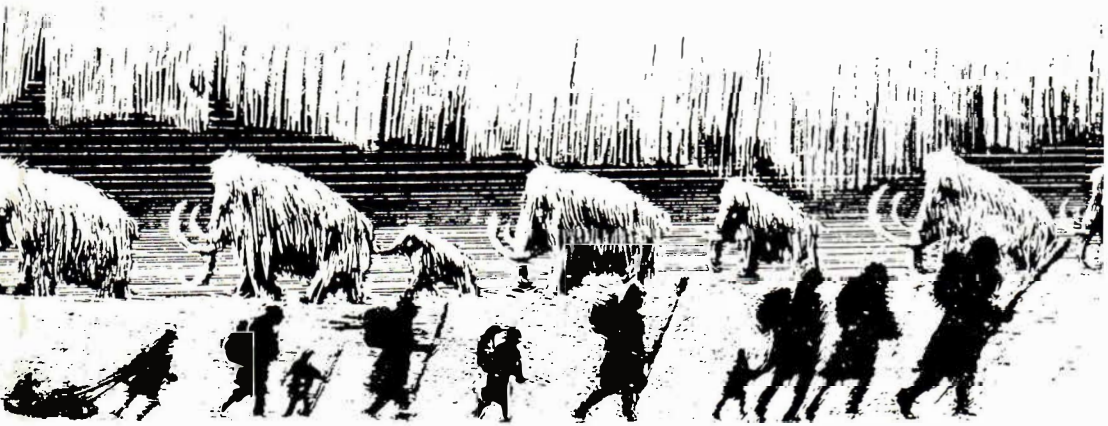
CURRENT RESEARCH IN THE PLEISTOCENE

Volume 4 1987



A Peopling of the Americas Publication

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CURRENT RESEARCH IN THE PLEISTOCENE

Volume 4 1987

Editor
Jim I. Mead

Quaternary Studies Program
and
Department of Geology
Northern Arizona University
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A Peopling of the Americas Publication
Center for the Study of Early Man
University of Maine
Orono, Maine

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From the Editor

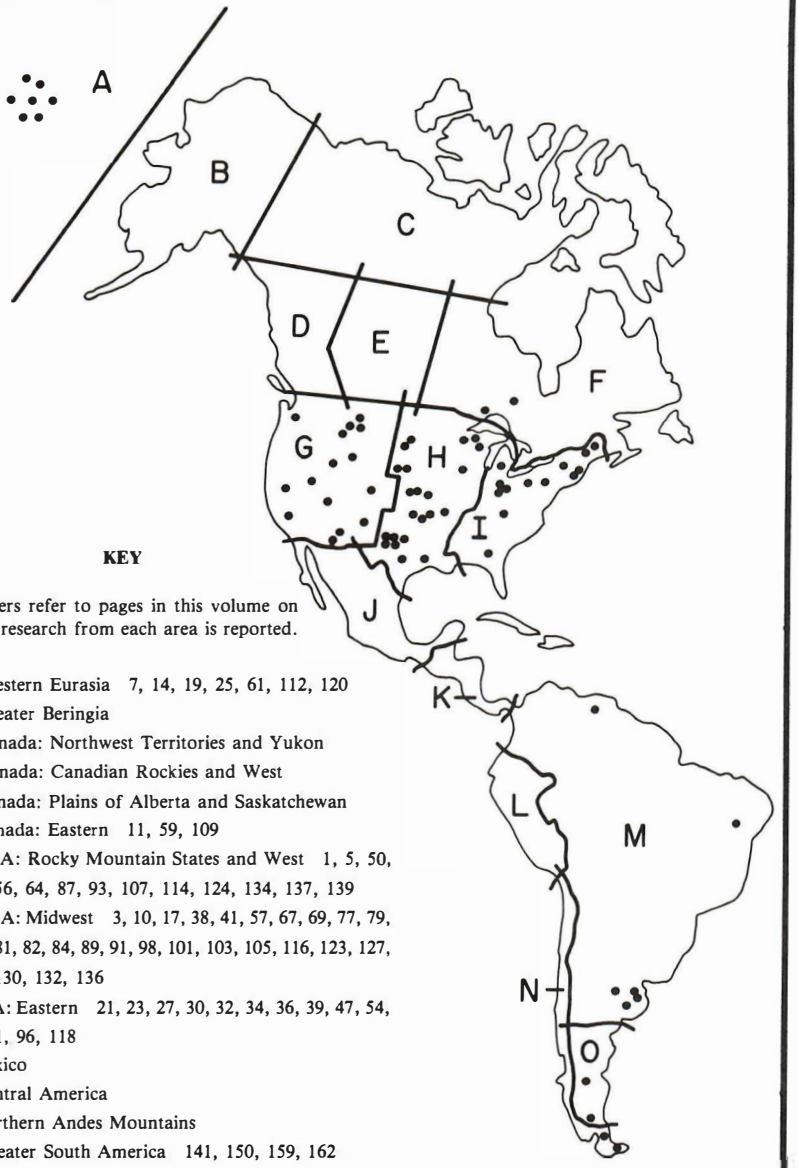
Study of the peopling of the Americas is fundamentally a Quaternary problem, global in scope and multidisciplinary in approach. No single researcher can reasonably master all the necessary disciplines encompassing Quaternary studies. Together specialists can approach such a problem from many directions. Thus, each must be kept abreast of advances made in related fields of research. Otherwise, important information may be lost, misinterpreted, or ignored between initial discovery and final analysis. The Center for the Study of Early Man, through its annual publication of **Current Research in the Pleistocene,** is a catalyst for the dissemination of new research information on the Quaternary and the peopling of the Western Hemisphere.

The purpose of **CRP** is to provide essential, up-to-the-minute information, ideas, and interpretations in one concise journal. In an age of increasing specialization, lengthy, detailed articles appear in a plethora of technical journals. Some small number of other journals do publish articles on the various Quaternary disciplines, but are often limited in what they can cover in a single volume. Every year **CRP** publishes as many high-quality, note-length papers as possible. This volume contains 71 timely reports from eight related subject areas that allow the reader to compare and synthesize information that may significantly affect their interpretations and upcoming research.

The editorial board continues to develop and define the scope of **CRP**. Last year we saw the introduction of a Special Focus section of invited papers on a particular geographic area. This year we have expanded our coverage to a "Holarctic" framework that acknowledges the global scope of the questions we ask and answers we seek about the peopling of the Americas.

I invite you to join us in the fast-paced, far-ranging dialogue we have established through **CRP**.

Regional Index



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Archaeology

Pleistocene Peoples of Southwestern Montana

Robson Bonnichsen, John Taylor and Mort D. Turner

In our search for new evidence bearing on the general problem of the peopling of the Americas, we have selected the upper Missouri River drainage system as our region to study. Aside from the raw beauty of this rugged mountain valley country, the geologic and physiographic history of this region is well situated for the preservation and exposure of late Pleistocene and early Holocene environmental and archaeological remains. The upper Missouri drainage occurs south of the southern most limit of the Wisconsin-age glacial margin and immediately east of where the most intense mountain glaciation occurred. The combination of fluctuating climatic cycles during the Pleistocene and tectonic uplift of the Rocky Mountains from at least Tertiary times until the present has resulted in a rich geomorphological record. The occurrence of alluvial and aeolian sedimentological records, limestone caves and rockshelters, deposits of chert and quartzite, and a diverse ecology are among the factors that have led us to the conclusion that southwestern Montana has excellent research potential for reconstructing the history of human adaptation to past environments.

The purpose of this brief report is to summarize the most important archaeological discoveries made during the 1985 and 1986 field seasons by University of Maine and U.S. Bureau of Land Management survey and testing team (Bonnichsen et al. 1986). Nineteen localities were located and evaluated for their potential to yield complex records suitable for reconstructing physical, biotic, and cultural history of local to aerial environments (Figure 1).

Spire Rock Spring and Pipestone Flats were tested during the 1985 season and South Everson Creek was tested during the 1986 field season. Erosion in the channel above Spire Rock Spring exposed a large bison skull and a small bone bed. Excavation of channel fill deposits covering the bone bed revealed the butchered remains of a single very large bison, charcoal, and a single stone flake. Osteometric comparisons between the Spire Rock Spring bison skull and metacarpal and modern and fossil bison

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suggest that the Spire Rock specimen most closely resembles a male *Bison antiquus occidentalis* and falls at the outer size limit of modern bison (*B. bison*). The charcoal sample from beneath the bison bone dated 410 ± 70 yr B.P., Beta-15713 and collagen from a complete cervical vertebra is modern (Beta-16705). The large and swept-back angle of the horn cores of the skull does not resemble modern bison. At present we lack a good explanation as to why the radiocarbon record and the osteometric data are not in agreement.

The Pipestone Flats site is a quarry site and occurs on alluvial fan surfaces on the north side of Pipestone Creek (Figure 1). The extensive Boulder Batholith lies immediately west of the site area. A related (?) surface volcanic body dating to the early Tertiary was apparently the source of glassy basalt cobbles incorporated into the alluvial fans. It was these cobbles that attracted native Americans in search of toolmaking materials. Surface artifacts are dominated by flakes, flake tools, and macroblades that have been modified by extensive weathering. A study of basalt weathering rates now in progress promises to provide a chronological framework for determining the relative age of artifacts from this site.

The largest site visited is known as the South Everson Creek Quarry (Figure 1). Subsurface chalcedony was mined from pit mines of various sizes at South Everson and Black Canyon and then processed into tools at nearby workshop sites (Turner et al. this volume). Preliminary geologic mapping along the flanks of South Everson

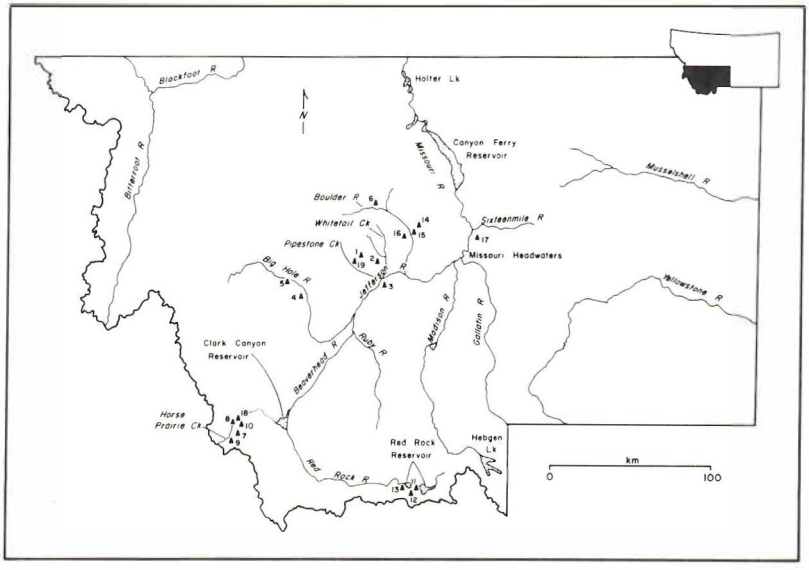

Figure 1. Location of sites visited during the extensive survey and testing program: 1) Spire Rock Spring, 2) Pipestone Flats, 3) Point of Rock Caves, 4) Madon Rock, 5) Big Hole Rockshelter, 6) Mount Hagen, 7) Section Corner, 8) South Everson Creek, 9) Bannock Pass, 10), Horse Creek Prairie, 11) Mud Lake, 12) Lima Reservoir No. 1, 13) Lima Reservoir No. 2, 14) Nowhere Spring, 15) Rattle Snake Spring, 16) John's Last Site, 17) Lombard, 18) Lower Everson Creek, and 19) Quartz.

led to the recognition of 16 terraces; most of these have workshop sites on their surfaces. Some of the surface artifacts from the upper terraces appear typologically old and include macroblade, Levaillois, and retouched flake-tool industries. Many of these specimens are deeply weathered and ventifacted. Our 1986 testing program focused on the recovery of archaeological samples from terraces of different ages. Excavation of a workshop site on the lowest terrace (t1) exposed what is probably Glacial Peak volcanic ash (11,200 yr B.P.). Upstream on the same terrace two pieces of flaked mammoth bone were found eroding out of a lithic workshop area. This locality has since been named the Mammoth Meadow Loci. Archaeological field work during 1987 will focus on the excavation of this loci, and on determining ages of mines and workshops on the upper terraces.

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Early Occupations at Berger Bluff, Goliad County, Texas

Kenneth M. Brown

Berger Bluff (41GD30) is an 8.7 m high sandy bluff on the Goliad County side of Coleto Creek, near Victoria on the Texas gulf coastal plain. The entire bluff (now drowned by Coleto Creek Reservoir) apparently contains stratified archaeological deposits, although the middle 4.5 m have never been sampled. The lower 2.25 m of deposits are cyclically bedded Coleto Creek floodplain deposits, believed to be late Pleistocene, apparently cemented by calcium carbonate-laden groundwater from a nearby spring (though no actual spring conduit was located). Spring discharge was apparently activated some time in the Pleistocene when a nearby ravine was incised into Goliad Formation bedrock (a local, calcareous aquifer capped and perhaps partially confined by Lissie Formation deposits). Localized cementation produced a resistant ledge when the Coleto Creek, sometime after the late Prehistoric (1,200–1,600, yr B.P.), incised its earlier Holocene deposits and eventually began penetrating Pleistocene deposits. Neither erosional contacts nor obvious paleosols are evident in the stratigraphic section, implying continuous aggradation until the recent incisive episode. Cyclic bedding of the lower deposits probably implies some kind of alternation in regional climate; the massiveness and lack of cementation in the Holocene deposits implies a near-simultaneous change in depositional style and interruption of spring discharge at the end of the Pleistocene.

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Excavations in the lower deposits (1979–80) and analyses by the University of Texas at San Antonio yielded three radiocarbon dates on wood charcoal (taxon unknown): 11,550 ± 800 yr B.P., Tx-3569, from a small hearth, Feature 5; 10,190 ± 160 yr B.P., Beta-16979, accelerator mass spectometer date; and 7,770 ± 810 yr B.P., Tx-4095. The latter date, a composite of three subsamples, seems anomalously recent. All five samples span only 31 cm in elevation and should give indistinguishable dates at this level of resolution. Cultural debris in this part of the site is sparse, consisting mostly of chipping debris, cores, a few introduced pebbles, and a small triangular biface reject. No diagnostic Paleoindian artifacts or extinct fauna were recovered, but three species of snails now extirpated in south Texas were found, including *Valvata tricarinata,* an aquatic snail now ranging from Oklahoma and Nebraska north to Canada (snails extracted by flotation were identified by Raymond Neck, Texas Parks and Wildlife Department). The species tolerates variant habitats and substrates but prefers deep water, cool to cold; in Nebraska, living in spring water at 15°C in July). *Pomatiopsis lapidaria,* another aquatic snail, prefers marshes with grasses, sedges, and cattails, found in the eastern and southeastern U.S. and in the plains as far south as Kansas. *Gastrocopta armifera* is a land snail found in north Texas living in decaying logs and under leaf litter. Altogether over 30 taxa of snails were identified in the lower deposits. Factor analysis of these suggests the springside habitat was moist, cool, well-shaded by a heavy tree canopy, usually with heavy vegetation and leaf litter.

The most significant discovery is perhaps the remarkable deposit of microfauna next to the small hearth (Feature 5, actually an unprepared, fired surface) from which radiocarbon sample Tx-3569 was derived. The chief concentration was 35 cm in diameter and 4 cm thick, at the same level as the hearth, with its center about 85 cm south of the center of the hearth. Around this was a zone of lesser density, a meter or so in diameter, extending into the hearth, and probably into adjacent unexcavated units. A few of the 639 bones recovered (probably representing most but not all of the entire deposit) were charred. The deposit consists entirely of the remains (mostly broken up, but without gastric etching) of various small animals: eastern mole (*Scalopus aquatics*), frogs, gophers (*Geomys* sp.), salamanders, birds, pocket mouse (*Perognathus* cf. *hispidus*), fish, kangaroo rat (*Dipodomys* cf. *ordii*), least shrew (*Cryptotis parva*), rabbit (*Sylvilagus* sp.), woodrat (*Neotoma* sp.), field mouse (*Peromyscus* sp.), northern grasshopper mouse (*Onychomys leucogaster*), vole (*Microtus* sp.), snake, and lizard. The largest species represented are rabbit-sized. Only 120 bones were recovered elsewhere in the early deposits from several cubic meters of fill, including over a 1 m^3 washed through window screen. We can observe: 1) Extreme clustering of the hearth deposit leaves little doubt the fauna were concentrated in the digestive tract of a predator. 2) At least two distinct assemblages are represented: aquatic/riparian species probably collected in or around the creek and spring itself; and a sandy grassland assemblage featuring fossorial rodents, probably either from the Lissie terrace surface above the site, or possibly from sandy floodplain deposits along the creek. 3) No arboreal or hibernating mammals are present. Of the mammals, two behavioral groups can be discerned. One groups, active both day and night (usually living in burrows, sometimes in thickets or debris) would be vulnerable to all kinds of predators. A second is nocturnal and fossorial. Venturing out at night to forage, these would be vulnerable to owls, but not hawks, and especially to humans since they are confined to burrows during the day. The eastern mole is of interest, rarely venturing above ground and only occasionally taken by owls.

4) The list of prey embraces a wide range of animal adaptations: aquatic, aerial, terrestrial, and terrestrial-fossorial habits are represented, indicating the Berger Bluff predator was capable of forager successfully in a diverse range of habitats. 5) The vertebrate fauna appears essentially Holocene, although considering the degree of breakage, the unidentified or taxonomically ambiguous bone might conceal extinct species.

The degree of concentration of this deposit suggests it represents fecal remains. The diversity of behavioral adaptations and source areas for the prey species, the extensive breakage (indicating mastication of the bones), the proximity to the hearth and partial charring of some of the bones all seem to indicate the predator was human. This deposit may well represent decomposed human coprolites, signalling a very early broad-spectrum foraging pattern seen at Baker Cave and Horn Rockshelter (Texas), at Medicine Lodge Creek (Wyoming), and perhaps at Shawnee Minisink (Pennsylvania). Similar prey were often captured by task groups of women and children in ethnographically known societies. Arguments in support of these conclusions will be more fully developed in the final report now in preparation.

Spring Cleanup at a Folsom Campsite in the Northern Rockies

Leslie B. Davis, Sally T. Greiser and T. Weber Greiser

Along Indian Creek in the Elkhorn Mountains of west-central Montana, at least two excavation loci contain remnant Paleoindian occupations (Davis et al. 1985). Excavations at the Indian Creek site (24BW626) Downstream locality have documented the natural history and associated human occupation from 11,000 years ago to the present. The earliest, and the only Paleoindian occupation at this locality attributable to a particular technocomplex, is Folsom (1985 OL 18 = 1986 Layer 1) which dated at 10,980 ± 110 yr B.P.

During preparation of the Upstream locality stratigraphic section in 1984–1985, several features were investigated through cutbank prospection due to unmanageable, hazardous overburden (7.6 m geological deposit of valley floor alluvium plus 4 m of overburden). The lowermost feature (the subject of this report) is attributed to the Folsom technocomplex, radiocarbon dated at 10,630 ± 280 yr B.P., Beta-13666 (small sample). Recovered in situ stratigraphically above the Folsom feature were Agate Basin and Hell Gap projectile points (Davis 1986), with Hell Gap component radiocarbon dates of 10,010 ± 110 yr B.P. and 9,860 ± 70 yr B.P.

The Folsom occupation at Indian Creek was marked at the upstream locus by a thin, but dense cultural deposit that comprised a secondary refuse discard feature. This deposit had been truncated by a mechanical dredge that cut through the undisturbed culture-bearing alluvium at that locus in summer 1982. That partial feature

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was trowel excavated to reveal two small, flat stones overlying the debris pile, the whole occupying 2 m^2 of the northfacing cutbank of Indian Creek.

This unusual concentration of debris was extremely informative. Recovered were 9,023 mammal bones and dentitions, whole and fragmentary (86% burned/calcined). Represented are a single bison (*Bison* sp.), a medium-sized artiodactyl (*Odocoileus/Antilocapra*), two yellowbellied marmots (*Marmota flaviventris*), one large rabbit/hare (*Lepus* sp.), two blacktailed prairie dogs (*Cynomys ludovicianus*), and two voles (*Microtus* sp.). On the basis of the young prairie dogs, a spring occupation was indicated. Two apparent bison rib tools with heavy abrasion and high polish on one end were present in the faunal assemblage. Whereas a majority of the bone fragments had green breaks, only one fragment had cut marks from butchering.

Lithic artifacts from this sample included 8 tools and approximately 2,400 flakes. At least 13 distinct lithologies were distinguished, including various cherts, predominantly chert from the Madison Formation which outcrops at known localities in the general vicinity; chalcedony; basalt; and obsidian. Some 72% of the lithic material was Madison Formation in origin. The only other material present in any quantity is an opaque moss "agate."

This feature is attributed to the Folsom technocomplex on the basis of a basal fragment of a Folsom point and nine channel flake fragments of the same material. The debitage attests to highly developed flintknapping skills since the flakes are thin and consistent in size, shape, and thickness over the various categories of biface reduction flakes. Prepared platforms indicated the use of soft hammer billets, at least for the removal of flakes larger than 1–2 cm in length.

A second projectile point from the feature is aberrant; it appears to have been reworked from several angles and thus is significantly smaller than most Folsom points, and technologically it is undiagnostic of any particular point type. This specimen was made from Madison chert. Another undiagnostic biface fragment is from the same chert as the Folsom point fragment and the channel flakes; this fragment may be from a Folsom blank.

Three end scrapers, one side scraper, and one unifacially-modified, proximal flake fragment which appeared to be part of a side scraper were present. All but the fragmentary scraper were of Madison chert, whereas the fragment was made from a dark greenish-brown, opaque, homogenous chert.

The abundance and density of discarded artifacts and faunal remains from this feature are striking for their diversity. The number and variety of small-game species in a single Folsom refuse feature departs significantly from the content of Folsom lithic and faunal assemblages from Great Plains sites (Greiser 1985). Only further detailed investigations at the Indian Creek site can explain this apparent difference.

We acknowledge sponsorship of the Indian Creek site investigations by Joseph and Ruth Cramer (Denver) and the National Science Foundation (BNS-8508068).

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Paleolithic Subsistence Strategies in North China

Chuan-Kun Ho and Zhuang-Wei Li

Since 1949 several hundred Paleolithic localities have been found in northern China, which consists of the provinces north of the Yellow River. More than 10 of them have been systematically excavated on a large scale. The abundant materials from these excavations are the evidence that is used in this paper to study the subsistence strategies of fossil man in northern China.

Lithic artifacts are the main evidence of the means of subsistence of primitive man. The occurrence of the same types of tools might indicate that the same mode of production and lifestyle existed. Under the same natural conditions and ecological environments, people could adopt the same lifestyle and produce similar types of tools.

There are two Paleolithic traditions in northern China—one with large choppers made on flakes and large triangular pointed tools, and one with small, boat-shaped scrapers and burins. The basic features of the large-tool tradition are varied types of choppers made on large flakes, large pointed tools, handaxes, and the artifact that most typifies this tradition, the triangular pointed tool. There is also a small proportion of smaller tools in these lithic assemblages, but there are only a few types of small tools. Representative sites of this tradition include Xihoudu, Kehe, and Fenchenshan in Shanxi Province; Gongwangling and Laochihe in Shaanxi; Sanmenxia in Henan; Xiachun in Fuyihe; Gujiao in Taiyuan; and Emoukou in Haijen Province.

The main characteristic of the small-tool tradition is the fact that most of the small tools are made from irregular flakes. Although there are large-tool components within this system, they occur in small proportion. Small tools are the most predominant ones. Lithic type diversity increases during the late Paleolithic period, secondary retouch becomes more complicated, and flake scars are smaller. Representative tools are boat-shaped scrapers and burins. The sites that belong to this system include Locality I of the Beijing Man site in Hebei; Shiyu in Shanxi; Xujiayao, Xiachun, Qingziyao, Hougadafeng, Xiqianfeng, Xiaochangliang in Hebei; Donggutuo, Hutouliang, Salawusu in Inner Mongolia; Shuidonggou, Ningxia, and Dali in Shaanxi; and Xiaonanhai in Henan. The overall spatial distribution of this tradition is wide, but most sites are densely clustered, particularly in the area of the Sanggan River.

During the process of their evolution, these two traditions must have influenced each other while evolving their own economic modes. The two different cultural traditions gradually formed their own modes of production and lifestyles. This can be shown in terms of lithic and faunal assemblages.

The large-tool tradition is geographically widespread but is mainly clustered in the middle Yellow River, Fen River, and Wei River areas of Shanxi, Shaanxi, and the southwestern portion of Henan Province (33°-38° 30′ N, 103°-114° E). Most lithic artifacts found here are large, including choppers, scrapers, and large triangular points. At one early Paleolithic site near Laochi He, a triangular point that is 18.6 × 12.3 × 8.3 cm and weighs 1,902 g has been found, while a side chopper found at a late Paleolithic site in Gujiao, Taiyuan, has an edge 130 mm long and weighs 2,600 g. This heavy tool was evidently used for digging and chopping, as evidenced by the manufacturing

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technique and use wear. Most axes, adzes, and hoes of Neolithic agricultural tribes have evolved from artifacts made within a large-tool tradition. Protoaxes, adzes, and stone sickles have been found at the early Neolithic lithic workshop at Emoukou, Shanxi.

Fossil bones recovered from sites of the large-tool tradition indicate that the paleo-environmental settings were warm and humid. There was more precipitation and the climate was more temperate than today. The faunal species are predominantly from the forest and forest-grassland zones, although the assemblage from Gongwanglian in Lantien Province reflect the character of fauna from subtropical southern China. At the Dingcun site, dated to 90,000 yr B.P., 28 mammalian species have been recovered from the middle and lower levels. Most of the species characterize forest and mountain regions. Species adapted to shrub, grassland, lacustrine, and peat-bog environments include the proboscidians *Palaeloxodon* cf. *tokunagai, Elaphus* cf. *nomadicus,* and *Elaphus* cf. *indicus. Bubalus* sp. (Unionidae) is presently distributed only south of Qinling, Hanshui, and the middle and lower Yangze River areas. This could indicate that Dingcun man lived in both warm, humid south and north of this subtropic environment. Under such environmental settings, people of the large-tool tradition adopted a gathering and hunting mode of economy that gradually developed into a mainly gathering economic lifeway and finally into agriculture.

The lower levels at the Beijing Man site have more large, crude tools that basically belong to the large-tool tradition. Numerous hackberry seeds were found in the lower deposits; most of the shells are broken and the nuts are gone. Bird and rodent bones were found in the same deposit, which indicates that Beijing Man may have adopted a lifeway that included gathering and hunting small animals during the early time period.

The large-tool tradition is widely distributed geographically. Sites from this system that predate the middle Pleistocene have not been found above 39° N in Shanxi, because this area is within the southern cold temperate climatic zone. The weather was cold, there was less rainfall, it was extremely dry, and the winter was long (6.5 months). Because these conditions are not favorable for a gathering economy, no sites representing the large-tool tradition have been found.

Sites of the large-tool tradition are located roughly on the present-day Central Plain. This area is quite warm, has plenty of precipitation, and is regarded as the best agricultural area in North China. Tracing the long history of agriculture, we find that its evolution may be related to the large-tool tradition. The gathering economy of the large-tool tradition evolved into primitive agriculture of the Neolithic period, and finally into modern agriculture.

The spatial distribution of the small-tool tradition is less compact than that of the large-tool system, but it still covers a long and narrow geographic zone (88° 33′-128° E, 35°-46° N), including Xinjiang, Ganshu, Shaanxi, Shanxi, Hebei, Liaoning, and Heilongjiang. The lithic artifacts of this system are comparatively well-made and small. The most representative tool types are the boat-shaped scrapers, burins, and small pointed tools or dart points.

The upper levels of the Beijing Man site exhibit evidence of the small-tool tradition. Scrapers are the most predominant tools in the assemblage. They are generally small (average 4 cm in length). The smallest is $2.1 \times 0.9 \times 0.4$ cm and weights 1 g. At two late Paleolithic sites, Sarawusu and Shuidonggou, even smaller scrapers have been found—each weighing less than 0.25 g. Such tools were apparently not used

as part of the gathering economy. The projectile points of late Paleolithic sites (e.g., Shiyu and Hutouliang) and the single-shouldered and concave-based pointed tools could be regarded as the prototypes of the arrowhead. The faunal assemblage in the Shiyu site included 130 wild horses (*Equus przewalskyi*) and 90 wild asses (*Equus hemionus*). The people who lived at this site could be dubbed "horse hunters." More than 300 antelope horns and 150 small antelope have been found at Sarawusu; thus, these people are dubbed "sheep hunters." Lithic tools of the small-tool tradition are more or less related to the strategy of hunting grassland species.

The faunal assemblages of sites from the small-tool system indicate that the ecological settings were cold and dry. The fauna are basically characterized by grassland species. For example, Xujiayao, which has been dated to 100,000 yr B.P., contained one species of ostrich and 19 mammalian species. The rest of the fauna are cold-adapted species: wild horse, rhinoceros (*Coelodonta antiquitatis*), large-antlered deer (*Megaloceros ordosianus*), red deer (*Cervus elaphus*), and bison (*Bos primigenius*). All of these species were common in the Terminal glacial period. Pollen data shows that the paleoclimate was glacial. It has been estimated that there are at least 213 horses in the assemblage based on the occurrence of 4,300 cheek teeth. This indicates that Xujiayao man could be termed "horse hunter," and that the subsistence strategy predominantly consisted of hunting grassland species.

The spatial distribution of the small-tool tradition is mainly in northwestern, northern, and northeastern China. This region has cold and dry climatic settings and mainly grassland and desert-grassland environmental settings today. Such zones are suitable for pastoral activities and hunting. These subsistence modes can be traced back to the Neolithic.

In summary, there were two different cultural traditions in the northern half of China during the Paleolithic. The evolution of these cultural systems has something to do with the natural environment and the ecosystem. This author believes that we can first differentiate between these two traditions at the end of the early Paleolithic. We can see this evidence in the deposits at Beijing Man site. Lithic tools below Level 6 are large and crude; above this level, tools become smaller and slightly more finely made. These changes may be related to the ecosystem. Above Level 6, both faunal and lithic analyses indicate that a temperate, semi-dry climate replaced a warm, humid climate, and dry-loving species of grassland fauna replaced aquatic forest species. The ecosystematic shift caused the change of production tools and lifestyle from a gathering mode of subsistence to a hunting-dominated mode of subsistence. According to paleomagnetic dating, Level 6 is dated to 370,000 yr B.P. Thus, we can be assured that the transformation of the large-tool tradition into the small-tool tradition occurred after 370,000 yr B.P. The case of the Beijing Man site indicates that the small-tool tradition was formed after the early Paleolithic.

Folsom Components at the Winters and Beckner Sites, Southwestern Oklahoma

Jack L. Hofman and Don G. Wyckoff

At least ten sites and localities in Oklahoma have yielded multiple Folsom points and may have discrete Folsom occupation sites or kill/butchery stations (Hofman, 1986). Two of these are the Winters and Beckner sites in Jackson County in extreme southwestern Oklahoma. Because so little has been published on Folsom occupations in Oklahoma, information pertaining to these locations is summarized here.

The Winters site (34Jk22) is located near the western end of the Wichita Mountains by the North Fork of Red River on a high Quaternary sandy terrace covered with shinnery oak and mixed grasses. Winters is within the Western Sand Dune Belts physiographic province that is adjacent to the Granite Mountain Region and encircled by the Central Redbed Plains (Curtis and Ham 1972). The site has been documented by reports on bifacial preform caches of Edwards chert (LeVick 1975; Wyckoff 1984). Occupations of the site extended from Paleoindian through the Protohistoric period. A discrete stratum of Folsom age has not been identified, but several Folsom point fragments, broken preforms, and a channel flake are surface finds from a limited area of the site. Other distinctive artifacts include about 25 delicate gravers made on flakes, unifacial tools, and numerous endscrapers, some of which are spurred. Most (N = 5) of the Folsom point and preform pieces from Winters are made of Edwards chert, although two are made of Alibates. Examples of Folsom artifacts from Winters are illustrated in Figure 1 (a through d).

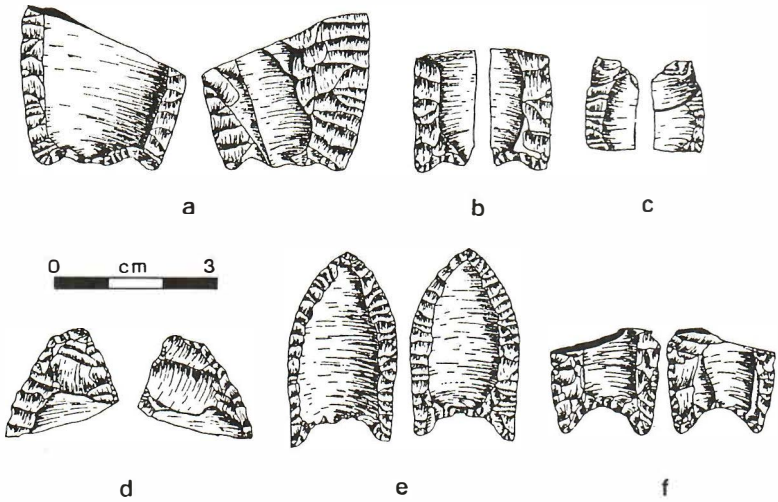

Figure 1. Selected Folsom points from the Winters and Beckner sites: a-d Winters site basal fragments, midsection and tip; e-f Beckner site point and base. Two sides of each specimen are shown.

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Limited testing was conducted by the Oklahoma Archaeological Survey at Winters in 1973 and included the excavation of two 1.5 × 1.5 m (5 × 5 foot) units removed in 7.5 cm (3 inch) levels. No diagnostic Paleoindian pieces were recovered during the excavation of these test units. Approximately 0.4 km (0.25 mile) north of the Folsom site area is a deposit where fossil remains of bison and turtle have been collected, but the age of these materials is unknown. Further study of this deposit is planned in hopes of gaining paleoenvironmental information relevant to the early occupation of the site area.

The Beckner site (34Jk6) is located on a high Quaternary terrace of the Salt Fork Red River in a setting which offers a good view of the Wichita Mountains to the northeast and of the Creta Hills to the southwest. Some of the site area is covered by eolian sand, but a deep gully has cut through the Pleistocene sediments into the underlying Permian clays and sandstone. One complete Foslom point, made of Niobrara jasper, was collected in an eroded area near this deep gully and a Folsom base (made from Edwards chert) was collected from a nearby high point on the terrace. A variety of more recent prehistoric materials have been collected from the site, but several scrapers and unifacial tools may belong with the Folsom component. 34Jk6 is located in the Mangum Gypsum Hills geomorphic province (Curtis and Ham 1972). Folsom points from 34Jk6 are shown in Figure 1 (e and f).

Future research with these collections and near these sites should substantially add to our information about Folsom period environments and activities in this region of the southern Plains.

Special thanks are extended to Elmer Craft and Lawrence and Gene LeVick without whose help the information provided in this paper would have been available.

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Early Paleoindian Occupation in Interior Southcentral Ontario

Lawrence J. Jackson and Heather McKillop

Comprehensive survey of the southern Rice Lake region of southcentral Ontario since 1984 has revealed the existence of early Paleoindian sites in interior locations not aligned with proglacial Great Lake strandlines. This research, supported by Social

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Sciences and Humanities Research Council of Canada grants 410-84-0104 and 85-0337, departs from highly successful surveys of the proglacial Lake Algonquin strandline and draws attention to our limited understanding of overall patterns of the late glacial land use.

Directly south of and parallel to the axis of the western Rice Lake basin is Plainville Valley, a small stream valley freed of glacial ice with retreat of the Simcoe-Kawartha lobe about 11,500 yr B.P. This valley and bordering uplands is now known to contain the easternmost settlement manifestations of the Paleoindian period in Ontario. Identified sites include an activity area complex adjacent to swampland on the valley floor, a kill site beside a freshwater spring near the valley head, hunting loss sites on a high drainage divide overlooking the valley, as well as on local features set back from valley floor kill areas, and an activity area on a plateau between Rice Lake and Plainville Valley (Figure 1).

Intensive survey resulted in coverage of roughly 60% of the arable land within a 100 km² area centered on the stream valley and extending about 16 km east-west and 6 km north-south. The configuration of sites found clearly denotes a variety of activities in an interior non-strandline situation. Recurrent combinations of physiographic associations included proximity to a water source—itself usually associated with cervid (deer family) feeding and traverse areas, enhanced field of vision, use of distinct but contained local physiographic features such as raised knolls, ledges, or ridges suited to camping, shelter, and access to other basic resources—with placement for

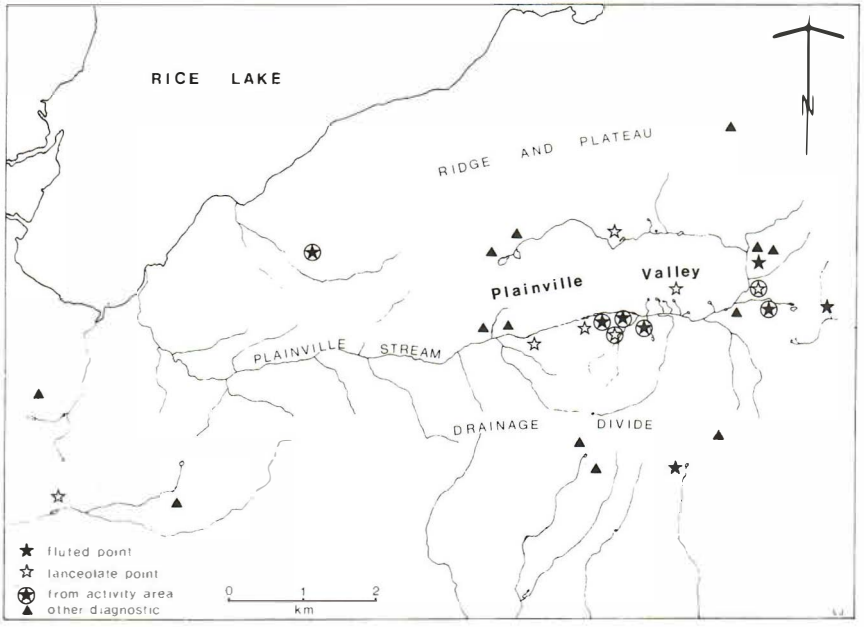

Figure 1. Distribution of early and late Paleoindian material in comprehensively surveyed Plainville Valley and adjacent uplands, southern Rice Lake region, Ontario.

prey entrapment a secondary consideration, slight to moderately inclined slopes, and fine-textured, well drained soils usually in direct proximity to mucklands.

Systematic tabulation of locational attributes supports Judge's (1973) analysis of Paleoindian site disposition in the Rio Grande valley of New Mexico where primary considerations were proximity to water source, overview, and hunting area contiguity. A "playa-ridge-drainage" settlement pattern obtained with sites typically on ridges near playas and often adjacent to a grazing area and major drainage. Wendorf and Hester (1962) note that Paleoindian sites of the Llano-Estacado, Texas to New Mexico, tend to occur on dunes, ridges, or hills overlooking stream channels or ponds.

Similarly, shallow meltwater pondings in Plainville Valley were well suited to feeding habits of migratory cervids such as caribou (*Rangifer*) and also attracted resident populations of deer (*Odocoileus*) and elk (*Cervus*) (Banfield 1974; Curran and Dincauze 1977; Kelsall 1968; Trail 1929). Recovery of some 120 projectile points of Paleoindian through Archaic periods, and the absence of ceramic at identified sites, strongly supports a primary hunting orientation. Both projectile points and end scrapers, the second most frequent artifact type recovered, were distinctly aligned with existing or relict water sources. Known point types from the survey region include earliest Gainey and Barnes points of the early Paleoindian period, distinctive Hell-Gap, Hi-Lo, and possibly Holcombe late Paleoindian types, small stemmed and notched early Archaic points, and a variety of late Archaic types. Continuous use of specific landforms by successive cultures supports resource continuity over the Pleistocene/Holocene transition.

The Plainville Valley sites show a strong tendency towards water source proximity, usually within 100 m, and a secondary orientation to water courses, most now either abandoned or seasonal. All situations in which Paleoindian material was found embodied dunes, knolls, ledges, or ridges with an enhanced view of local terrain. Two to five meter elevation above and 180° through 360° view of surrounding low terrain was most common. An isolated site on a drainage divide was 50 m above the valley floor with a panoramic view through 360° and visibility to 10 km. Locally, it was on a moderately inclined ridge-slope 5 m above a seasonal pond. An activity area with a distinctive end scraper assemblage was on a small knoll of the plateau between Rice Lake and Plainville Valley, 20 m above the nearest water course with a 360° view and within 250 m of a fresh water spring.

A small complex of fluted point sites along the Lake Algonquin strandline near Udora, 100 km to the west in southcentral Ontario, shows a similar physiographic orientation to the Plainville Valley sites (Jackson 1984). Paleoindian hunting site disposition may have utilized terrain configurations fortuitously presented by both proglacial strandlines and interior valleys. Both areas are, in fact, linked by the occurrence of identical tool types and use of the distinctive Collingwood (Fossil Hill Formation) chert source.

Implications of our work in the southern Rice Lake region bear mainly on preconceptions of site distribution and function arising from more than a decade of research on Ontario proglacial strandlines. Site disposition is clearly based on a geographically comprehensive, subsistence strategy which often included strandlines but was by no means restricted to them. A diversity of physiographic situations satisfied complex site settlement functions. The probability that hunting strategies were devised around dominant features of late glacial topography may help account for common locational attributes while divergences may reflect local peculiarities of terrain and

prey species interaction. Effective hunting groups must have been aware of topographic influences on prey and would have used this knowledge in locational decisions; recognition of hunting areas with channelling, water crossing, and vantage features being as necessary to survival as a good campsite (Gordon 1981).

Understanding the nature of topographic effects on human groups and their prey may prove critical to revealing the patterning of Paleoindian life. Continuing investigations in the southern Rice Lake region will attempt to clarify predator/prey relationships in an interior late glacial context which may have broad application to the glaciated Northeast.

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Living Environment of Late Paleolithic Man in Northeast China

Jiang Peng

The purpose of this paper is to have a tentative discussion of the living environment of late Paleolithic humans in the northeastern part of China by using comprehensive materials of cultural remains, fossils of *Homo sapiens,* ^{14}C dating, and analysis of pollen.

At present, there are 17 sites where human fossils and cultural remains have been found in this area. There sites can be divided into four categories; five of the sites belong to the first category in which human fossils, stone tools, and mammal fossils are found. The second, six sites contain stone tools and other cultural remains. The third category contains two sites where only human fossils are found. Four sites in the fourth category contain only stone tools.

In the above mentioned sites are some human fossils and abundant cultural remains among which there are tens of thousands of stone tools, along with some bone tools and ornaments. The study of these human fossils and cultural remains enables us to have a certain understanding of the primitive humans in northeastern part of

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China and allows the culture to be reconstructed. In what kind of condition did the primitive human create his culture? This problem will be discussed as follows.

Northeast China is located in the highest latitudes in the country. This geographical location has decisive influence on the fauna, flora, and climate. In winter during the late Paleolithic, the ground of this area was covered with ice and snow, underneath which was a thick permafrost horizon, some traces of which exist even today. These conditions not only restricted the growth and existence of the fauna and flora but also affected the variety and quantity.

Analyzing the remains of the fauna, flora, and climate, it can be said preliminarily that late Paleolithic humans in northeast China lived in a periglacial environment. The main testimonies are as follows:

1) Long periods of frozen ground are formed under conditions of a periglacial climate. This period in the northeast part of China occurs in the permafrost horizon along the northern part of Eurasia. Looking at the permafrost area in China, we find all the Paleolithic sites of northeast China are inside this region.

Periglacial traces are found in the late Paleolithic sites of northeast China and their contiguous stratum: such as ice wedges in Guxiang Village (Harbin) and in Dajiagou (Dehui), frost cracks in Pingtai (Baicheng), and involutions in Shashichang (Baicheng). From the relation of the strata and dating, the period of the glacial traces is set at around 30,000 yr B.P. 30,000 years ago China was in the middle and late Paleolithic period, and it was a time when the glacial stage was at its coldest.

2) There are 53 kinds of mammal fossils excavated from the late Paleolithic sites of northeast China; they belong to *Mammuthus-Coelodonta* Fauna (mammoth-rhinoceros), except for those excavated from the accumulation in caves. Besides the mentioned late Paleolithic sites, there are over 200 places where fossils are found in northeast China. The ^{14}C dating of the fossil of *Mammuthus primigenius* (woolly mammoth) indicates that the animal lived 10,000–40,000 years ago. The distribution of *Coelodonta antiquitatis* (woolly rhinoceros), which lived at the same time, was south to that of *Mammuthus primigenius,* the southern point nearing to 32°N lat. This indicates *Coelondonta antiquitatis* had stronger adaptability than *Mammuthus primigenius.* The distribution of *Mammuthus-Coelodonta* Fauna and their living environment indicate that they were animals fond of cold climate. Therefore, these animals can be considered a periglacial fauna. From the variety and quantity of the fossils excavated from the sites, we may conclude that big mammals of the periglacial fauna were the main prey of late Paleolithic humans.

3) From the analysis of pollen obtained from the strata of these late Paleolithic sites, we can see there have been several kinds of periglacial flora.

I) *Betula* (birch) and *Abies* (fir) were the predominant pollen types recovered. These trees now grow in higher places in the Changbai, Daxingan, and Xiaoxingan mountains. These conifers are the products of the glacial stage or the cold periglacial climate. *Pinus* (pine), *Betula,* and *Abies* pollen have been found in the late Paleolithic sites such as caves in Antu, Zhoujiayoufang Yushu, Guxiang Village (Harbin), and Huangshan.

II) The environment of the birch forest was like that of conifers but mixed with a grassland. Birch also belongs to the periglacial flora and is characteristic of the northeastern part of China.

III) Grasslands were dominated by Chenopodiaceae and Compositae. At present the species of the pollen have not been identified, but we know the vegetation represented a dry grassland of the cold and dry climate during the latest glacial stage.

In the following, I will discuss the above-mentioned periglacial vegetations in detail using pollen data recovered from Zhoujiayoufand, Yushu County, in the center of northeast China as an example.

Pollen from woody species makes up 74.8% of the total (of which *Betula* accounts for 65% and *Picea, Abies,* Cupressaceae, and *Ephedra* sp. account for the remaining percent). Herbaceous species make up 25% of the whole amount of pollen, of which *Artemisia* accounts for 28%; there is also Chenopodiaceae, Saxifragaceae, Ranunculaceae, and Rubiaceae represented. Of the pteridophytic pollen types, that of Polypodiaceae comes first in amount, then that of *Selaginella, Lycopodium* and *Botrychium* sp.

Within pollen sections, we have recovered the fossils of *Mammuthus primigenius, Coelodonta antiquitatis, Crocuta ultima* (hyaena), *Equus przewalskyi* (horse), and *Bison (Parabison) exiguus* (bison).

The reconstructed periglacial flora (pollen) and the fossils of *Mammuthus primigenus* and *Coelodonta antiguitatis* both imply that there was a cold periglacial climate during the late Paleolithic in northeastern China.

IV) In the site of Yanjiagang (Harbin) an ancient campsite ramparted with animal skeletons was discovered. This is the first find of this type in China. The campsite is the shape of a semi-circle with an opening to the southwest. The arc of the campsite is 5 m long with width of 40–60 cm. A great number of animal skeletons were erected into a semi-circle of a regular pattern. Six semiarticulated *Bison (Parabison) exiguus* skeletons were used in the construction. This articulation indicates that there had been at least tendons on the joints at the time of the construction. The simple campsite built of animal skeletons not only illustrates the level of hunting by humans at that time, but also helps us to better understand the function of ancient campsites.

In the vast plain of northeast China, during summer the climate is warm and grass and trees grow luxuriantly, and primitive man might have had no great difficulty in making a living, but in winter, human activities were greatly restricted.

V) The periglacial traces (animal fossils and pollen) provide a basis for research of the changes in the climate during the glacial age. In general, the climate was tending to become colder. The course of becoming cold was divided into two warm and three dry cold periods, based on the peak values of pollen. The temperature of the entire period was lower than today by 6°–14°C. Since northeast China has a vast area and occupies an especially enormous span from south to north, the change of temperature also became greater from south to north.

From what is mentioned above we can see the living environment of humans in the late Paleolithic was different from that of today. From the features of fauna, flora, periglacial traces and climate at that time, the living environment can be summarized as follows: under the conditions of periglacial climate, grass and trees withered and snows covered the ground in winter and in summer grass and trees grew luxuriantly. The grasslands with forest or with few trees not only formed good places for big animals like *Mammuthus primigenius, Equus przewalskyi,* and *Cervus xanthopygus* but also became places where primitive humans gathered and hunted. Human activities of production might have varied according to the difference of season. In summer the weather was warm and there was lush growth of grass and trees, and humans mainly went in for gathering. But in winter except for some conifers like *Picea* and *Abies,* grass and trees became withered and the ground was covered with snow and ice. Humans had shortage of food which could only be made up for by hunting. It was in such environment that our ancestry lived and worked.

Ryan's Site: A Plainview Occupation on the Southern High Plains of Texas

Eileen Johnson, Vance T. Holliday, Ronald W. Ralph, Ruthann Knudson, and Sonny Lupton

Ryan's site (41LU72) is located on the upland surface of the Southern High plains, near Shallowater, Texas, about 4.3 km southwest of southeasterly-trending Yellowstone Draw, an ephemeral tributary of the Brazos River. The site is about 16 km updraw from Lubbock Lake (Johnson and Holliday 1981).

Obvious topographic surficial geological or archaeological expression of Ryan's site are lacking. The site occurs between an agricultural field and a county road and is subject to wind deflation and gully erosion. In 1985, two lithic bifaces were found explosed in an erosional channel that cuts into the site. Two potholes (1 m^2 each) subsequently yielded in situ material. The site was recorded in 1986 by Johnson and Ralph who made several shovel tests and recorded a flake in situ.

Most archaeological sites on the uplands of the Southern High Plains are either surface scatters resting on the Pleistocene eolian cover of the region or are in late Quaternary dunes. Ryan's site is in neither situation. The artifacts are found in or at the top of a very dark brown (10YR 2.5/2, moist) apparently organic-rich, noncalcareous, silty clay with common carbonized plant remains. These sediments, overlain by a thin veneer of recent aeolian sand, are at least 1 m thick and cover an area less than 100 m^2. The clayey artifact-bearing sediments are very similar to late Quaternary deposits found in the ubiquitous playa-lake basins of the region (Holliday 1985a) as well as Paleoindian-age lacustrine sediments of Yellowhouse Draw at Lubbock Lake Landmark (Holliday 1985b). Ryan's site probably was a very small playa that existed in latest Pleistocene times, was present during the Plainview occupation of the area, but completely filled the lacustrine sediment by the early Holocene.

The material recovered in situ from the two potholes consists of nine points that appear stylistically and technologically similar to those from the Plainview site (Knudson 1983a), about 30 bifaces or blanks, several blades, and numerous used and waste flakes. Several of the points appear to have been made on flakes, with the flattened ventral surface not as extensively parallel-flaked as the dorsal surface. Several have small pressure chips or a break on the lateral edges at about 14 mm above the proximal corners, suggesting that this marks the top of a constricting shaft or foreshaft. The large bifaces/blanks primarily are ovoid with a thickness up to 2 cm. The size and thickness of the bifaces/blanks indicate a source of tabular material rather than the common source of Ogallala gravel (Holliday and Welty 1981). The technology is typical of that of the Plainview collection (Knudson 1983a) and the Lubbock Lake Paleoindian lithic tool collection. The material appears to exhibit the range of

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characteristics, including blades and perhaps bipolarity, termed Sudplano by Knudson (1983b). Most of the lithics appear to be of Edwards Formation chert although a few are from Tecovas jasper. The closest outcrop of the tabular Edwards Formation chert is about 260 km to the southeast. Tecovas jasper crops out about 130 km northeast of the site. Bone of any kind is lacking. The major activity represented in the lithic assemblage appears to be retooling.

Sites with in situ Plainview occupation are rare and such sites that are not focused on bison procurement are elusive. Based on the current limited evidence, Ryan's site appears to be an undisturbed, single-component campsite of Plainview occupation dating to about 10,000 yr B.P. based on the age of other Plainview occupations (Johnson and Holliday 1981). By its setting and nature, Ryan's site is quite different from Lubbock Lake but related to it by proximity and usage by people from the same cultural group. Lubbock Lake (Holliday 1985b) provides the regional cultural outline, natural history, and climatic overview for the Southern High Plains. Ryan's site, on the other hand, represents a type of site that is critical to providing the expanded data for a more in-depth regional view of any one particular cultural group. Ryan's site has the potential for providing additional data on the Plainview settlement pattern and landscape usage, Sudplano lithic technology and its role in Plainview economy (Knudson 1983a), and the relationship of that technology to Plainview bone technology (Johnson 1982).

Ryan's site was discovered by Sonny and Ryan Lupton and named for Ryan. We appreciate Ryan's continued interest in the site and his willingness to have it investigated professionally and to protect it. This investigation is part of the continuing research of the Lubbock Lake Project into the cultural and ecological changes on the Southern High Plains, and initial field work was funded through The Museum, Texas Tech University.

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Japan's "Early Paleolithic": Recent Pro and Con

Charles T. Keally

The existence of "early Paleolithic" humans (prior to 30,000 yr B.P.) in Japan is one of the most controversial questions in Japanese Pleistocene archaeology. Until recently, the most serious discussions of this question focused on the lithic materials excavated mostly by Chosuke Serizawa at Sozudai in Kyushu, western Japan, and at Hoshino, Iwajuku, and a few other sites in North Kanto in eastern Japan (Serizawa 1976, 1986; Ikawa-Smith 1978). Since 1980 the focus of the controversy has shifted to a group of sites in Miyagi prefecture on the Pacific coast of northeastern Japan. These new sites include six published reports: Zazaragi (Sekki Bunka Danwakai 1978, 1981, 1983), Nakamine C (Fujinuma et al. 1985), Babadan A (Tohoku Rekishi Shiryokan and Sekki Bunka Danwakai 1986), Kitamae (Sato and Saino 1982), Yamada Uenodai (Watabe and Shuhama 1981), and Shibiki (Kamata 1984). Additionally, there are two unpublished sites (Aobayama B and Nagakuki) and a number of surface finds (Tohoku Rekishi Shiryokan 1985). The only English texts from Miyagi are the resumes to the third Zazaragi report, the Nakamine C report, and the Babadan A report.

Serizawa's materials do not seem to have been widely accepted in Japan, although a thorough rebuttal has never been published. The Miyagi materials are gaining wider acceptance; they have been extensively published by their chief proponents Michio Okamura and Toshiaki Kamata, and by several other archaeologists. Nevertheless, a great many archaeologists and geologists dispute their dating or their human workmanship, or both (e.g., Oda and Keally 1986).

The Miyagi "early Paleolithic" is given dates from 30,000 yr B.P. to over 350,000 yr B.P. based on a number of fission-track and thermoluminescence measurements. There are three types of components: 1) those with mostly shale, hard shale, or tuff artifacts; 2) those with agate, chalcedony, and other fine-grained lithics; and 3) those with andesite or other coarse-grained lithics. The shale and tuff components all fall near the end of the "early Paleolithic" and have many similarities to components in the succeeding "late Paleolithic." The other two types of components are found throughout the "early Paleolithic" age range, but in no definite sequence. Sozudai is the only major component among Serizawa's materials that is usually compared to these older Miyagi materials. Okamura and Kamata (1980) indicate that Hoshino and Iwajuku bear no resemblance to the Miyagi materials, even though they parallel them in time. On the other hand, Okamura and Kamata (1980) say the Miyagi materials are rather similar to European and Chinese middle Paleolithic materials.

The arguments against the "early Paleolithic" materials including both Serizawa's finds and the new ones from Miyagi, are very much like the arguments against the pre-Clovis sites in the Americas (see Waters 1985). Specifically, Shizuo Oda and I recently studied all of the publications on the Miyagi "early Paleolithic" and concluded that those materials are highly dubious (Oda and Keally 1986). We feel that the shale and tuff components are human artifacts but that they are of "late Paleolithic" age and type. Some of the oldest of these components are quite similar to components in the oldest phases Ia and Ib in the Musashino late Paleolithic sequence in Tokyo (see Oda and Keally 1979). Further, we feel that the other two, older types

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of components are inadequately dated and very unlikely to be artifacts. Notably, there seem to be no conjoinable pieces in any of these two older types of components, and fine-screening of the "early Paleolithic" deposits in layer 20 at Babadan A failed to recover any flaking debris (Kamata pers. comm. 1986). These older components certainly do not "appear to have a relatively high integrity and sound dating" as claimed by Reynolds (1986). Additionally, the age of 30,000 yr B.P. that proponents of the Japanese "early Paleolithic" use as the absolute boundary separating the early and late Paleolithic (e.g., Serizawa 1979) is arbitrary and culturally unsound; it ignores any recognizable boundaries in the cultural sequence. In fact, some of the oldest of the shale and tuff components in Miyagi, as well as the phase Ia components in the Musashino sequence, might be as old as 35,000 yr B.P., an acceptable age for artifacts of "late Paleolithic" type.

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Redundancy in Early Postglacial Land Use in Robbins Swamp, Southwestern New England

George P. Nicholas

Land use patterns are a critical source of information on the processes of human adaptation and environmental change during the early postglacial, a period having no modern analog. These patterns represent not only a class of data absent at single sites, but one that can be directly correlated with coeval environmental developments. Long-term land use patterns may be either in-phase or out-of-phase with local pollen sequences and regional paleoenvironmental or climatic trends (e.g., early Holocene warming), and adaptation to these changes may be accomplished through shifts in settlement, subsistence, technology, or social organization.

On-going study of Paleoindian and early Archaic land use at one location in southwestern New England, Robbins Swamp, provides evidence that particular parts of the early landscape were re-used, perhaps on a regular basis. The type of redundant land use represented there in archaeological site location suggests that early prehistoric use of space was structured, which implies decreased mobility, changes in social organization, and other relatively complex behaviors normally associated only with later Holocene populations. These data also offer some confirmation of ecological models that postulate: 1) a positive correlation between prehistoric land use and areas of high resource productivity, biomass, and diversity during the early postglacial period, and 2) a generalist mode of human adaptation within such environments (e.g., Curran 1987).

Robbins Swamp is an extensive glacial lake basin/wetland system located in northwestern Connecticut. Intensive field investigations since 1983 have revealed evidence of relatively continuous human occupation spanning the late Pleistocene and Holocene periods. Of the over 500 sites located to date, more than 40 have revealed evidence of Paleoindian and early Archaic occupation (Nicholas 1986). This data base offers a unique opportunity to examine the spatial dimensions of early postglacial spatial organization at one location over time, and to compare patterns of early land use to those of the later Holocene.

Ecological contrasts between biomes are viewed as an important factor influencing human land use. During the early postglacial period in the Northeast, some former glacial lake basins are thought to have been relatively unique places on the landscape where resource diversity, productivity, and reliability were much higher than in adjacent riverine and upland areas. Land use should be more focused in places like Robbins Swamp than elsewhere, a trend reflected in the frequency of early sites identified. A second concentration of Paleoindian and early Archaic sites is found about 50 km to the south of the former Glacial Lake Danbury area. The ecological uniqueness of these basins lasted to the middle Holocene when the distinction between basin and non-basin areas declined through increases in deciduous forests in the uplands and river valleys. Pollen sequences from two cores in the study area (Black Spruce Bog [Gaudreau and Suter 1984] and Keep Swamp [Whitting 1974]) indicate a decline

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in pine and NAP, and a significant rise in upland oak and hickory pollen percentages after 8,000 yr B.P., a trend indicative of increased resource productivity in adjacent, non-basin areas.

If places like Robbins Swamp were used as core areas of focused, long-term settlement in the early postglacial period, then some degree of redundancy in site location should be evident. At least three areas in Robbins Swamp show evidence of repeated use at this time. The first is at the former confluence of the Blackberry and Whiting rivers; the second is on an old lake shoreline above the modern wetland; the third is an intertributary/lake basin area. Data from these and other sites also show that the early occupation of Robbins Swamp was relatively continuous, spatially intensive, and economically generalized, as indicated by artifact assemblages and by the variety of site/landform associations represented. In some respects, this land use record is not dissimilar to that of the later Holocene periods, particularly in terms of the type of site re-use associated with semisedentary behavior. One important difference is that the Archaic and Woodland occupations may be more specialized, suggesting Robbins Swamp had become a peripheral part of core areas located elsewhere in the Housatonic drainage. Shifts in economic specialization during the Holocene may be correlated not only with forest succession, but with changes in the strength of seasonality due to climatic factors (Kutzbach and Guetter 1984).

Continued archaeological and paleoenvironmental research in the Robbins Swamp area will increase resolution in the early prehistoric record and understanding of early land use behaviors and associated social relations. Similar patterns of redundant land use should be sought in other areas of ecological contrast during the late Pleistocene and early Holocene periods.

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Another Holocene Sequence and Recent Progress of the Piscataquis Archaeological Project in Central Maine

James B. Petersen and David E. Putnam

Continuing archaeological investigations in the Piscataquis River drainage, Piscataquis County, Maine, included test excavation of a third deeply stratified multi-component archaeological site, the Sharrow site (ME 90-2D), the testing of the multi-component Brockway site and the identification of 15 previously unknown sites within the drainage in 1986. The Sharrow site is located near the Brigham (ME 90-2C) and Derby (ME 90-2B) sites at the confluence of the Sebec and Piscataquis rivers, the focus of prior studies by the Piscataquis Archaeological Project (PAP) (e.g., Petersen 1986a, 1986b; Petersen et al. 1986). Eight new radiocarbon dates were obtained for cultural features within the stratified sequences at two sites to further document a chronology of human occupation at the confluence since the late Pleistocene (Figure 1).

Excavation at the Sharrow site for the Maine Department of Transportation revealed at least nine distinct cultural horizons stacked within three of the four uppermost alluvial strata that extend to over 2 m below the modern surface. These deposits span ca. 9,000 yr B.P. to 1,000 yr B.P., the early Archaic through the middle Woodland periods on the basis of stratigraphic position, diagnostic artifacts and six dates from discrete contexts. Early dates of 8,250 ± 320 yr B.P., Beta-18235, and 7,200 ± 140 yr B.P., Beta-18236, were associated with cultural features in lower stratum III, overlying deeper, as yet undated deposits. A date of 6,320 ± 110 yr B.P., Beta-18324, was associated with a ground slate point tip and a flaked slate preform. Side notched projectile points attributable to the Laurentian tradition were associated with three dates in lower stratum IV and upper stratum III: 4,480 ± 100 yr B.P., 5,370 ± 120 yr B.P. and 5,820 ± 110 yr B.P., Beta-18231, -18232, -18233. Two additional dates were also obtained for late Archaic period components at the Brigham site using previously collected samples. A Laurentian component in stratum VII yielded a date of 5,760 ± 100 yr B.P., Beta-18878, and one attributed to the Moorehead complex in stratum IX was dated to 3,900 yr B.P., Beta-18879, in association with a stemmed projectile point with a ground tip.

Of the three stratified confluence sites, the Sharrow site contains the greatest density of cultural remains and has provided copious subsistence and paleoenvironmental data in the form of plant macrofossils and large calcined bone samples from all cultural horizons. Similarly, numerous lithic tools and large quantities of lithic flakes were recovered during the 1986 phase II excavation at the Sharrow site.

Several additional CRM projects conducted within the PAP research area in 1986 led to the identification and testing of three previously unknown sites and the testing of another, the Brockway site (ME 90-3). A red ochre-stained feature at the Brockway site produced a radiocarbon date of 3,740 ± 100 yr B.P., Beta-19970, again related to a Moorehead complex occupation (Petersen and Bartone 1987). These sites and 13 other sites identified through the cooperation of amateur and professional archaeologists enhance the steadily accumulating data base for the PAP (Bartone and

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Petersen 1987; Petersen and Bartone 1987; Putnam and Petersen 1987). In 1987, phase III mitigation excavation is planned at the Brockway site and possibly, the Sharrow site. Other immediate objectives include the recovery of a sediment core from a pond in the PAP study area and the analysis and interpretation of pollen contained therein. This core will provide a local paleoenvironmental record which can be correlated with the composite archaeological sequence still being outlined in the Piscataquis River drainage.

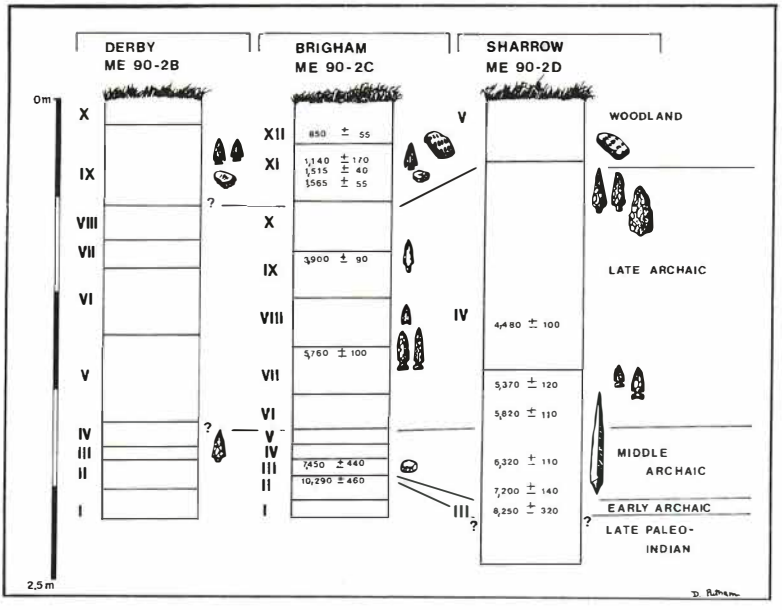

Figure 1. Schematic excavation profiles at the Derby (ME 90-2B), Brigham (ME 90-2C) and Sharrow (ME 90-2D) sites, with composite dates and diagnostic artifacts in their respective strata.

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The Loessic Paleolith: A New Term in Paleolithic Terminology

V.A. Ranov

The close association of upper and middle Paleolithic sites with upper Pleistocene loess deposits was established years ago. The pecularities of the archaeological layers embedded in such sediments are well understood. Archaeological layers such as living floors, hearths, dwellings, cultural middens, manufacturing areas, burials, and so forth are well-preserved in such deposits. These archaeological horizons are associated with the loess (cold glacial periods) or with the paleosols (interstadial or interglacial periods).

There are a lot of reasons why archaeological layers are found in buried soils. The pedological analyses are not established by the archaeologist, even at the macromorphological level. The paleosols are not used for the reconstruction of the paleoecology, but only for the general establishment of the interstadial or interglacial periods. The use of micromorphological techniques will greatly help in the understanding of the paleosols, but these methods are only now beginning to be used.

During the last 10 to 12 years of Paleolithic archaeological studies in the USSR, a whole series of sites have been discovered containing much earlier cultural horizons in loess units and paleosols dating to the middle and lower Pleistocene, and also in the Eopleistocene, as used in the Soviet stratigraphic scheme (Adamenko et al. 1984). These discoveries were being made simultaneously in South Tadzhikistan (Dodonov in press; Ranov 1980) and in the Ukraine (Gladilin 1985). Investigations of the loess and paleosols continued, but in Siberia (by G.I. Medvedev) and Moldavia (by N.K. Anisutkin). As a result of these field studies, stone artifacts were recovered in stratigraphic sequences dating from the Gunz to early Wurm glaciations. I propose here to name these sites and artifact sequences by the term "Loessic Paleolith."

The Loessic Paleolith sites yield very complete and distinctive stratigraphy. At present we have the Paleolithic artifacts in 4 to 12 paleosols in South Tadzhikistan and in 2 to 7 paleosols in the Ukraine. The study of the loessic sites containing the artifacts is very complicated due to the thick covering of loess; for example in the South Tadzhikistan, the 10 paleosol layers are found at a depth of 90 m. Because of these difficulties, many of the sites have not been completely excavated on a horizontal scale.

The stone industry recovered in the South Tadzhikistan is clearly a pebble-tool culture, absolutely without the use of a bifacial technique. However, in the Ukraine, there is a pebble-tool tradition, incorporating the bifacial technique as an integral part of the industry. These loessic sites seem to be only temporary hunting camps. I believe that simultaneously as these hunting camps were being used, there existed base camps, with a rich set of tools and living surfaces. But, today we are only working with the temporary hunting camp sites. The base camps were probably situated below the hunting camps, along lower river terraces that have since been completely eroded.

I have had the opportunity to publish some of my ideas about the dynamics for the accumulation of the artifacts in the paleosols of South Tadzhikistan, but this is not totally clear as there are some alternatives (Lomov and Ranov 1985). But in

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all cases in South Tadzhikistan, the stone tool industry is embedded in the climatic optimum portion of the paleosols. In the Ukraine we do not have this same strong correlation.

So, due to the position of the stone tool industry in very ancient loess sediments and in the distribution within the paleosols, Loessic Paleolithic sites are not similar to typical middle and upper Paleolithic open-air sites found in Wurmian age loessic sediments. Loessic Paleolithic sites are a special paleolithic phenomenon. Due to the hunting activities and the character of the stone tool concentrations in the loess/paleosol sequences, pre-Mousterian sites in the loess regions of the USSR are a new and specific type of lower Paleolithic industry, previously undescribed. It is important to emphasize that these newly discovered sites are unique to the USSR. The explorations in central Asia and in the Ukraine by Soviet archaeologists have opened up new regions to study and provide a new look at the Paleolithic of Eurasia.

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The following paper is the Russian version of this article.

ЛЁССОВЫЙ ПАЛЕОЛИТ

(новый термин в палеолитоведении)

I. Тесная связь верхне и средне палеолитических стоянок с верхнеплейстоценовыми лёссовыми отложениями установлена давно и прочно. Особенности археологических горизонтов, заключенных в подобных седиментах изучены достаточно подробно. Археологические горизонты подобных памятников содержат хорошо сохранившиеся жилые уровни, очаги, жилища, кухонные остатки, скопления костей, места обработки каменных орудий и рабочие площадки, погребения и т.д.

Подобные археологические горизонты ассоциируются с отложениями лёсса (холодный период оледенений) или с палеопочвами (интергляциальный или интерстадиальный периоды).

Имеется много примеров когда археологические горизонты связаны с погребенными почвами, но, как правило, детального педологического анализа почвы, содержащей археологические остатки не производится, в том числе даже и на макроморфологическом уровне. Особенности палеопочвы мало используются для палеоэкологической ситуации, исключая общих заключений о интерстадиальных или интергляциальных условий, хотя возможности некоторых палеопедологических методов (климатический оптимум, зачаточная почва, условия существования педофауны и т.д.) позволяют делать определенные выводы. Много перспектив обещает и микроморфологическое изучение почвенной структуры, которое еще не получило широкого распространения.

2. За последнее десятилетие работы советских археологов привели к открытию целой серии стоянок, связанных с более древними горизонтами лёссов и палеопочв времени среднего и нижнего плейстоцена и даже – эоплейстоцена. Подобные исследования одновременно начались в южном Таджикистане (В.А.Ранов), Закарпатье (В.Н.Гладилин). Позднее подобные исследования осуществлены в Сибири (Г.П.Медведев) и в Молдавии (Н.К.Анисюткин). В результате каменные орудия найдены во временных границах, охватывающих 0.8–0.04 млн. лет. На закарпатской стоянке Королево древнейшие орудия включены в аллювиальные отложения, подстилающие толщу лёсса и относящиеся к гюнцскому времени (около 1 млн. лет).

Существует предложение называть подобные стоянки термином "лёссовый палеолит".

3. Изученные серией физических и естественных методов стоянки лёссового палеолита в настоящее время демонстрируют очень четкую стратиграфию. Эта ситуация, прежде всего, определяется хорошими условиями консервации каменных орудий и отсутствию заметных перерывов в лёссово-почвенных накоплениях. Это положение подтверждается приблизительным сходством по времени лёссово-почвенных разрезов на территории нашей страны. В настоящее время каменные орудия известны в 12-4 палеопочвах Южного Таджикистана и 2-7 – в Закарпатье.

4. Исследование стоянок лёссового палеолита имеет свою специфику и сложности, связанные с большими объемами вскрышных работ (в Южном Таджикистане 10 палеопочва лежит на глубине 90 м). Это затрудняет вскрытие площадей и определение границ стоянок вглубь склона.

5. Индустрия лёссовых стоянок Южного Таджикистана демонстрирует хорошо выраженную галечную культуру, практически, но ли-

шенную двусторонне обработанных орудий - бифасов и имеет свою собственную периодизацию. На Украине в нижнепалеолитических горизонтах галечная техника так же доминирует, но здесь хорошо прослеживается появление и развитие бифасиальных приемов обработки орудий как интегральной части индустрии Королево.

6. Представляется, что первоначально выдвинутая идея об исключительном архаизме индустрии стоянок лёссового палеолита постепенно сменяется более реалистическим представлением, поскольку теперь мы значительно лучше понимаем, что облик палеолитической индустрии лёссового палеолита связан (во всяком случае в южном Таджикистане) с характером стоянок, представляющих собой временные охотничьи лагеря, остатки которых мы встречаем в палеопочвах лёссовых отложений, покрывающих высокие (до 2-х тысяч) водораздела. На Украине в лёссовой пачке перекрывающей высокие террасы такой строгой привязки к почвам не наблюдается. Это связано с различными климатическими условиями.

Можно думать, что одновременно существовали и базовые лагеря, в которых должны сохраняться набор более детально обработанных орудий, а также остатки культурных горизонтов со всеми сопутствующими этому феномену деталями. Однако, в южном Таджикистане эти базовые лагеря располагались гипсометрически ниже и в настоящее время, очевидно, полностью уничтожены эрозией.

7. Имеется уже несколько публикаций, объясняющих положение каменных орудий в палеопочвах Южного Таджикистана и динамику их накопления, однако, ни одна из гипотез не имеет характера окончательной. Вместе с тем, в южном Таджикистане, практически во всех случаях, каменные орудия связаны с климатическим оптимумом палеопочвы, но на Украине такой жесткой связи не наблюдается. Здесь горизонты орудий (более четко, чем в первом случае расположены по горизонту) связаны с верхним лимитом палеопочвы или, наоборот, лежат в ее основании, а в отдельных случаях - и в лёссе или в слое зачаточной почвы. Но в обоих регионах в стоянках лёссового палеолита имеются лишь скопления палеолитических изделий при полном отсутствии каких-либо других элементов культурного слоя.

8. Итак, по своей особой позиции внутри очень древних отложений лёсса и распространению орудий внутри палеопочв и лёссов, а также по характеру археологической ситуации, стоянки лёссового палеолита резко отличаются от открытых стоянок среднего и верхнего палеолита, связанных с верхнеплейстоценовыми лёссами. Перед нами особый феномен. Остатки охотничьих лагерей, погребенных под мощными отложениями лёссов водораздела или высоких террас пре-мустьерского времени и еще не найденные соответствующие базовые лагеря образуют совокупность стоянок лёссового палеолита, ранее неизвестной группы палеолитических стоянок.

9. Нужно подчеркнуть, что выделение и первоначальное исследование лёссового палеолита является заслугой советских археологов, поскольку ни в одном из лёссовых районов мира подобные палеолитические памятники еще не обнаружены и не проведено соответствующее их исследование. Работы в Средней Азии и на Украине, как кажется, открывают новые перспективы в изучении древних этапов палеолита Евразии.

Paleoindian Research in Michigan: Current Status of the Gainey and Leavitt Projects

Donald B. Simons, Michael J. Shott, and Henry T. Wright

Three years ago, we reported in this journal the current status of Michigan Paleoindian studies (Simons et al. 1984a). Considerable progress made since then justifies a second status report, but we emphasize that it remains very much a report of work in progress.

Since 1984, an additional 750 m² have been excavated at the Gainey site, the type site for the presumed earliest widespread Paleoindian occupation phase in the Great Lakes (Figure 1) (Simons et al. 1984b). In total, (1,867 m²) have been excavated by hand there, which nearly doubles the figure cited in our original report. Following the strategy described previously (Simons et al. 1984a), most or all of at least 5 artifact clusters have now been excavated, yielding many intact and fragmentary tools including approximately 60 fluted bifaces, 225 other bifaces, 330 end scrapers, 65 side scrapers, numerous other tools and tool fragments, abundant chert debris, and 15 Paleoindian features. Our original suspicions about Gainey's size and promise have been borne out; the site is one of the most extensively excavated and perhaps the largest and most significant early Paleoindian site between New England and the

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western Plains. It bears emphasizing that the work at Gainey—from excavation of 0.2 ha, to cataloging, mapping, tool illustration and partial analysis—continues to take place on a volunteer basis, without funding of any kind.

Excavation in 1987 will focus on two functionally distinct clusters, one possibly a dump and the other a locus where apparently serviceable tools were discarded. Results should complement the cluster assemblages excavated to date.

We hope to comprehensively analyze the site, starting with detailed measurement of tools to determine production techniques, use applications and curation rates. Assemblage formation processes can be studied through methods devised in an earlier study (Shott 1986). Comprehensive re-fitting of tool fragments should help determine if clusters were occupied simultaneously or successively. Intercluster comparisons can test hypotheses concerning organizational variability between coeval groups or successive occupants. Some of this work is done, but much more remains to accomplish before intercluster variability is clarified. In addition, we are awaiting chert source identifications from samples submitted in 1985.

Ethnobotanical analysis of feature charcoal continues, but most have yielded assemblages which resemble modern, not early Holocene, flora. Radiometric dating may be attempted, but we also have submitted burned chert specimens for thermoluminescent (TL) dating. One assay yielded a date of 12,360 ± 1,224 yr B.P. This is somewhat earlier than expected, but the recent end of its range accords with our expectations. We emphasize that this date is not equivalent to radiometric assays, and the error term cannot be interpreted in the same way as ^{14}C sigmas. Nevertheless, the result is broadly consistent with expectations and it is the only plausible date of any kind from a midcontinental Paleoindian site.

The Leavitt site (Figure 1) is a Parkhill Phase occupation in central Michigan. Roughly 250 m² were excavated there in 1984; combined with earlier surface collections, the assemblage includes 8 fluted bifaces, 13 other bifaces, 24 end scrapers, 15 side scrapers, and a large debris collection. Analysis of the assemblage and its spatial

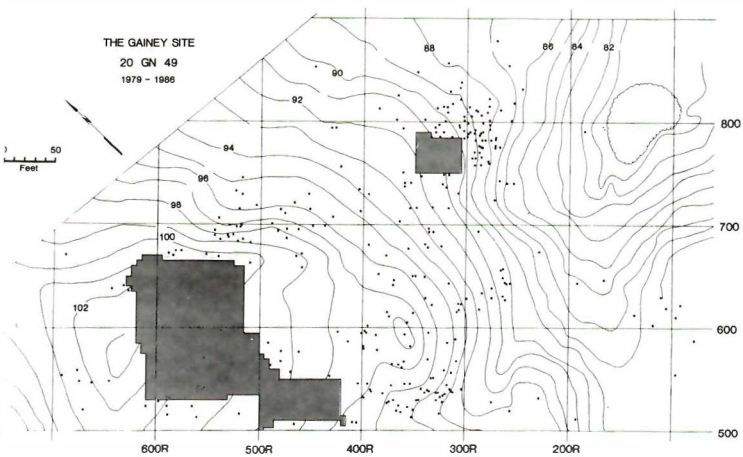

Figure 1. The Gainey site excavation as of November 1986. The dots represent a precise plotting of Paleoindian artifacts found before 1985.

distribution is complete and a report is in progress (Shott n.d.). The Leavitt assemblage is fashioned primarily from Bayport chert, whose major sources are 125 km northeast, although closer sources may exist (Shott 1986). Some Ten Mile Creek chert also is present, and two tools are composed of Upper Mercer chert. Leavitt is a comparatively small site which consists of a single cluster or two overlapping ones, and probably includes two occupations at best. It exhibits important differences from the Barnes site 70 km north (Voss 1977; Wright and Roosa 1966). Detailed comparisons to Ontario's Parkhill Phase Thedford site (Deller and Ellis n.d.) is in progress.

A single Paleoindian feature was discovered at Leavitt; it yielded spruce, oak and basswood charcoal (Egan n.d.) Tandem accelerator mass spectometer (TAMS) assay of the two spruce specimens produced results of 1,100 ± 600 yr B.P., AA-1222, and 7,886 ± 115 yr B.P., AA-1223. Since spruce disappeared from the area by 10,000 yr B.P. at the latest (Webb et al. 1983), these results are inexplicable.

Clearly, both Gainey and Leavitt are important as chronological and typological markers of Great Lakes Paleoindian occupation. However, their research potential is not confined to these issues. The assemblages were the focus of an organizational analysis which examined the relationship between technology and settlement mobility, and which documented systematic differences in technology under distinct mobility regimes (Shott 1986). We believe their utility can be extended still further, to document organizational variability in other components of forager cultural systems. But at this point, a major task—the comprehensive cataloging, description and documentation of the Gainey assemblage—remains incomplete. It must be accomplished before we can move on.

When that happens, we can turn our attention to the larger settlement systems of which each site formed only a part. Currently, each stands in isolation and we simply do not control regional variability in site locations, sizes and assemblages for either the Gainey or Parkhill systems. We envision a long-term regional study utilizing both systematic survey and the well-documented collections of several avocational archaeologists. The task is forbidding in scope; the Gainey system probably extended to eastern Ohio, a distance of over 300 km, where tools closely resembling Gainey forms have been discovered (Gramly and Summers 1986; Prufer and Wright 1970). But it is critical to progress in our understanding of early Holocene land use systems in the Great Lakes, advances in the theory of assemblage formation, and the ecology of forager cultural systems.

Shott gratefully acknowledges support for the Leavitt excavation by the National Science Foundation (BNS-8314076). Gainey TL assays are being performed by Dr. Ralph Rowlett of the University of Missouri. Leavitt charcoal was assayed at the University of Arizona's National Science Foundation Acceleration Facility for Radioisotope Analysis, for which we thank Dr. C. Vance Haynes. The Gainey project has been aided by many persons, but we wish to single out Scott Beld for his contribution.

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Paleoindian Settlement and Lithic Procurement Patterns in the Karstic Region of Southcentral Indiana

Edward E. Smith

Collector interviews and archaeological reconnaissance conducted between 1983 and 1985 in the karstic region of unglaciated southcentral Indiana has documented over 100 Paleoindian localities. Data were gathered from both the riverine and upland portion of the study area. The contexts of Paleoindian finds range from substantial sites to isolates. Many diagnostic Paleoindian projectile points have been recovered from multicomponent sites. The research was funded in part by two Survey and Planning grants from the Indiana Department of Natural Resources, Division of Historic Preservation and Archaeology. Additional support was provided by the Glenn A. Black Laboratory of Archaeology.

The research is intended to elucidate patterns of Paleoindian landuse and lithic resource acquisition and reduction within the "chert belt" region of the state. The study assesses the applicability of the cryptocrystalline model (Gardner 1977; Goodyear 1979) to the Indiana karst. The study area includes the Wyandotte (Harrison County) chert source, a high quality cryptocrystalline chert.

The unglaciated region of Indiana is a northward extension of the Interior Low Plateaus (Highland Rim Section), a large, ecologically diversified portion of the continental interior. The Plateaus present a number of edaphic and topographic settings, including glades, barrens, sinkholes, caverns, and various other karst features (Quarterman and Powell 1978). The limestone bedrock affords a variety of exploitable cherts. An intensive Paleoindian occupation of the region has long been recognized.

Paleoenvironmental data are also being collected. Sites suitable for palynological investigations have been located which may permit the reconstruction of the vegetational history of the study region. The age of the prairie-like vegetation of the bar-

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rens is a topic of particular relevance to the study. The research is intended to have applicability to the Plateaus, and to unglaciated eastern North America in general.

Most of the Paleoindian projectile point types that are recognized in unglaciated eastern North America occur within the research area, including Clovis, Cumberland, Quad, Beaver Lake, Agate Basin, and Plainview. Wyandotte chert was the primary raw material utilized in Paleoindian biface manufacture, although other regionally available cherts were also used to a limited extent. Representation of extra-regional cherts is extremely limited.

Paleoindian sites occur in virtually all microtopographic settings within the study area. Most are open air sites, but several rockshelters and possible buried sites are also represented. The larger and more diversified sites are located on the high terraces of the Ohio River in proximity to highly dissected upland topography. A number of small sites are associated with upland karst springs and sinkholes. Salines and other mineral water sources are also being investigated as possible focal points of Paleoindian hunting activities. The Early Archaic settlement pattern closely approximates that of the Paleoindian period, with evidence of exploitation of the uplands being especially well-represented.

Of particular significance is the Magnet site (12Pe171), located on one of the high terraces of the Ohio River (Smith 1984; Tomak 1980). This is an intensively occupied site, primarily of late Paleoindian affiliation. The site appears to have functioned as a lithic workshop and habitation locality. The site is located within 17 km of the Wyandotte chert source area, presumably a major factor in aboriginal site selection. The principal projectile point types are Quad, Beaver, Lake, and Agate Basin. A large and diversified uniface tool assemblage is also present, including a well-defined large blade industry.

Also of significance is the Swan's landing site (12Hr304), a single component early Holocene lithic workshop site located within the Wyandotte chert source area. The cultural zones are exposed in the caving bank of the Ohio River beneath 3–4 m of Holocene overbank alluvium. Hundreds of Kirk cluster projectile points and uniface tools have been recovered from this site by local collectors. In situ charcoal-bearing cultural features and animal bone have also been reported.

Overall, the karstic regions of eastern North America, particularly within the Interior Low Plateaus and the Gulf Coastal Plain, may constitute large-scale Paleoindian "hot spots". The diversity of readily available high quality cherts and regionally concentrated edaphic settings would have provided abundant resources for procurement by late Pleistocene hunter-gatherers.

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The Magnet Site: A Late Paleoindian Site in Southcentral Indiana

Edward E. Smith

The Magnet site (12Pel71) is an open multicomponent site with evidence of multiple Paleoindian occupations. The site is situated on the second terrace of the Ohio River in the Little Bend region, approximately 2 km southeast of the settlement of Magnet in eastern Perry County, Indiana. Cultural material attributable to the Paleoindian occupations occurs in variable density for about 0.5 km along the eroding terrace margin.

This locale originally was recorded by Kellar (1958) during his survey of Perry County. The site subsequently has been re-examined by Tomak (1980) and Smith (1984). The Magnet site has been collected heavily by several local avocational archaeologists who have carefully curated the materials recovered. To date, over 100 diagnostic projectile points have been recorded from these collections and from limited surface reconnaissance by the author.

The slope and summit of the eroded terrace is covered with a heavy concentration of artifacts, lithic debris, and burnt sandstone. Numerous battered hardstone cobbles litter the site. These hammerstones were apparently used in the reduction of chert and in the fabrication of lithic tools.

The inventory of projectile points includes one Clovis fluted point (Figure 1a) and several unclassified fluted point midsections. A number of Quad (Figure 1b, c) and Beaver Lake (Figure 1d) points also occur, as do numerous Plainview (Figure 1e) and Agate Basin (Figure 1f) points. The latter two types are most similar to forms from the Great Plains, whereas the former are typical of the greater Southeast. This may reflect the transitional environment of the region and the major communication corridor afforded by the Ohio River. Other bifacial implements from the site include drills, preforms, and various tool fragments.

The uniface tool inventory includes large end-of-blade scrapers (Figure 1h, i), various forms of sidescrapers, gravers (Figure 1g), and a few large constricted haft endscrapers (Figure 1j) manufactured on blades. A number of scraper-chopping tools resembling those from the Sims site (Adair 1976) also occur. The small hafted end scrapers characteristic of many Paleoindian sites in eastern North America are rare at the Magnet site.

Wyandotte (Harrison County) chert is overwhelmingly the predominent chert type represented in the Magnet assemblage. A low percentage of other cherts available in the region also occurs.

The Magnet site is interpreted as a lithic tool manufacturing and habitation locale that was periodically reoccuppied over the course of the Paleoindian period. The

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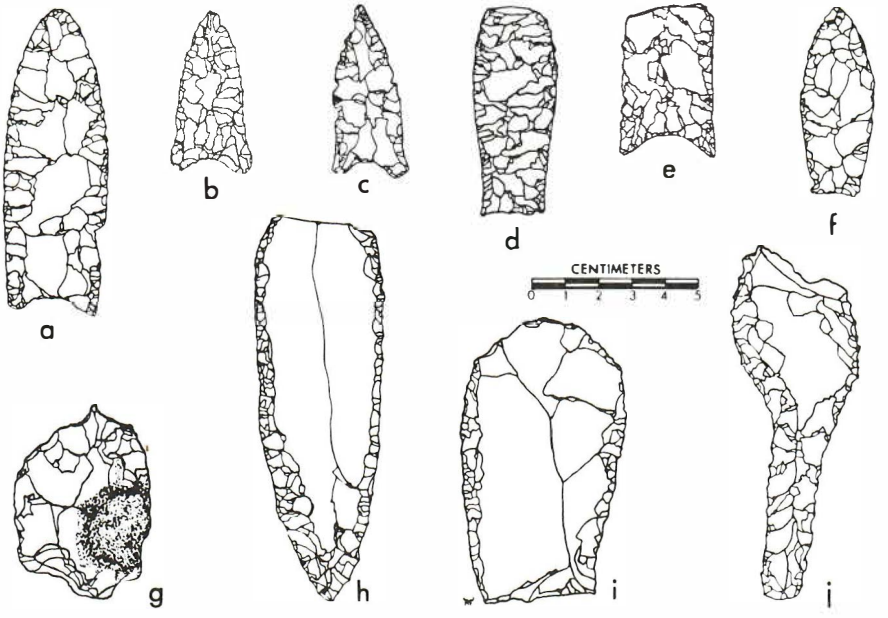

Figure 1. Representative artifacts from the Magnet site (12Pel71): a-f, projectile points; g-j, uniface tools; a, Clovis fluted; b,c, Quad; d, Beaver Lake; e, Plainview; f, Agate Basin; g, graver; h,i, end-of-blade scrapers; j, constricted haft endscraper.

heaviest utilization occurred during the later part of this period. The site appears to have functioned in part as a retooling station where Paleoindian bands stopped during the course of their subsistence rounds. Quantities of Wyandotte chert were brought to the site from nearby exposures for the purpose of replenishing their tool kits. During the process of retooling, a number of worn or broken (curated) tools were discarded at the site. Other habitation debris suggests that the site may have functioned as a base camp during at least part of the occupational sequence.

The Magnet site was investigated during a reconnaissance of Paleoindian and early Archaic sites in southcentral Indiana funded in part by the Indiana Department of Natural Resources, Division of Historic Preservation and Archaeology, from Survey and Planning funds. Additional support was provided by the Glenn A. Black Laboratory of Archaeology, Indiana University. Thanks are extended to Dr. Patrick J. Munson, who served as principle investigator, and to Dr. James H. Kellar who made available the resources of the Glenn A. Black Laboratory. The manuscript was reviewed by Dr. Patrick J. Munson, Dr. Christopher S. Peebles, and Cheryl Ann Munson. Jill Harris-Cowan and Rachael Freyman prepared the illustration.

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Patterning in Paleoindian Behavior: The Michaud Site

Arthur Spiess and Deborah Brush

Analysis of the recently excavated Michaud Paleoindian site located near the Lewiston-Auburn Airport in central Maine has led us to examine the extent of patterning in northeastern Paleoindian sites on several levels. The Michaud site, relatively intact, lends itself well to an examination of internal site patterning, on both an intra-concentration and an intra-site level. We use the internal site patterning and other data to explore the place of the Michaud site in the greater context of other northeastern Paleoindian sites.

The Michaud site is located on subaerially duned sandy proglacial outwash deposited during a brief marine transgression circa 13,000 yr B.P. The site's location on a sandy surface coupled with its proximity to a bog and stream are thought to be significant. Over 2,000 m^2 were excavated in an area delineated by surface finds and initial test excavations, resulting in the definition of eight non-overlapping, low density tool concentrations or loci. Approximately 135 artifacts and 2,500 flakes and microflakes of various cryptocrystalline rocks which are of nonlocal provenance were recovered, together with over 400 cores, flakes, and shatter of a coarse-grained diabase which is locally available. Scraps of calcined bone were recovered, some of which is identifiable as large mammal longbone. A accelerator mass spectometer date of $10{,}200 \pm 620$, Beta-15660, has been obtained on charcoal from one of three eliptical, basin-shaped hearths associated with the above mentioned tool concentrations.

Two distinct areas of tool concentrations (areas A and B) were delineated based on dominant lithic material and differences in intra-areal spatial patterning. Area A consists of three tool concentrations which together extend 16–18 m. The westernmost concentration (I) contains five fragments of heavily worn fluted points and three biface preform fragments representing a number of stages in fluted point manufacture. The presence of channel flakes and many biface thinning flakes indicate that tool replacement was the focus of concentration I activity. The easternmost tool concentration in area A (III) was dominated by sidescrapers, but also contained several endscrapers and utilized flakes. Use-wear pattern examination suggests that hide-working may have been the primary concentration III function. A concentration (II) of flaking debris, with a few small tool fragments with a small amount of red ochre was recovered from distinct area between these two functionally specific concentrations. The intermediate concentration (II) may represent domestic space which was flanked by highly diverse work areas.

Area B includes five concentrations which are more randomly spaced than are the concentrations in area A. In contrast to the functionally complementary tool groups of area A, the tool groups in area B are roughly homogenous. Generally, a single fluted point fragment and from one to a few sidescrapers, endscrapers, graver/perforators, utilized flakes, and a variable amount of debitage are represented in each of the five area B concentrations.

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Areas A and B contrast further on the basis of raw material. Three major raw materials are represented at the Michaud site: several varieties of Munsungun chert, a glassy rhyolite, and a black patinating to mottled olive green chert. The rhyolite bedrock source is unknown. Preliminary research suggests that black/green patinated chert bedrock source provenance is in northwestern Vermont. The predominant raw material for tool manufacture in area A is the black/green chert, while it is represented in area B by several artifacts only, with no associated debitage. The glassy rhyolite is represented by two tool fragments and no debitage in area A, but it dominates manufacturing debris from area B. Munsungun chert was available for some tool manufacture in area A, but is present only in the form of spent tools in area B.

We suggest that areas A and B at the Michaud site represent the remains of two small groups of Paleoindians who either occupied the site simultaneously or during different segments of a seasonal or otherwise defined pattern of movement. The highly ordered patterning of area A and relaxed spatial patterning of area B suggests a difference in social organization.

Further, we have defined a New England centered Paleoindian region based on 1) the inter-site use of a similar suite of lithic materials and 2) similarities in many site location attributes. General site size, however, is a significantly variable element. Sites of three orders of magnitude are present in the New England region: large sites containing 4,000 to 8,000 tools, including Bull Brook and the Vail site, medium sized sites including Bull Brook II, and small sites of about 50 to 100 tools including the Michaud and Whipple sites. Both of the large sites have geographically related satellite sites which may have been occupied before or after the main occupation. We suggest that the Paleoindian settlement pattern for the New England region included population density fluctuation somehow related to seasonally diverse resources and lithic procurement strategies. The Michaud site represents a short term occupation by two small groups of Paleoindians, suggesting that the Paleoindian settlement pattern included movement of one or a few family groups, or movement of hunting, lithic procurement or otherwise employed specific function groups.

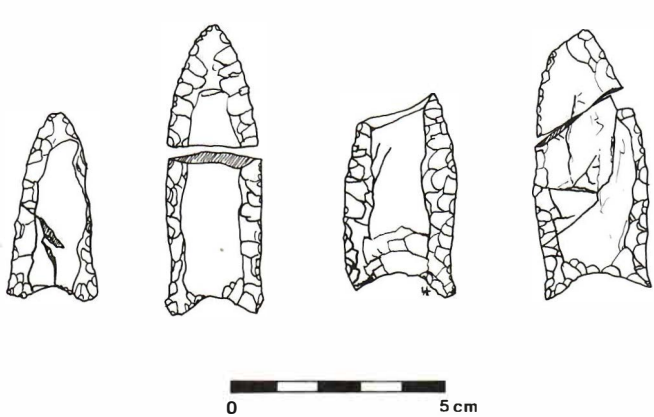

Figure 1. Outline drawings of the four most complete fluted points recovered from the Michaud site.

Big Bone Lick: A Clovis Site in Northcentral Kentucky

Kenneth B. Tankersley

Big Bone Lick is located in the outer Bluegrass region of Kentucky, approximately 28 km southwest of Cincinnati, Ohio. Historically, this area is known for its salt springs, paleontological deposits, and the academic involvement of famous scientists such as Benjamin Franklin, Thomas Jefferson, George Cuvier, and Charles Lyell.

During the early Woodfordian, Big Bone Lick was the location of a large, slightly saline, backwater lake that attracted large herbivores such as musk ox, caribou, ground sloth, moose-elk and mammoth. By the late Woodfordian, the lake had been reduced to a back swamp area with saline springs recharging at several locales. This environment continued to attract large gregarious herbivores including mastodon, horse, and bison. By ca. 10,500 yr B.P., Paleoindians were possibly exploiting these species as displayed by the presence of Clovis cultural material and the remains of megafauna recovered from the immediate vicinity of the spring deposits (Tankersley 1985).

In the course of the late prehistoric, ca A.D. 1450, bison returned to the lick and were once again exploited by the peoples inhabiting the region (Tankersley 1986). Also, at this time, stream piracy occurred exposing the late Pleistocene fossil-bearing back swamp deposits. The fossil remains were collected and traded throughout the Ohio River Valley well into historic times.

Today, the floodplain alluvium contains late Pleistocene, Holocene, and modern deposits in horizontal juxtaposition as a result of lateral and vertical accretion. Floodplain development is identical to that found in the neighboring Ohio River Valley (Gray 1984). Consequently, in situ Clovis bearing cultural strata, if it exists, will occur at the same elevation as much more recent strata.

Clovis cultural material has been surface collected from Big Bone Lick's late Pleistocene deposits for more than 180 years: Dr. William Goforth, between 1803 and 1807 (Figure 1 a, b, c); Herbert Schiefer in 1898 (Figure 1 d); J.D. Moore in the 1930s (Figure 1 e); Ellis Crawford in 1959 (Figure 1 f); and Kenneth Tankersley in 1981 (Figure 1 g). All of these artifacts are manufactured from high quality nonlocal raw material whose source areas are located more than a hundred kilometers from the site. The possibility that stratified Clovis deposits may be present was first suggested by the University of Nebraska's paleontological excavations (1962 to 1966) when cultural material was recovered from fossiliferous strata. Recent test excavations demonstrated that heavily patinated retouch flakes do occur in direct association with spirally fractured late Pleistocene large mammal long bones, however, the strata are secondary deposits (Tankersley 1985). While it may be argued that the cultural material and megafauna are contemporary, an in situ association has not been confirmed.

Interestingly, Big Bone Lick is the only early Paleoindian site in Kentucky with a correlative, but not associated radiocarbon date. A radiocarbon assay of 10,600 ± 250 yr B.P., W-1358, was obtained on a wood sample from alluvium containing the stream-

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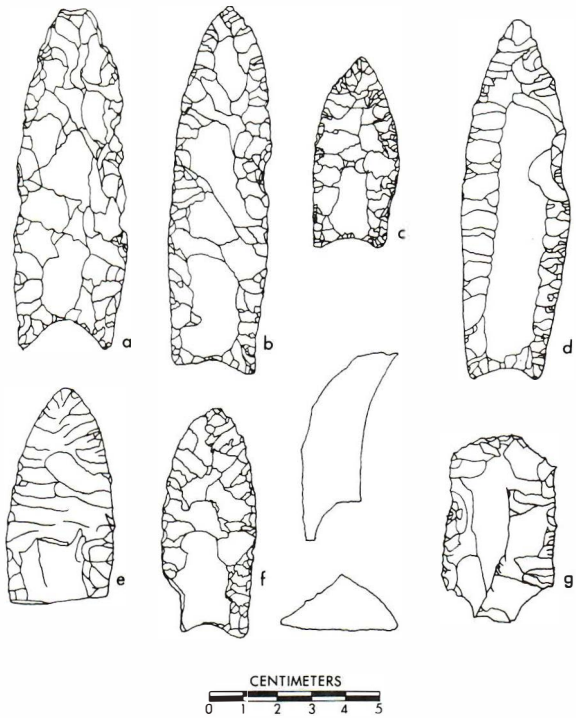

Figure 1. Clovis cultural material from Big Bone Lick, Kentucky.

worn remains of ground sloth, mammoth, mastodon, and horse. But, these remains also represent an admixture of early and late Woodfordian fauna. Typologically, all of the fluted projectile points from the site belong to the Clovis cluster. Cumberland points, on the other hand, have not been reported from this locale. One might speculate, therefore, that this radiocarbon assay is contemporary with a Clovis occupation at the site.

Illustration by Rachael E. Freyman. Special thanks to Edward E. Smith for reviewing the manuscript.

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The Trail Draw Alberta Site in the Black Hills, South Dakota

Alice M. Tratebas

Test excavations designed to locate subsurface cultural remains associated with the surface find of an Alberta point produced some unexpected results. The Trail Draw site is a small open campsite in the higher elevations of the Black Hills, South Dakota. The site is on a low open knoll along the north side of South Fork Castle Creek. The steep south wall of the valley is blanketed with white spruce (*Picea glauca*). Short limestone cliffs and scattered rock fall, interspersed with ponderosa pine (*Pinus ponderosa*) and aspen (*Populus tremuloides*), form the north canyon wall. Soil depth on the knoll extends to 70 cm although the cultural remains were concentrated between 20 and 35 cm below the surface.

The artifacts exposed in a disturbed area were an Alberta point, a lanceolate knife, a biface broken with a reverse hinge fracture, a disk-shaped chopper, and a few flakes. The quartzites used for the bifaces were from the Black Hills and the Spanish Diggings quarries in Wyoming.

The testing was limited and only a 1 m^2 sampled undisturbed occupations. Although no diagnostic artifacts were recovered in situ, the cultural deposits are considered to be Paleoindian on the basis of 1) their greater depth compared with more recent occupations in similar soils, 2) the presence of hematite, which has not been found on later sites in the Black Hills interior, and 3) the graver forms.

The testing revealed two lenses of scattered charcoal chunks and charcoal-stained soil. Although no intact hearths were found, the quantity of charcoal suggests that hearths are nearby. Lithic artifacts in the two lenses were similar enough that little time may separate the two episodes of fire building and other activities. The major artifacts recovered from the single test unit in the undisturbed area were 345 flakes, most the result of knapping a high quality local red chert. Broken preforms and biface thinning flakes indicate biface manufacture. Most of the expedient unifacial tools recovered were made on red chert waste flakes. Four gravers include a chisel graver (Irwin and Wormington 1970), a type never found on more recent sites in the area. The other three gravers were minute, carefully-shaped tools. All were multifunction tools with utilized edges. Eleven other small flakes were also utilized for cutting or scraping. The scraping tools are small flakes with square edges. Because this chert is brittle and tends to produce broken flakes, a refitting study would probably be needed to determine whether the square edges were produced intentionally by radial fracturing (Frison and Bradley 1980) or snapping. A bifacial knife was also recovered in situ, as well as small pieces of hematite with abrasion facets. Quartzite was recovered mainly as retouch flakes. Because each flake is a different color and texture variant, a much larger tool kit was probably brought to the site than is represented by the discarded tools.

A single posthole extended down from the lower charcoal-stained lens. The posthole stain had a diameter of 16 cm near the top and tapered obliquely to end at a depth of 19 cm below the bottom of the occupation lens. Along one side of the post was

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a vertically oriented clump of unidentifiable blocky bone fragments, possibly remnants of a bone brace. At the bottom of the posthole was a remnant of semi-charred wood 7 cm in diameter. Although highly decomposed, the wood was comparatively firm to the touch. Funding is presently being sought to date the post and the occupational lens to verify a Paleoindian date for the cultural material and the association of the post with the occupation. If the post is not intrusive, it may be part of a structure, possibly a shelter or drying rack.

A study of Black Hills settlement patterns has shown that the major Paleoindian site type in the higher elevations was small hunting camps (Tratebas 1986). Both prehunt tool preparations and post-hunt faunal processing are hypothesized for these sites. The Trail Draw site appears to fit this pattern. The expedient flake tools might have been used for tool manufacturing, while weapons and butchering tools represent hunting activity. How a structure built with posts would relate to such a limited activity site remains to be demonstrated.

Few Alberta sites have been excavated. The Hudson-Meng site, a bison kill in western Nebraska, has been reported in the greatest detail (Agenbroad 1978). Other sites include only the Fletcher site in Alberta (Forbis 1968) and the Alberta levels at the Hell Gap locality in Wyoming (Irwin-Williams et al. 1973). Despite the small size of the Trail Draw site, it has the potential to provide a significant glimpse of a much different part of the seasonal activity cycle than large bison kills can show. Future work is planned to expand the excavations at this site.

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Durham Cave, A Pre-Clovis Occupation of Pennsylvania?

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Archaeological investigations at the Durham Cave complex in eastern Pennsylvania over the past year have focused more on the realm of research than actual fieldwork. To this end, the author has travelled to the Smithsonian Institution, the American

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Museum of Natural History, the Philadelphia Academy of Natural Sciences, and the Mercer Museum in Doylestown, PA, to discuss work done by these institutions at Durham Cave. What was revealed was an interesting history of archaeological/paleontological investigations over the past 100+ years at this site. By piecing together what each museum had recovered, and interpreting it in light of the present fieldwork, the author was able to come up with a hypothesis regarding the possible pre-Clovis occupation of this complex.

Durham Cave #1 and Durham Cave #2 have been associated with "Indians" by the locals ever since Europeans arrived in the area, and found the cave occupied by a group of native Americans. In 1855 the Academy of Natural Sciences conducted paleontological excavations at Durham Cave recovering 13 species of Pleistocene mammals and a collection of prehistoric artifacts. Henry C. Mercer's search for early humans led him to Durham Cave in the 1880s. Mercer recovered a large amount of Pleistocene faunal remains, including the northernmost occurrence of peccary remains. Mercer noted (1893) that a good potential existed for defining an association between early humans and the Pleistocene mammals of Durham Cave. In the late 1890s the American Museum of Natural History conducted some studies at the cave, resulting in the identification of more Pleistocene faunal remains and the first identification of the species *Bison appalachicolus* (Ray 1966), which is now referred to as *Symbos cavifrons* (extinct muskox). In 1969–70 Mr. Fred Grady of the Smithsonian Institution conducted investigations at the Durham Cave complex recovering over 500 bones which represent 60+ species including many which are now extinct or at least no longer extant in eastern Pennsylvania. More important, in terms of the present research, was the recovery of associated bone expediency tools.

Over the past year the author's archaeological investigations have expanded upon these past investigations, and have resulted in the discovery of a variety of modified bone. Taphonomic features present in the Durham Cave assemblage include cut marks, greenbone breaks, spiral fractures, calcining, dynamic loading, and longitudinally splitting. Many of the modified bones appear to be fracture-based utilitarian tools. Due to the number and size of the rock falls that cover the cave floor, the recovery of bones bearing evidence of impact initiated spiral fractures is not surprising. What is surprising is that these seemingly fracture-based utilitarian tools can be seperated out from other fractured bone based on the presence of wear patterns suggesting heavy usage. These expediency tools seem to be a direct result of the butchering activities by Pleistocene inhabitants of the Durham Caves. These tools were apparently made efficiently and quickly, and were apparently designed to aid in the butchering activities, and then were discarded with the rest of the faunal remains. It seems apparent that some form of a bone tool technology was being utilized by the inhabitants of the Durham Caves to aid in the processing of Pleistocene mammals.

The author recognizes the fact that the capabilities of extinct predators such as *Arctodus* sp. and *Canis dirus* (recovered in the cave deposits) are still virtually unknown, so it seems that it might be a little early to eliminate these predators as sources of the modified bone. Future archaeological investigations at Durham Cave will focus on further defining this extremely simple bone tool technology manifested in the Pleistocene levels of the Durham Cave complex, and whether or not this represents a postulated pre-Clovis occupation of Pennsylvania. Another interesting direction the investigations will be taking is to use the small mammals to study paleoenvironments, and by incorporating the small mammal data into a regional synthesis

the author hopes to be able to draw some conclusions about evolutionary tempo and mode by studying evolution, migration and paleoecology of the various small-mammal species.

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Research on the Late Pleistocene in Oklahoma

Don G. Wyckoff, Peggy Flynn, Brian J. Carter, and Branley A. Branson

Cooperative investigations by members of the Oklahoma Archeological Survey and the Oklahoma State University Department of Agronomy are beginning to yield information on late Pleistocene settings in Oklahoma. During 1986, varying degrees of field work were undertaken at three locations in northwestern Oklahoma. This work has benefited from the wise counsel of Smithsonian Institution archaeologist Dennis Stanford and University of Kansas scholars Wakefield Dort and Larry Martin.

The most extensive work was at the Hajny mammoth site (34DW-23) in the Canadian River valley of Dewey County. Initially encountered during 1983 quarrying of gravel, bones of mammoth (*Mammuthus*) were discovered in apparent spring sediments. Quarrying was halted by the landowner until radiocarbon dates could be obtained and appropriate excavations undertaken. Bone apatite fragments recovered during our preliminary inspection yielded a date of 8960 ± 240 yr B.P., WSU-2941, whereas snails from presumably associated sediment yielded a date of 27,890 ± 415 yr B.P., WSU-2942. Because the bone date was potentially relevant to a time when Paleoindians were in Oklahoma, plans were made to excavate this find. This work was possible only because volunteers, especially Oklahoma Anthropological Society members, contributed hundreds of hours of effort. As a result, 18 m^3 of sediment were stratigraphically removed from 64.5 1 × 1 m squares and screened through 6.4 mm mesh hardware cloth. Also, 111 m of backhoe trenches (70 cm wide) were dug to as much as 3 m below the surface and profiled in detail. All findings are now being compiled and synthesized for thorough reporting elsewhere.

The Hajny site is located 35 m above the Canadian River's present bed. At 524.2 m above sea level, the site is within the second highest terrace identified (Fay 1959:Figure 5) for this segment of the Canadian Valley. Both this terrace and the highest one are attributed (Fay 1959) to the Kansan age. Exposures to the north, east, and south of the mammoth remains bear witness to the find being part of a very complex taphonomic, alluvial, and pedogenic record. Differentially preserved bones

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of three, and perhaps four, mammoths were found in sediments atop fluvial sands and gravels. At four locations within 50 m of each other, conical vents (1–2 m diameter at the mouth) interrupt the horizontal layers of sand and gravel. These four features are characterized by vertically aligned fill of white sand or gray-green loamy sand that becomes increasingly horizontal near the orifice and eventually mantles several square meters of the surrounding fluvial sands. Concentrations of snails (predominantly *Gyraulus parvus, G. circumstriatus,* and *Lymnaea caperata*) are observable at different locations in these mantles. Two of the conical features also exhibited 5–10 cm thick linings of red loamy sand. One conical feature was profiled to a depth of 4.5 m where it terminated in disintegrated Permian sandstone. All four are believed to be conduits for springs that flowed up through the fluvial sands.

The mammoth found during quarrying lay on its left side (with head to the southeast) directly east of one conduit. Several ribs and vertebrae slope into this vent, and two vertebrae were uncovered in the conduit 60 cm below its orifice. While portions of the mammoth elements had been scraped away by heavy machinery, the remaining ones were relatively articulated although broken by the weight of machines and ancient pedogenic processes. Directly east of this skeleton were two tusks, a mandible, upper molars, a left scapulae, several ribs, a pelvis, a left femur, a left tibia, and a left fibulae of another mammoth. These bones are disarrayed and display evidence of weathering not manifest on the first animal. For example, a gravel-scoured left femur and overlying gravel can be linked to a gravel-filled channel directly north of both finds. From 30 to 40 cm of gleyed silt and greenish silty clay overlay most bones of this second individual, and the stratigraphy here closely resembles that overlying the tusk to a third proboscidian exposed in a backhoe trench some 50 m southeast. Directly east of this third find, a 5 m profile records several fluvial sand layers deposited above the ponded sediments containing mammoth bones. These sand deposits are covered with 1.8 m of weathered soil and an 80 cm mollic horizon. Other profiles around the gravel pit reveal that at least two of the upper fluvial deposits have been stripped away by major erosion episodes.

Presently, the Hajny mammoth site is suspected to contain two different accumulations of mammoth remains. The disarticulated, partially gravel-scoured individuals are believed to be within the pre-Wisconsin river channel that eventually formed this high terrace. The more articulated mammoth lies within spring deposits that formed after the river channel was active. The snail assemblage and dated snails from one of these deposits supports the conclusion that this spring was active in early Wisconsin times. No artifacts were found in these deposits.

A second study was started in October of 1986 at the Burnham site (34WO-73) in Woods County of northwest Oklahoma. This site is located about 5 km north of the Cimarron River on the southern margin of the Red Hills, an eastern remnant of the Ogallala capped High Plains escarpment found along the Kansas and Oklahoma border (Fenneman 1923). Farm pond construction uncovered the filled channel of an ancient east-draining arroyo. Overlying this is 40 cm of red silty clay, a 15 cm thick caliche layer, and nearly 2.0 m of red loamy sand. Snail shells and bones of turtle, horse (*Equus*) mammoth, and bison (*Bison*) are eroding from the exposed gray channel fill. Recent erosion uncovered part of a large bison skull, and the October field work consisted of excavating a 2×2 m unit around this skull. Nearly 1,000 kg of channel fill was waterscreened for snails and small animal bones, a contour map was prepared, and a grid system for future work was established. The skull is nearly

intact, has a basal horn core circumference of 44 cm, and apparently represents *Bison latifrons*. Several ribs, a mandible, a right scapulae, and a vertebra of this animal were also recovered with a large angular cobble of local flint. No other gravel is evident elsewhere in the channel fill. Radiocarbon samples are submitted, and plans are being made for further field work.

The final field project was the preliminary investigation of mammoth remains exposed in the bank of Thompson Creek, a tributary to the Salt Fork of the Arkansas in the Rolling Redbed Plains of Kay County, north central Oklahoma. Ribs, a femur, and part of a tusk occur in the profile of an aggraded stream channel 2.5 m below the surface. A radiocarbon date of <14,000 yr B.P., WSU-3353 was derived from dense bone apatite fragments collected here. Further work is planned to better document the context and the remains.

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Physical Anthropology

Inbreeding and Wisconsin Glacial Barriers

Laurine A. Rogers and Richard A. Rogers

Populations which entered the New World during the Wisconsin required not only cultural adaptations to survive within the restricted areas bounded by glacial barriers, but the biological ability to adapt to increased levels of inbreeding as well. All populations carry recessive genes arising by mutation. Some of these genes are deleterious in the homozygous state and contribute to a population's "genetic load." Changes in population size and degree of endogamy affect the equilibrium frequency of these genes (Haldane 1940). As the proportion of expressed versus unexpressed deleterious recessive genes changes in each generation, the mean quantitative values of fitness-related traits also change. Populations entering the New World would have been subject to changes in the proportion of expressed deleterious recessive genes exposed to selection.

Over the years there has been a controversy as to whether human populations differ in genetic load, and in the manifestation of inbreeding depression (Sanghvi 1975, Chakraborty and Chakravarti 1977). However, the effects of inbreeding after random mating are considered to be almost universally harmful (Wright 1921).

Movement past Wisconsin glacial barriers would have caused changes in population size and levels of endogamy. These changes could have affected the manifestation of inbreeding depression and the opportunity for natural selection to act on recessive genes. The factors which would have caused an increase in inbreeding and a change in the proportion of recessive genes exposed to selection are the following: 1) an initial reduction in population size through fissioning and migration into new areas; 2) increases in exogamy due to restrictions in gene flow along glacial corridors or in ice-free refugia; and 3) increases in population size from limited founding stocks after establishment in new unoccupied territory.

The routes past the Wisconsin glacial barriers were most likely along the Northwest Coast or an interior ice-free corridor between the Cordilleran and Laurentide glacial complexes. These Wisconsin routes were quite constricted (possibly even closed) during glacial maxima, but were more open during intervals of glacial retreat. Each route was well over a thousand kilometers in length. As hunter-gatherers moved into these

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corridors their population densities were probably quite low. The restricted areas of these routes would tend to limit gene flow between populations, particularly between populations at the extremes of the range. Restricted entry ranges may have increased band or tribal endogamy. Greater local population inbreeding would increase the probability that deleterious recessive genes would be expressed in the homozygous state. This would also be true for populations which may have become isolated for thousands of years in ice-free refugia as has been suggested by Rogers (1985) on the basis of linguistic evidence from the Northwest Coast.

Attempts to analyze inbreeding in modern, small, reproductive isolates have yielded conflicting results. High rates of inbreeding have been associated with deleterious effects in some groups, but not in others. Some evidence has been presented that the deleterious effects of inbreeding decrease as a human population inbreeds over a long period of time (Sanghvi 1975, Rogers 1984). A possible explanation is that natural selection eliminates the deleterious recessive genes as they are expressed in the homozygous state in endogamous populations. As the frequency of deleterious recessive genes is decreased through time, the manifestation of inbreeding depression is reduced. Thus, populations which increased inbreeding as a result of passage past Wisconsin glacial barriers, or populations which remained isolated in refugia during the duration of the Wisconsin glaciation, would have experienced only a limited period of "inbreeding depression." The combined effects of inbreeding and selection in founding populations could explain evidence of reduced genetic load reported in some native American populations such as the Caingang Indians of Brazil (Salzano et al. 1962).

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Lithic Studies

Recent Paleoindian Research in Georgia

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Although it is not widely known, the first Paleoindian fluted projectile point found in secure excavation context in the eastern United States, and recognized for what it was, came from Macon Plateau (Kelly 1938). Only one fluted point was found at Macon, however, in spite of a massive excavation effort. The Macon Plateau investigations were thus the first to indicate the apparent scarcity of fluted points on sites of this time level in many areas of the lower Southeast. This pattern, markedly different from that observed in the Plains and in the Northeast, where dense kill sites have been reported, has prompted some investigators to suggest Southeastern Paleoindian populations were highly mobile, generalized foragers. Although the excavations at Macon represented some of the first work undertaken on Eastern Paleoindian, very little follow-up research was done over the next 40 years (Waring 1968). Occasional reports of fluted points appeared, but since no systematic effort at recording this information occurred, much of the data was lost. Only within the past ten years has substantial interest in documenting Georgia's early occupants reemerged.

Recent evidence for Paleoindian occupation has come from both surface and excavation context. Like the original Macon excavations, some of these finds have come from extensive excavation efforts. At the Theriault chert quarry site along Brier Creek, for example, a single fluted point was found just above the sterile clay, in an excavation block encompassing 142 m^2 (Brockington 1971). The single fluted point found at Rucker's Bottom, on the upper Savannah River, came from an excavation block 160 m^2 in extent (Anderson and Schuldenrein 1985). Dense Paleoindian components have been found in test excavations at two locations, at the Taylor Hill site near Augusta, and at the Muckafoonee Creek site near Albany. At Taylor Hill the density of material was high—565 tools were found in the 12 test units, including 2 fluted points and 2 Daltons (Elliott and Doyon 1981). Given the high diversity of flake tool and variety of raw materials, the site has interpreted as a residential camp or a specialized logistical camp. The site is in an ideal location for settlement, on the Fall Line ecotone. The Muckafoonee site, a quarry/workshop, is a stratified Archaic to late

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Paleoindian deposit situated on a terrace of Muckafoonee Creek in Dougherty County (Elliott 1982). Chert outcrops occur both to the southeast on the Flint River, and nearby along Muckafoonee Creek. Six m^2 were examined, and the Paleoindian/early Archaic levels contained 59 tools and 6,407 flakes, including 1 fluted point.

Several Paleoindian components have also been found in testing operations in and near the Wallace Reservoir along the central Oconee River in recent years (O'Steen et al. 1986). Most recently O'Steen et al. (1986) have prepared an overview of Paleoindian settlement in the Georgia piedmont, based on data from a 60 km stretch of the Oconee River watershed. Paleoindian points were grouped into three subperiods, early, late, and transitional. The first subperiod, early Paleoindian, contains fluted points similar to the traditional Clovis form. The points are relatively large and thick with nearly parallel haft edges, slightly concave bases and single or multiple flutes. The second subperiod, late Paleoindian, is characterized by small fluted points and fluted or unfluted points with exaggerated constrictions of the haft. These points are presumed to be later, although absolute stratigraphic evidence is lacking locally. These two groups are assumed to date from ca. 11,500–11,000 yr B.P., and 11,000–10,500 yr B.P., respectively. Some temporal overlap of these forms is probable, and it is also possible that the late Paleoindian forms continued in use after 10,500 yr B.P., into Dalton times. Dalton points, varyingly referred to as Paleoindian, early Archaic, and transitional Paleoindian make up a 'transitional' Paleoindian grouping.

Ninety-one Paleoindian sites yielding 141 diagnostic hafted bifaces were identified in the study area, including 9 early Paleoindian (N = 11 points), 14 late Paleoindian (N = 24 points), 67 Dalton (N = 106 points), and 3 indeterminate Paleoindian components. Three site types were recognized, based on site location, size, and diversity of the tool assemblages. These types included small low density camps, quarrys, and possible base camps. A fourth type of Paleoindian site, isolated point finds, may reflect individual kill sites or foraging camps. Most of the components in the sample are small limited activity sites. Sites were also examined by landform, and a gradual expansion into new areas over time is indicated. Early Paleoindian sites were located primarily in the floodplain. Later Paleoindian sites still appear frequently in the floodplain, but there is evidence for increased exploitation of the upland or interriverine areas. A majority of the Dalton sites, in contrast, were in the uplands. The use of local as opposed to extralocal raw material increases dramatically over time in the Wallace Reservoir sample. Early Paleoindian diagnostics are predominantly on extralocal materials, while only small numbers of late Paleoindian and Dalton diagnostics were made on extralocal cherts (O'Steen et al. 1986).

The coastal plain and ridge valley provinces appear to have been more heavily utilized than the piedmont during the earlier Paleoindian period. Piedmont Paleoindian points tend to be small and extensively reworked, suggesting, possibly, that the area was on the fringes of settlement networks centered elsewhere. Areas where large numbers of Paleoindian points have been found closest to the Georgia piedmont are in northern Florida, the Atlantic Coastal plain, and in the ridge and valley province (Anderson et al. 1986a). The Georgia piedmont may thus represent a relatively unoccupied area between two or more population "concentrations." Raw material distributions (measured on diagnostic points), furthermore, suggest that interaction between these areas was fairly minimal.

Another locality characterized by dense late Pleistocene/early Holocene settlement is located in south central Georgia. The Feronia locality is a concentration of 16 sites

located near the Big Bend of the Ocmulgee River in northern Coffee County (Blanton and Snow 1986). An extensive late Pleistocene/early Holocene assemblage has been recovered in surface context from the locality, including Suwannee, Dalton, and side and corner notched points, and an array of formal unifacial tools. A wide range of lithic raw materials is present, suggesting a considerable range of movement and/or exchange was occurring. A noteworthy aspect of the Feronia locality setting is that it is not near lithic raw material outcrops. The nearest known lithic sources of any significance lie ca. 80 km away. The area is, however, very near the interface between the Atlantic and Gulf watersheds, a divide that may have had considerable territorial or social significance in the late Pleistocene/early Holocene.

Coupled with intensive research at specific sites and localities, Paleoindian research in Georgia has also recently focused on the compilation of projectile point data. In mid-1986, the authors began a fluted point survey, something that, surprisingly, had not been initiated previously (Anderson et al. 1986b). Prior to the start of this effort, fewer than a dozen fluted points were formally recorded in the state site files. In the massive compilation of fluted points from eastern North America conducted by the Eastern States Archaeological Federation (Brennan 1982), only 10 of 5,820 Paleoindian projectile points came from Georgia. The low count from Georgia was underscored by the high totals from adjoining states, and represented a conspicuous gap in the Paleoindian data base from the eastern United States. The Georgia Paleoindian Fluted and Lanceolate Projectile Point Recordation Project was initiated to correct this situation.

The goal of the project is documentation: compiling evidence, in the form of descriptions, of diagnostic Paleoindian artifacts and site locations across the state. To do this, information about diagnostic Paleoindian artifacts is being collected, using a standardized form modeled after those currently in use in a number of southeastern states. Both fluted and non-fluted Paleoindian points of all types are being recorded, including Clovis, Suwannee, Simpson, Cumberland, Quad, Dalton, and other forms; complete, broken, and reworked points are all being examined.

In the six months since the project was started, information on 74 fluted Clovis or Clovis variants, 18 unfluted Paleoindian lanceolates, and well over 100 Dalton points has been collected. Excluding Daltons, information on 92 probable pre-Dalton Paleoindian points has been submitted. Fluted points have been recorded from 28 counties so far, mostly from the northeastern and southern parts of the state. In addition to the fluted and non-fluted lanceolates, large numbers of Dalton points have been noted. Many of the Georgia Dalton points are fluted or, more properly, basally thinned, arguing for a direct, possibly local transition from earlier fluted point assemblages. Although just beginning, within a few years Georgia should have as solid a data base on the Paleoindian as exists anywhere in the eastern U.S.

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Paleoindian Occupation in Central-Eastern California: The Komodo Site

Mark E. Basgall

Although Paleoindian occupation of central-eastern California has been posited on the basis of isolated projectile point finds (Campbell 1949; Davis and Shutler 1969; Glennan 1971), spatiotemporally discrete assemblages have gone unreported. Recent archaeological investigations at the Komodo site (CA-Mno-679) in Long Valley caldera, Mono County, California, have identified such a component. Characterized by basally-thinned, edge- and basally-ground concave-base projectile points, the assemblage is provisionally dated to the early Holocene.

The site is located in the center of the caldera, several kilometers west and southwest of the Owens River. At an elevation of 2,160 m, it sits on a slight rise that provides a wide view of the valley floor. The Komodo site covers an area of about 3,200 m^2, however, the core part of the deposit is no more than 1,000-2,000 m^2 in extent. Cultural material is confined to the upper 15 cm of soil, which is a homogeneous mixture of volcanic ash and sand. Eroded beds of hydrothermally altered sandstone underlie the soil zone.

The Komodo assemblage is composed entirely of flaked stone; despite excavation of 60 m^3 of deposit, no faunal or floral remains, ground stone, or features were encountered. The artifact inventory is functionally restricted, containing broken pro-

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jectile points, bifacial preforms and blanks, core/cobble fragments, and debitage. Diagnostic points associated with the component are concave base specimens, thinned basally by two or more flake removals on at least one face, edge ground, and, in a number of cases, basally ground. Of 42 specimens, 24 (57%) are ground on both margins, 12 (29%) on a single edge, and 21 (50%) are basally ground. All but three points (reworked, complete items) comprise proximal fragments snapped at the haft.

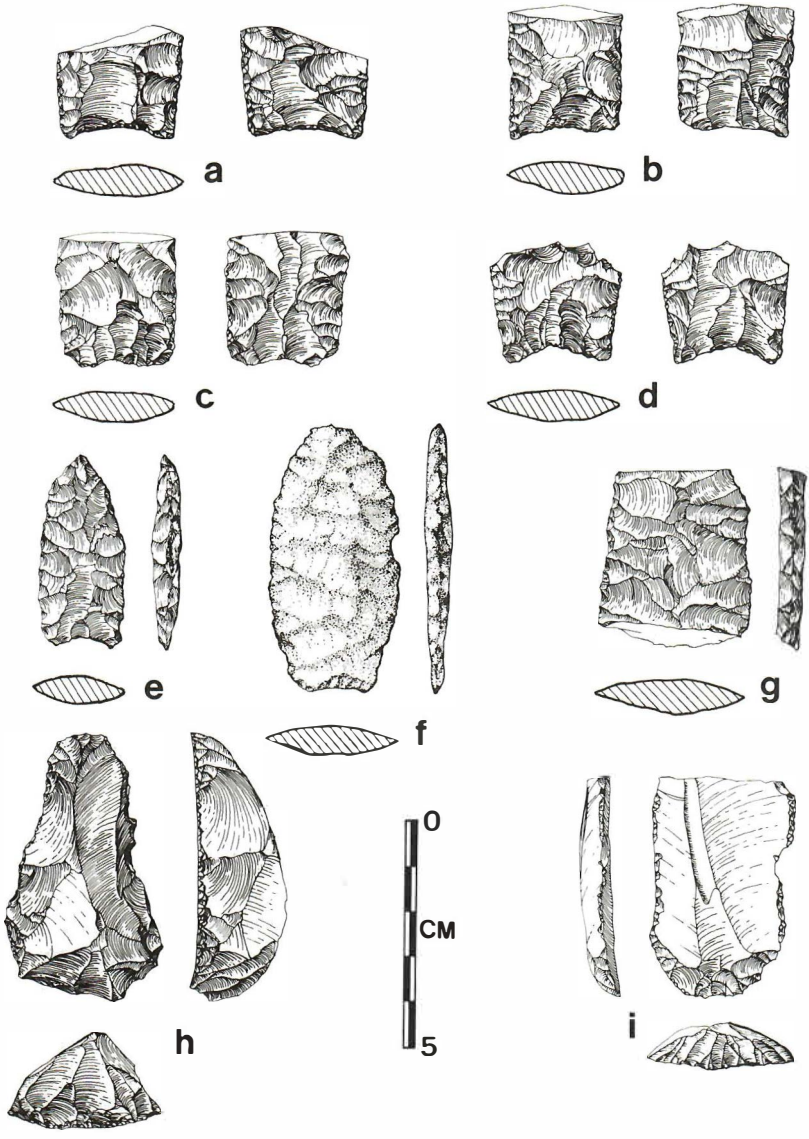

Figure 1. Artifacts from the Komodo site.

The remaining tool inventory includes 64 bifaces (14 late stage; 28 preforms; 11 blanks; 11 indeterminate stage), 49 retouched unifaces (13 steep-edged, plano-convex; 16 acute-edged, thin-section; 19 simple, irregular), 11 core/cobble fragments, several miscellaneous fabricating implements (cf. gravers), over 150 edge-modified flakes, and more than 4,000 pieces of unmodified debitage (Figure 1). The latter consist primarily of small percussion and pressure retouch flakes. In the larger size fraction, biface thinning flakes are most typical (also serving as blanks for many of the flake tools), but smaller amounts of core shatter are present.

Most of the flaked stone from Komodo is obsidian. Various cryptocrystallines and fine-grained igneous materials are present in limited amounts, particularly within the debitage class, where they occur principally as smaller finishing and resharpening debris. This suggests that most non-obsidian arrived at the site in finished or near-finished form. Within the obsidian assmeblage, X-ray fluorescence (XRF) trace element analysis has identified seven distinct sources. These include four (Casa Diablo, Truman/Queen, Fish Springs, Mono Glass Mountain) that are commonly represented in archaeological collections dating to more recent periods in the region, as well as three "unknowns" that cannot be geographically traced at present and are all but absent from later assemblages (Basgall 1984, n.d.; Hall 1983; Jackson 1985). Although the sample of geochemically analyzed specimens is limited to 34 items, macroscopic evaluation (cf. Bettinger et al. 1984) corroborates the XRF results in indicating that all artifact classes exhibit substantial source variability.

The Komodo site is situated virtually on top of the extensive Casa Diablo obsidian quarry, yet 53% of the sourced artifacts are from other glass localities. Again, this contrasts to later sites in the region, and reflects raw material acquisition across a wide area.

The chronological position of the Paleoindian component at Komodo can be estimated on the basis of artifact typology, relative source-specific obsidian hydration measurements, and absolute hydration rates derived for specific source types present in the collection. Morphologically similar points have been consolidated under the rubric "Great Basin Concave Base" elsewhere in the Great Basin (Pendleton 1979). The few radiocarbon assays associated with such forms range between perhaps 8,000 and 11,000 yr B.P.

Twenty-two of the points chemically assigned to the Casa Diablo source were subjected to hydration analysis. A range of from 7.5 to 12.2 μ was obtained, with a mean meaurement of 9.6 μ. Two unifaces produced readings of 9.5 and 10.5 μ, and four bifacial preforms ranged from 8.1 to 8.5 μ. When contrasted to hydration profiles for other dated point types in the region (cf. Hall 1984; Jackson 1985), it becomes apparent that measurements on the Komodo points average 2.6 μ larger than the oldest Pinto/Little Lake points (dated ca. 3,150–5,950 yr B.P.) yet analyzed (the latter ranging from 4.8 to 6.9 μ). Thus, if Casa Diablo hydration measurements of 7.0 μ correspond to an age of about 6,000 years, the Komondo specimens are clearly markedly older.

A number of empirically derived hydration rates have been proposed for Casa Diablo glass (e.g., Hall 1984; Meighan 1981; Michels 1982). These include both linear and curvilinear models that provide divergent, although not incomparable calendrical estimates. Meighan (1981), for example, has proposed a rate of approximately 1,000 years/μ; this would place the Komodo points between 7,500 and 12,200 yr B.P. (average, 9,600 yr B.P.). Hall's (1984) curvilinear rate, which is probably more reliable for earlier periods, provides an average age estimate of 8,100 yr B.P.; the largest

hydration measurement would correspond to an age on the order of 12,500 years. In the absence of radiometric associations with Casa Diablo obsidian hydration measurements of such age, extrapolation from middle Holocene contexts (e.g., Elko and Pinto/Little Lake materials) still suggests that the Komodo site is at least 8,000 years old, and perhaps more ancient.

The narrow functional range of the Komodo assemblage is consistent with the site's role as a "location" (Binford 1983) or some such equivalent, and the inventory suggests that on-site activities were hunting-related. A predominance of point bases, snapped well below the blade midpoint, could indicate that broken points were returned to the site in still hafted, then removed and discarded. The occurrence of bifacial preforms and blanks, together with a high incidence of biface thinning flakes, provide evidence that point replacements were also being fashioned at Komodo (and an even distribution of fragment types across these classes is consistent with failed reduction). A wide array of flake tools and modified flakes suggests that processing activities (i.e., butchering) occurred at the locality. The steep-edged unifaces were probably associated with hide preparation. Finally, obsidian source profiles reflect lithic procurement over a large territory, and given that material acquisition was likely embedded within the broader subsistence-settlement system, the annual range of the Komodo occupants appears to have been quite extensive.

Three seasons of work at the Komodo site were funded in part by the University of California, Davis, the U.S. Forest Service, and Far Western Anthropological Research Group, Inc. Obsidian hydration and XRF analyses were performed gratis by R. Jackson and R. Hughes, respectively. The author extends his thanks to these individuals and institutions-agencies, as well as students and colleagues (particularly M. Biorn and J. Onken) for volunteering during field and laboratory phases of the project.

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Paleoindian Components at 36LA336, Lancaster County, Pennsylvania

Jay F. Custer and Glen R. Smoker

36LA336 is a recently discovered Paleoindian site in the Triassic uplands section of the southeastern Pennsylvania piedmont. Intensive surface collections of the site have produced an assemblage of more than 300 artifacts, 12 of which are bifacially flaked tools and 20 of which are unifacially flaked tools. The remaining artifacts are all debitage. Of the six finished projectile points, two are broken fluted points (Figure 1) and one of these is clearly a Clovis point base. Both fluted points, and 95% of

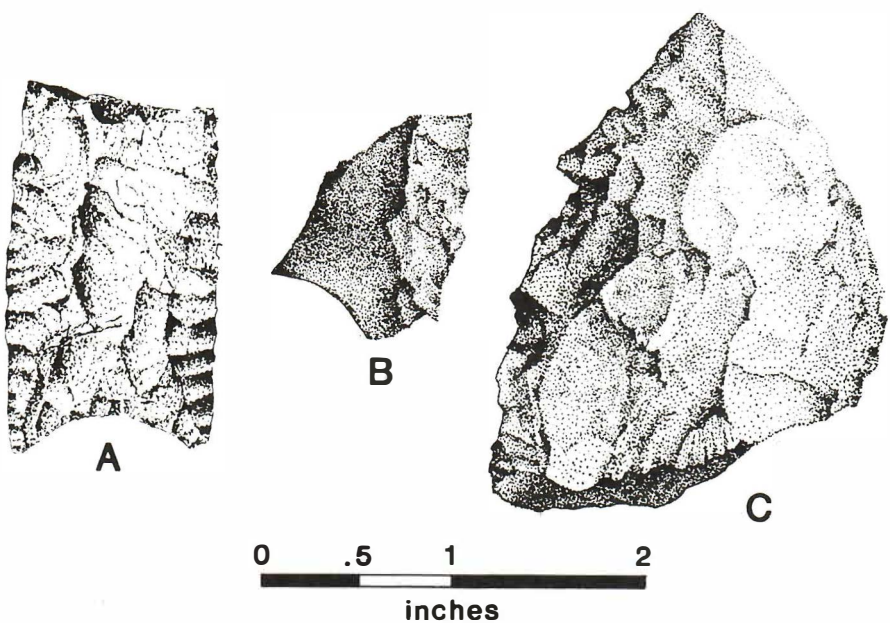

Figure 1. Bifacial tools from 36LA336, all made from jasper.

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the entire lithic assemblage, are manufactured from jasper and black chert. The remaining Archaic period projectile points are quartz and quartzite. Twelve of the flake tools are steeply retouched end scrapers. No flake tools with multiple working edges are present.

The local environmental setting of the site is a small rise adjacent to a swampy frequent floodplain of a low order ephemeral tributary of the Conestoga Creek within the Susquehanna drainage. The Triassic uplands of the southeastern Pennsylvania piedmont contain many of these small, poorly-drained lowlands interspersed by upland knolls of varying elevation. Marsh Creek, a similar poorly-drained area approximately 35 km southeast of 36LA336, produced a series of pollen samples dated to the late Pleistocene and early Holocene (Martin 1958). These pollen samples indicate that a mixed boreal forest with interspersed hydrophytic seres was present in the Triassic uplands during Paleoindian times. The local environment of 36LA336 is interpreted as an interface of the upland boreal woodlands and the low-lying swampy floodplain. Such a setting would be a highly attractive hunting and gathering environment.

Although many of the artifacts had been washed, all bifaces, tools, and a random sample of the debitage were analyzed at the University of Delaware Center for Archaeological Research for the presence of blood residues using techniques originally developed by Loy (1983). Most of the tools studied showed negative reactions to the test; however, a large early stage biface (Figure 1) showed a strong positive reaction. No signs of use wear are readily apparent on the tool. Of the random sample of 45 unmodified flakes tested, 5 (11%) showed strong positive reactions. Samples of residues have been saved for possible species identification. Flakes and the biface fragment showing positive blood residue reactions will be subjected to high magnification edge wear analysis to determine if the blood residues are associated with artifacts' use as tools or if the blood is derived from accidental splashing or spills.

Based on the preliminary data presented here, it is hypothesized that 36LA336 is a Paleoindian procurement site based on its small size, limited tool types, and location.

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Lithic Flake Attributes: Calico Lithic Specimens and Experimental Knapping—A Comparison

Louis V. Hoffman, Ruth D. Simpson, Rose Marie Higginbotham, and L.W. Patterson

Calico Early Man site, located in the Mojave Desert of southern California, has long been the object of some controversy. In approaching the question of whether or not Calico lithic specimens are the products of human manufacture, L.W. Patterson proposed that a flake attribute study be done on a large representative sample from the Calico collection. Patterson (1983) stated that "controlled flaking by man results in predictable attibute patterns that can be subjected to qualitative and quantitative analyses." Accordingly, such a project was started in May, 1982. From the Calico collection stored in the San Bernardino County Museum, 13,678 specimens from 5 units randomly selected from the 30 units in Master Pits 1 and 2 were examined. From these specimens, all flakes larger than 15 mm^2 (N = 3,337) were subjected to further detailed analysis.

Patterson (1983), in commenting on the value of experimental verification, stated that "all types of objects in proposed early man collections can be replicated, using the same types of raw material as the original specimens. Attributes of experimental man-made specimens can be compared with matching items in collections under study. Possible manufacturing techniques and patterns can thus be studied with more confidence in conclusions." So it was suggested that an experimental knapping project be undertaken by Hoffman, using material found on the surface near the Calico site. The knapping was done under strictly controlled conditions, using a clean floor from which all material could be retrieved. The total weight of the retrieved material, including spent cores (but not including hammerstones), was 2.9 kg. All of the material was screened; 0.16 kg passed through window screen. All of the 3,803 pieces which did not pass through 3 mm screen were examined. Among these were 473 flakes larger than 15 mm^2, which were subjected to the same analysis as the flakes from the Calico site.

In this analysis, a flake was defined as a rock specimen having a length or width at least three times its maximum thickness. All flakes were examined for the presence of bulbs, bulb scars, ripple lines, striking platforms (condition, angle and type), number of dorsal face facets, flake type (primary, secondary or interior according to amount of cortex present), flake size and thickness, flake material and evidence of edge rounding due to transport.

In comparing the results of the analyses, 26.2% of the Calico flakes had force bulbs, and 24.3% of the experimental flakes had bulbs. 11.8% of the Calico flakes with bulbs had bulb scars, and 18.3% of the experimental flakes having bulbs had bulb scars. Ripple lines were present on 18.5% of the Calico flakes and on 33.4% of the experimental flakes. Ripple lines may be related to the type of material being frac-

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tured as well as force employed. Striking platforms were intact on 4.5% of the Calico flakes and on 13.7% of the experimental flakes. Acute striking platform angles were found on 94.3% of the Calico flakes, compared with 95.5% of the experimental flakes. The number of major dorsal face facets can indicate serial impacts on a core. The Calico flakes with a single such facet accounted for 52.0% of the flakes, 41.0% had two facets, and 5.1% had three facets. Of the experimental flakes, 51.8% had single facets, 35.7% had two facets, and 5.3% had three facets. Flakes whose dorsal surface is covered with cortex are classified as primary flakes. There were 10.0% primary Calico flakes and 9.1% experimental. Secondary flakes are those whose dorsal surface is partially covered with cortex, and for Calico, 19.3% were secondary flakes, and 29.8% experimental secondary flakes. Interior flakes are those with no cortex remaining on the flake. 70.6% of the Calico flakes were interior flakes, and 61.1% of the experimental flakes were interior flakes.

Flake size distribution curves for Calico and experimental flakes are almost identical in shape, being skewed toward higher percentages of smaller size flakes. The values are quite similar with no significant difference between Calico and experimental data. The average thickness was 6.8 mm for Calico and 5.8 mm for experimental flakes. Of the Calico flakes examined, no evidence of edge rounding due to transport was found, and sharp edges were evident on the experimental flakes, as was to be expected.

In view of the similarity of results, the evidence found in this comparison study of lithic flake attributes would seem to indicate that there is a good possiblility that Calico flakes may be the products of lithic manufacture by early man.

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The Occurrence of Folsom Points in Oklahoma

Jack L. Hofman

Eight Folsom and two Midland points from the Cedar Creek locality in Washita County comprise the most extensively studied collection of Folsom material in Oklahoma (Bell 1954), but no discrete Folsom component has been documented. Despite considerable archaeological research in Oklahoma, only one Folsom point has been recovered as the result of state or federally funded work (Hughes 1977). This highlights the importance of avocational input and reliance on private collections in locating and studying Paleoindian materials and sites. Folsom points are now known from 23 counties (Figure 1), primarily in the western half of the state. At least 110 Folsom points, preforms, and fragments are known, but detailed information is presently available for only 75 specimens, of which 31 are isolated finds or are from sites with no other Folsom material.

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Approximately one-third of all presently known specimens have been collected from a single locality (Cedar Creek), but at least nine additional sites and localities have produced multiple finds of Folsom artifacts. A few sites have buried deposits of Folsom age, and future studies should provide useful information for interpretation of Folsom economy and environment ca. 10,500 B.P. These localities are Cedar Creek in Washita County (at least 37 Folsom points documented), Payne Canyon in Blaine County, Bethel locality in Caddo County, the Winters and Beckner sites in Jackson County, Cox City locality in Grady County, the Lake Texoma area in Marshall County, the Riddle locality in Ellis County, and the Stegelman site in Kingfisher County. Selected information pertaining to these locations has been summarized elsewhere (Hofman 1986).

Many studied specimens exhibit impact fractures and reshaped distal ends or reshaped bases. Two asymmetrical specimens may have been used as knives, but no use wear analysis has been undertaken. My impression, based on numerous impact fractured distal ends and few intensively retouched lower laterial margins, is that finished Folsom points were seldom used as knives.

Flaking patterns on Folsom point margins do exhibit variability. Several have oblique flaking from the upper left to lower right (viewed with the distal end up) and most of these pieces fall within Sollberger's (1985) Variety 3 Folsom points having substantial post-fluting marginal retouch. The significance of such variability has yet to be adequately investigated.

Diverse frequencies of lithic types are manifest in different areas of the state. The 75 specimens of known material type are made predominantly of Edwards chert (N = 43, 57.3%). This figure may actually be low as several of the "unidentified" chert specimens may actually be Edwards. The intensive use of Edwards among Folsom knappers is well documented in other collections from the region (e.g. Hester 1972). Second in importance in the Oklahoma sample is Alibates (N = 12, 16%). All but three of the Alibates Folsoms are from the Canadian River drainage or further north. Folsom points manfactured from Niobrara jasper (N = 3, 4%) have been recovered from Harper, Caddo, and Jackson counties. Further analysis may facilitate the definition of "boundaries" or spatially discrete breaks in the frequencies of Folsoms made

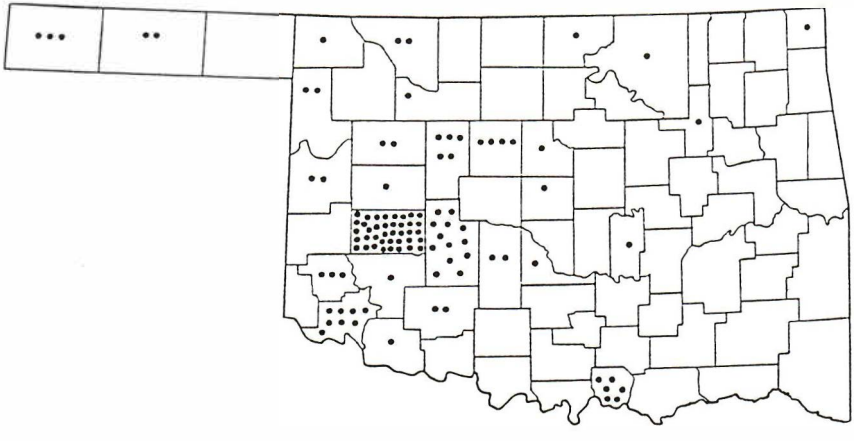

Figure 1. Distribution of Folsom points and fragments in Oklahoma by county as of 1986.

from Alibates, Edwards and other distinctive materials. Raw material variability, when studied in conjunction with production stage, breakage, and rejuvenation patterns, should relate to such factors as distance and direction of movement, exchange of materials, and the consistency or redundancy of these activities.

Technological variability is evident by occurrences of both bifacial and flake blank preforms. With the possible exception of pseudo-fluted Folsoms, all of Sollberger's (1985) Folsom varieties are represented in the Oklahoma collections. Removal of at least three channel flakes is evident on several specimens and this may relate to variation in preform thickness and production of ancillary tools from Folsom preforms.

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Instrumental Neutron Activation Analysis of Archaeological Quartzite from Cummins Site Thunder Bay: Determiniation of Geological Source

P.J. Julig, L.A. Pavlish, and R.G.V. Hancock

Cummins is a large stratified quarry/workshop and habitation site in Thunder Bay, Ontario (Figure 1, inset). It is located on a proglacial Lake Minong beach, with Plano period taconite assemblages in beach deposits of terminal Lake Minong (ca 9,500 yr B.P.). The initial occupation is represented by deeply buried water-worn artifacts in lag gravels dating to an earlier Minong phase ca. 10,100 yr B.P. (Julig 1984; Julig et al. 1986). Basal organics from Cummins pond ^{14}C date to 11,080 ± 190 yr B.P., DIC-3241.

Lithic artifacts are predominately local taconites, with exotic dark brown cherts, agates, siltstone, quartz and quartzite sparsely represented. Difficulties exist in precise visual identification of many lithic materials, particularly on Paleoindian sites where samples of geologically remote sources may be represented. The nature of the Cum-

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mins archaeological specimens, small flakes and occasional complete tools, precluded the petrographic (thin section) method of identification. In this study, instrumental neutron activation analysis (INAA) of short half-life elements (major, minor, and trace) was conducted with the objective of: 1) characterizing archaeological samples with respect to a specific suite of short half-life elements, 2) likewise characterizing prospective geological sources, and 3) comparing the results in attempting to determine sources. While INAA was conducted on all major exotics at Cummins, this note will consider only the analysis of quartz and quartzites.

Quartz is fairly ubitquitous on the Canadian Shield and was used by Paleoindians and subsequent cultures. However, quartzite artifacts are less frequent, and certain sugary orange specimens from the Cummins area compare favorably with Hixton silicified sandstone. Hixton is a sugary white to orange quartzite (opal and chalcedony cemented quartz sand grains) from Silver Mound in Jackson County, westcentral Wisconsin (Porter 1961), and was widely used by regional Paleoindians (Mason 1963). Hixton is reported in Paleoindian components from northwest Minnesota to Lake Agassiz beaches in northwest Ontario (Fox 1975). Clovis points of Hixton have been reported, but the Scottsbluff type are most common, including a recently recovered specimen at Thunder Bay. Another type of sugary (white to pink) quartzite heavily utilized by upper Great Lakes Paleoindians is Lorraine (Sheguiandah) quartzite from the Sheguiandah site, Manitoulin Island, northern Lake Huron (Lee 1955).

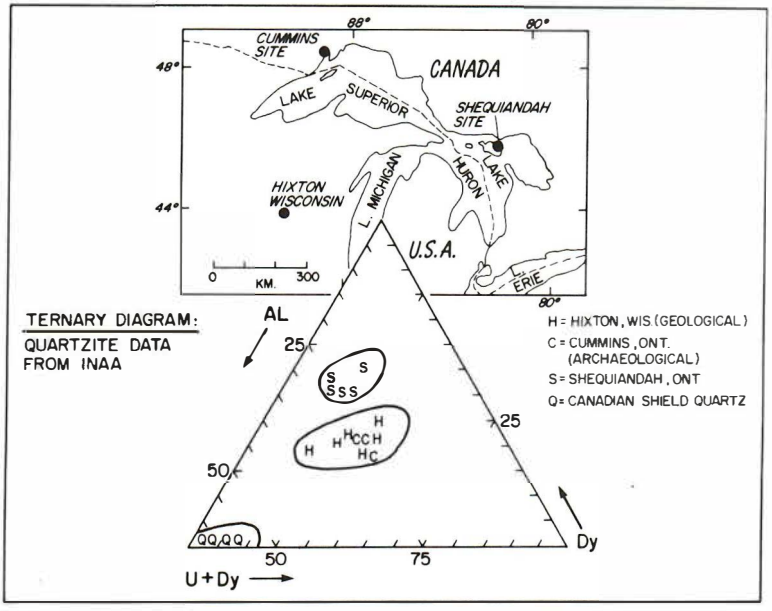

Figure 1. Shows the source location of the materials analyzed. Ternary diagram indicates geological quartzites from Hixton WSs. (H) are chemically similar to Cummins archaeological quartzite (C) and clearly separated from Sheguinadah quartzite (S). Canadian Shield quartz from the Thunder Bay area is also chemically distinct. The data on the ternary diagram is derived from the formula: (U + Dy) + Dy + AL = TOTAL (T). Thus: $\frac{(U + Dy)\% + Dy\% + AL\%}{T \quad T \quad T} = 100\%$

The concentration of 16 major to minor trace elements, which produce short-lived radioisotopes upon neutron activation, were determined for a series of samples at the University of Toronto SLOWPOKE Reactor Facility. Samples of 200–300 mg were irradiated for five minutes at a flux of 5×10^{11}n. $cm^{-2}s.^{-1}$. After allowing the ^{28}Al to decay for 18 minutes the samples were assayed using a solid state gamma ray spectrometer. Elemental concentrations were calculated from the net gamma ray peak areas using the comparitor method.

The INAA results of the Cummins archaeological specimens and geological sources are shown on Figure 1. Of the 16 elements measured, Dysprosium (Dy), Aluminum (Al), and Uranium (U) proved to be the most diagnostic. Sheguiandah quartzite clearly separates from the Cummins archaeological quartzite, with greater Dy. Local Thunder Bay quartz is distinctively lacking in Dy. The archaeological samples tested match well with the geological Hixton from the Wisconsin quarries, suggesting that Hixton silicified sandstone was transported to Cummins by regional Paleoindians, probably as a result of social interaction with southern bands. This research supports the previous visual identification of Hixton artifacts in the Thunder Bay region.

We Wish to thank William Ross for the Hixton geological samples. The Ontario Heritage Foundation and Social Sciences Humanities Research Council of Canada (SSHRC) funded the Cummins Paleoindian site investigations. The INAA was made possible by the NSERC infrastructure grant to the SLOWPOKE Reactor Facility. Further information on this study is available from the authors.

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The 30,000-Year-Old Lithic Components from the Musashidai Site, Tokyo, Japan

Charles T. Keally and Izumi Hayakawa

Musashidai is a prolific upper Pleistocene archaeological site, particularly noteworthy for two large collections of lithics from its deepest cultural layers, designated Xa and Xb (Toritsu Fuchu Byoin-nai Iseki Chosadan 1984). These lithics are stratigraphic-

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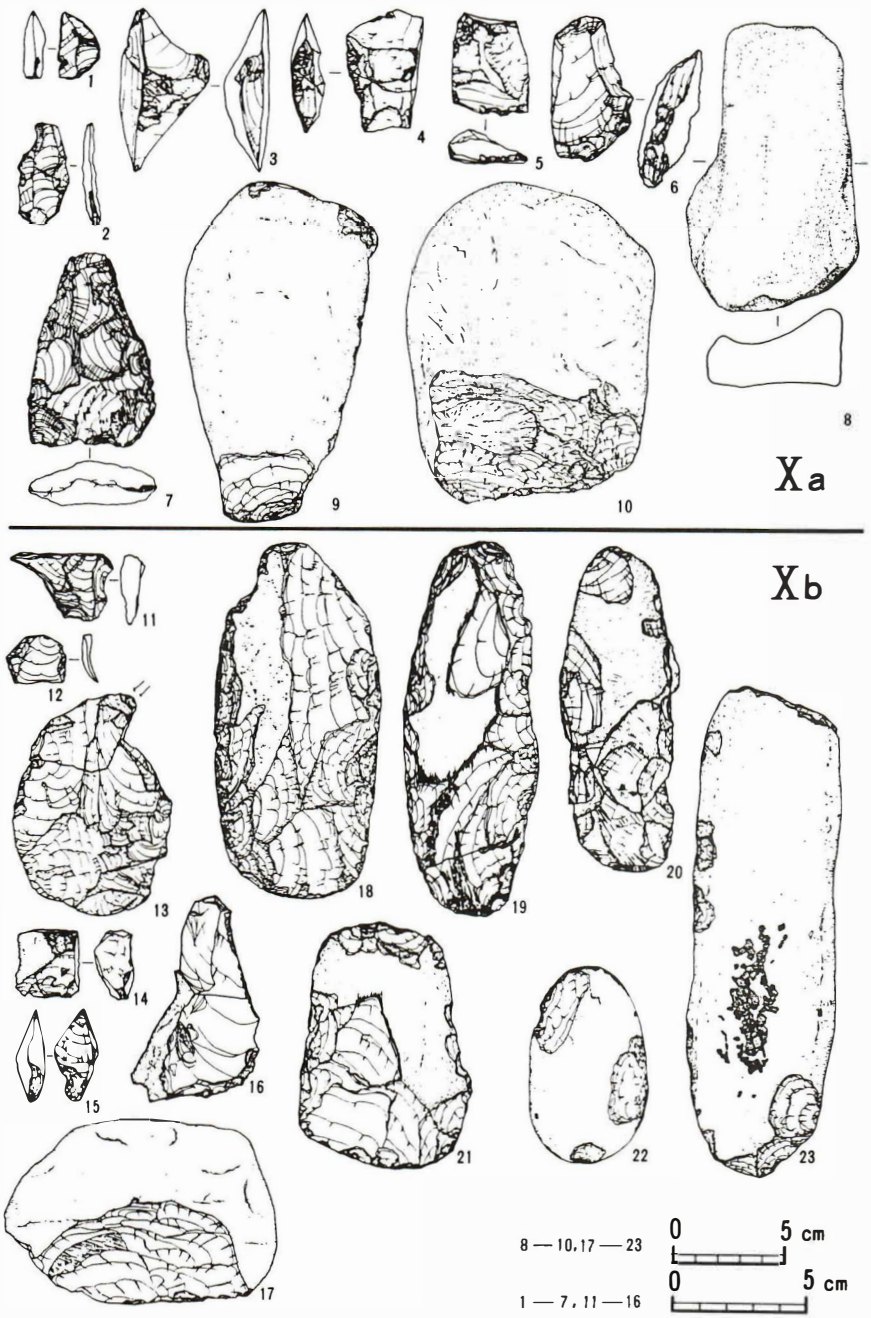

Figure 1. Lithic artifacts from components Xa and Xb at the Musashidai site, Tokyo, Japan.

ally among the oldest generally accepted human artifacts in Japan, and they belong typologically to Phase Ia and early Phase 1b in the Musashino upland sequence (Oda and Keally 1979).

The site is situated on a 12 m bluff on the Musashino Terrace, near the southern edge of the large Musashino Upland, about 30 km west of downtown Tokyo. The area is rich in Palaeolithic sites (Akazawa et al. 1980), several of which have components of about the same age as the oldest at Musashidai—for example, Nakazanya (Kidder and Oda 1975) and Nishinodai Location B (Oda and Keally 1974; Oda 1980). Excavations conducted at Musashidai since 1979, under the direction of Hideichi Sakazume, have unearthed about 2,000 m^2 of the site so far, with an additional 5,500 m^2 now in progress. The site has not been dated directly through chronometric dating methods, but the geology of the site is clear and the components can be readily compared stratigraphically to well-dated geological and cultural sequences in dozens of nearby sites: the Musashidai Xa and Xb components are around 30,000 years old or slightly older. The size of these two collections and the thoroughness with which they have already been studied give an unusually good idea of the range of tool types and technology possessed by the likely earliest inhabitants of the Japanese islands.

Component Xa contains 209 stone artifacts, including 156 flakes. The tools are 6 knife-shaped tools (Figure 1:1–3), 1 spatula-shaped tool (Figure 1:4), 3 gravers, 4 scrapers (Figure 1:5–6), 33 various amorphous flake tools, 1 edge-ground obsidian ax-like tool (Figure 1:7), 3 double- and single-edged pebble tools (Figure 1:9–10), and 2 whetstones (Figure 1:8). The edge-ground ax-like tool is 7.2 cm in length. A large proportion of the lithics are obsidian (Figure 1:1–7), mostly from sources near Wada Pass in Nagano prefecture, about 100 km to the west. This is the oldest known occurrence of obsidian artifacts in Japan.

Component Xb contains 3,203 stone artifacts. Of these, 3,055 are flakes and chips, and 38 are cores. Refitting of these artifacts resulted in reconstruction of 98 nodules, which show a relatively opportunistic use of platforms for flake removal and no apparent attempt to produce flakes of any definite shape or size. The tools are 66 varied and difficult-to-define flake tools (Figure 1:11–16), 2 chipped ax-like tools (Figure 1:18), 6 edge-ground ax-like tools (Figure 1:19–21), 4 double- and single-edged pebble tools (Figure 1:17), 2 pointed pebble tools, 28 pounders (Figure 1:22–23), and 2 whetstones. The chipped and edge-ground ax-like tools range in length from 9.4 to 19.1 cm. These are perhaps the oldest examples of such tools in Japan (Oda and Keally 1973). The grooves in the whetstones (including those from Xa are smaller than the blades of the edge-ground tools and might indicate the production of wood or bone tools (Ikawa-Smith 1986:204).

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Fluted Points from the Pacific Northwest

David J. Meltzer and Robert C. Dunnell

Fluted points are rare in the Pacific Northwest. With the notable exception of the Dietz site in south-central Oregon (Fagan 1986), there are only 20 isolated fluted point occurrences in Oregon and Washington; 9 were found west of the Cascade Mountain Range (Aikens 1983; Carlson 1983; Minor 1985; Osborne 1956). Most of these appear more Clovis-like than Folsom. None have been reported from British Columbia (Roberts 1984).

The scarcity of fluted points in this region underscores the importance of any new finds, so we report here a fluted point from the Puget Lowland, south King County, Washington (45-KI-215), and discuss the implications of fluted points from this region for the origin of the fluting technology and a coastal route for the peopling of the Americas.

In the summer of 1983, a fluted point was discovered by an avocational archaeologist in peat recently mined from a commercial peat bog south of the city of Seattle. The 53 acre bog is a remnant of an ice-block kettle situated on top of a glacial-laid terrace approximately 100 m above the floodplain of the Cedar River. Because the point was found in a secondary context it was possible to determine that it came from the shallow (ca. 3 m) edge of the bog, the area then being mined, but not precisely within that area. We cleared a vertical face on that part of the intact bog closest to the location where the owner indicated peat had been mined when the point was found. No additional artifacts or cultural features were detected.

The exposed bog section comprises three main segments: the uppermost segment of oxidized peat, including several well-defined layers of charcoal of variable thickness and a tephra layer (78 to 85 cm below the surface) attributable to a Mazama ash fall; a middle segment of partially decomposed peat including an additional undulating charcoal layer; and a basal segment of undifferntiated gyttja. This bog sequence is underlain by lacustrine deposits, the upper portion of which is clay mixed with organic debris and is separated from distinctly laminated blue clays by a 4 mm dark band. Underlying the laminated clays is a sandy gravel.

Two cores of the bog were taken by Matsuo Tsukada (University of Washington, Quaternary Research Center), one from near the approximate location of the point

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and the second from the center of the bog (ca. 10 m). The shorter core has been described elsewhere (Turner 1985) with particular reference to sponge macrofossils.

Presumably the point was deposited at the site sometime after local deglaciation (ca. 13,000 yr B.P.) and the lowering of proglacial lakes, perhaps 11,500 yr B.P. (Thorson 1980). Given the age of fluted points elsewhere, it was likely in place before the deposition of the Mt. Mazama ash ca. 6,800 yr B.P. (Sarna-Wojcicki 1983). Beyond that, a more precise age estimate is impossible.

In 30 years of peat operation no other artifacts or bone have been recovered from the bog which might provide a context for this find. The absence of fossil bone is attributable to the bog chemistry. Early in its formation it was neutral or alkaline (Turner 1985); today it is highly acidic. The area surrounding the bog has yielded few artifacts, mostly non-fluted projectile points and debitage (C. Hamilton pers. comm. 1983).

The fluted point itself (Figure 1) is manufactured of an orange chert weathered to dark gray. The chert source is unknown but could well have been local, given the abundance of glacially-derived chert gravels in the region. The point is finished and is ground on the base and midway up the blade on each edge. Presumably it was lost in use.

Flaking has obscured all traces of the original preform, and "finishing" basal retouch has removed much of the evidence for the fluting technique. There are multiple flute scars on each face; on the obverse face the main (medial) flute scar nearly covers a previous (lateral) flute. The flutes on each face are rather short and shallow, suggesting that fluting was from a beveled base, rather than a prepared nipple. This is evident also in the rather shallow basal concavity, and the lateral flute scars, which are necessary for fluting a point so thin and lacking a pronounced medial ridge. The flaking on the point is dominantly collateral, produced mostly by percussion, though

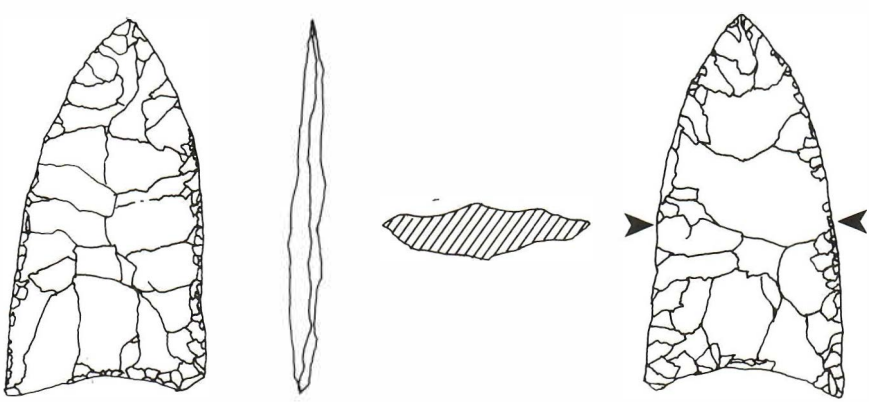

Figure 1. Fluted point from 45-KI-215. The arrows indicate the extent of laterial grinding on the specimen. Summary measurement data: maximum length: 48.83 mm, blade length: 46.51 mm, maximum width: 26.12 mm (partial measurement owing to corner break), basal width 26.12 mm (partial owing to corner break), maximum thickness: 5.94 mm, thickness at flute scar: 4.66 mm, obverse flute length: 17.39 mm, obverse fluted width: 8.96 mm, reverse flute length: 13.69 mm, reverse fluted width: 9.32 mm, edge grinding right: 19.29 mm (partial owing to edge break), edge grinding left: 23.21 mm, depth of basal concavity: 2.32 mm, weight: 7.4 g (*Drawing by Robert C. Dunnell*).

with some pressure flaking. The point does not exhibit evidence of reworking or use-wear. The two breaks, on the right corner and left blade edge are recent.

In morphology and size this point is decidedly not a classic Clovis form: it is quite small, thin, and sharp. In this regard, it bears a close resemblance to a fluted point found to the south in the Chehalis River Valley west of Olympia, Washington, and now housed in the Thomas Burke Memorial Washington State Museum (TBMWSM-1-1907). Osborne (1956) suggested this point might be a Plainview, but it is clearly fluted and not just basally thinned. Although once on loan to the Burke Museum, we were unable to locate for comparison an obsidian point from Olympia that Osborne (1956) identified as Clovis.

Krieger (1954) argued that northern fluted points were a late "backwash," the fluting technology having been invented earlier in mid-latitude North America thence carried northward. But more recently Clark and Clark (1983) have raised again the possibility that the origin of fluted points and the fluting technology was in Alaska or the far north. Yet none of the Alaskan specimens is firmly dated (Dumond 1980) or predate the earliest occurrences of fluted points in the south (Clark and Clark 1983). Nonetheless, by assuming it is "highly probable" that older dates on Alaskan fluted points will be forthcoming, and that the fluting technique lasted 2,000 years and could have begun in Alaska ca. 12,000 yr B.P., Clark and Clark (1983) propose a northern source for the points and the technology.

The Clarks' suggestion can be evaluated even in the absence of firm dates on northern fluted points. For it is implied in their argument that the technology of northern fluted point forms will not have attributes reminiscent of later Paleoindian point types, but instead will be similar to Clovis fluted points dated to 11,500 yr B.P.

Fluted points from the Pacific Northwest have a bearing on this debate. In technology, morphology, and form many of the Pacific Northwest points show similarities in basal and blade features to certain of the Alaskan fluted point materials (Meltzer unpublshed data; see illustrations in Clark and Clark 1980, 1983; Dumond 1980). Together they show features characteristic of *later* fluted points and fluted point technology. They tend to be thinner and smaller overall than the classic Clovis forms, and in their technology have affinities to later Paleoindian projectile points, such as the Plainview form, which perhaps explains Osborne's (1956) confusion regarding the Chehalis Valley point. This suggests, but by no means confirms, Krieger's belief (1954) that fluted points in Alaska and the far north are late in the Paleoindian sequence, and a "backwash" of the fluting technology moving north.

The scarcity of points from the Pacific Northwest, and their apparent late age within the Paleoindian period, provides no support for a model that the Americas was peopled by fluted point-making groups migrating down the Pacific coast from Alaska. This does not preclude a coastal migration by peoples lacking a fluted point technology.

We would like to thank Mr. Norman Dunstone for making the point available to us for study, and Mr. Clay Hamilton for permission to study and sample his peat bog. Dr. Matsuo Tsukada provided valuable information on the age and origin of the bog.

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Preliminary Study of the Distribution of Fluted Points in Nebraska

Thomas P. Myers

Surface collected material provides an overview of prehistoric occupations of an area. Excavated sites fill in the details. Both kinds of evidence yield important information about the past and are the bases for hypotheses for further research.

In a continuing survey of public and private collections, I have recorded 64 fluted points from the state of Nebraska: 19 Clovis and 45 Folsom (Figure 1). Nine of the Clovis points come from the tall grass prairies of the southeastern corner of the state, particularly from tier of counties which borders the Missouri River. Most of the rest come from the high plains of the Nebraska panhandle. In contrast, Folsom points are concentrated in the central portion of the state from its southwestern corner northward into the Sand Hills.

The contrasting distribution of Clovis vs Folsom points requires explanation. There is no reason to suppose that the collector prized one over the other. The near absence of Clovis points in the center of the state may be due to the fact that stream cutting has progressed far enough to expose Folsom points, but not Clovis. Indeed, most of the Folsom points from Lincoln County, where 13 points were found, have been found in an impoundment where the lake waters must have cut into a Folsom site. Farther to the west, there is reason to believe that the waters of the South Platte River

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are downcutting, since collectors report that they are beginning to find Paleoindian points for the first time. Such geomorphological considerations will not account for the near absence of Folsom points in the far west or in the southeast. Perhaps in the far west the sample sizes are so small that the apparent anomaly is simply due to sampling error but in the southeast the discrepancy may be an accurate reflection of the original distributions.

Most of the Clovis points in the southeast come from the bluffs overlooking the Missouri River which is now the northwesternmost extent of the oak-hickory forests of eastern North America. Some of the Clovis points were even found on the same site as Dalton points. It seems likely that these Clovis points are the products of an Archaic lifestyle focused on deer and forest products whereas those of western Nebraska were utilized by plains-dwelling mammoth hunters.

This proposed split between east and west is supported by the fact that the western Clovis points tend to be made of Republican River (Smoky Hill) jasper or other materials originating in the west whereas eastern Clovis points tend to be made of materials which probably originated in eastern Nebraska or east of the Missouri River. The apparent gap between eastern and western Clovis may reflect a transitional zone, marginal for both eastern and western economies. If so, the frequency of Folsom points in the center of the state may reflect either the eastward migration of the high plains and/or the less specific gastronomic prefrences of the bison. The near absence of Folsom points in eastern Nebraska may reflect the high plains orientation of their makers while eastern Nebraska, with its oak-hickory gallery forests, seems to have been occupied by peoples of the Dalton tradition.

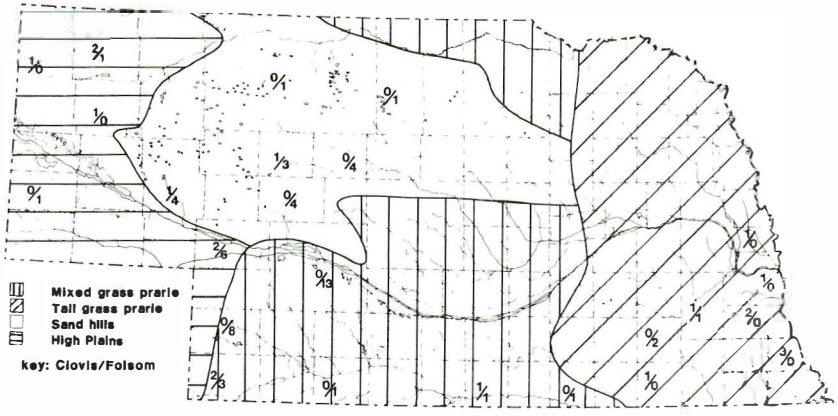

Figure 1. The distribution of fluted points in Nebraska.

The Diskau Site: A Paleoindian Occupation in Northeast Kansas

Larry J. Schmits

Current research at the Diskau site, located west of Tuttle Creek Lake, in the Prairie Plains of northeast Kansas provides some of the most detailed information regarding Paleoindian adaptations in the eastern central Plains. The site is located on upland slopes overlooking a tributary of the Big Blue River and consists of a light lithic scatter discovered by the landowner in the 1940s. Fluted points from the site (Figure 1) most closely resemble Clovis points suggesting that the site dates to about 11,000 yr B.P. The smaller size of some of the points and their similarity to Folsom points could suggest a slightly later date. Fluting in most cases consists of the removal of two flakes often from a single face of the point.

A total of 123 formal chipped stone tools including 8 projectile points, 26 knives, 62 scrapers, 15 gravers, 2 spokeshaves, 2 perforators, 1 drill, 1 piece d'esquille, 3 discoids and 4 biface fragments has been recovered from the site. The assemblage is characterized by a high percentage of unifacial and marginally retouched tools, especially end scrapers and gravers relative to bifacial tools. A high percentage of small transverse spurred end scrapers is present.

The lithic assemblage from the site is highly curated as is indicated by a high ratio of tools to debitage and the intensive utilization of the tools. Many tools exhibit evidence of resharpening and multiple use, and appear to have been discarded only when they became worn out and could no longer be resharpened.

Analysis was conducted based on 15× to 100× microscopic observation. The relative hardness of the material being worked was inferred by the type of use-wear present. Graving or incising was recognized by blunting of a corner or projection. Cutting, scraping, or graving of hard materials was recognized by blunting, while work on softer materials such as hides or soft woods was identified by smoothed or polished edges. Cutting wear was distinguished from scraping wear by its presence on both tool edges and its parallel rather than perpendicular orientation to the edge.

The lithic use-wear analysis indicates a high degree of utilization with evidence of wear present on nearly all tools. Many tools exhibit use-wear on multiple edges or exhibit multiple types of wear. A total of 192 episodes of use-wear was observed on the 123 tools. These data indicate that the predominant activities that took place at the site were associated with graving and incising (35.4%), the scraping and cutting of hard materials such as bone or hard woods (43.3%), and the scraping of a combination of hard and soft materials (14.6%), which could have included either soft woods or hides. Cutting of soft materials, boring-piercing or scraping of soft materials alone occurred less frequently.

Perhaps the most remarkable feature of the assemblage is the high percentage of non-local raw materials, many of which have come from a considerable distance even hundreds of km from the site. Local Permian Flint Hill cherts comprise a minor component of the assemblage. The most common lithic material is Cretaceous Smoky Hill jasper or niobrarite from the Smoky Hill Formation of western Kansas. Other

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materials include Flattop chalcedony from the Chadron Formation of northeast Colorado/southwest Nebraska, Knife River flint from the Dakotas and gray chalcedonies, similar to those from the Wyoming Casper Formation or the Colorado Fountain Creek Formation. Moss agates from the Cretaceous Cloverly or Dakota Formation of Wyoming are also present.

Preliminary results of the continuing research indicate that the Diskau site represents an upland Clovis occupation that was probably occupied ca. 11,000 yr B.P. Based on the number of tools and range of activities indicated, the site appears to be a residential camp rather than a more specialized kill site. The major activities at the site appear to have been associated with cutting, scraping and graving of hard materials such as bone and hard woods. Subsistence was probably focused on large upland herbivores. The lithic assemblage from the site documents a highly curated technology based on high quality cherts, chalcedonies, agates, jaspers and flints procured from a considerable distance from the site. A high degree of mobility and probably trade relations with neighboring Clovis groups are indicated.

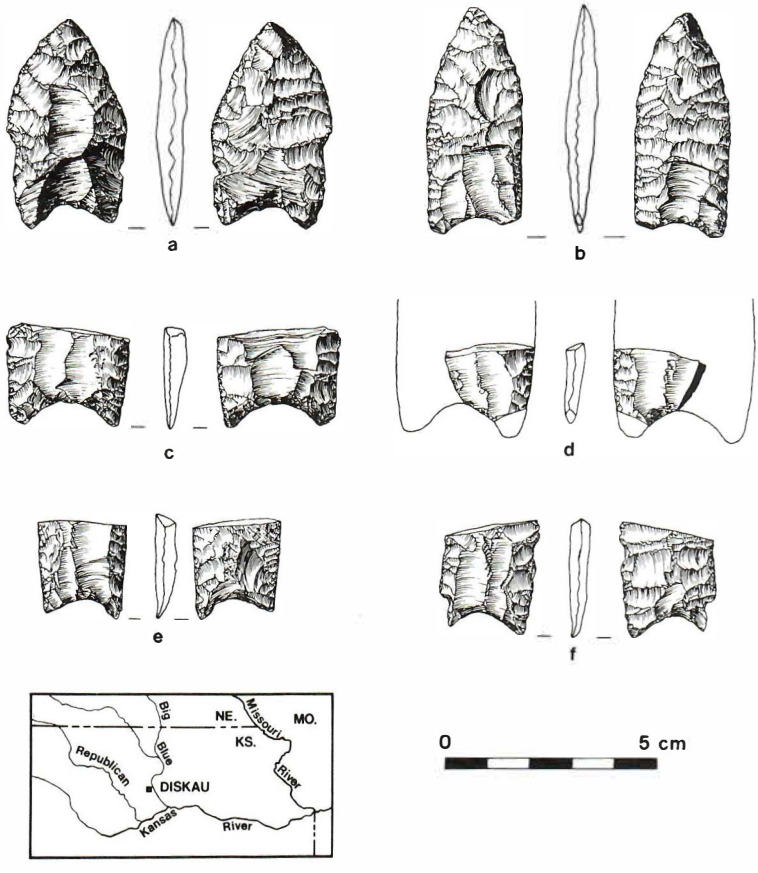

Figure 1. Fluted projectile points from the Diskau site: a-d are Smoky Hill jasper; e-f are Casper or Fountain Creek chalcedony.

The Swan's Landing Site: An Early Archaic Lithic Reduction and Tool Manufacturing Site in Harrison County, Indiana

Edward E. Smith

The Swan's Landing site (12Hr304) is a deeply buried, stratified series of early Archaic period components on the caving bank of the Ohio River in southwestern Harrison County, Indiana. The site has been severely damaged by river erosion and vandalism. Tomak (1982) made preliminary observations on the site, but his summary is based largely on interviews of collectors. During July and August 1986 the Glenn A. Black Laboratory of Archaeology, Indiana University, conducted archaeological investigations to assess the site's eligibility for inclusion on the National Register of Historic Places (Smith 1986).

Testing employed machine assisted hand excavation and the mechanical extraction of a series of solid earth cores to determine the vertical and horizontal extent of the early Archaic deposits and the geological structure of the site. These cores were carefully inspected for evidence of more deeply buried cultural deposits possibly dating to the Paleoindian period. However, no unequivocal indications of Paleoindian occupations were detected.

Approximately 15 m^3 of the cultural deposits were excavated during the 1986 field season. These investigations revealed three distinct occupation zones contained within one meter of sediments. These zones are buried beneath 3 to 6 m of culturally sterile Holocene overbank alluvium. A penecontemporary living surface was also encountered at a depth of 60–70 cm on the adjoining Kosmos site (12Hr91).

All of the 26 projectile points recovered from stratified context are variants of the early Archaic corner-notched tradition: Kirk corner-notched (small variety), Pine Tree corner-notched, and Charleston corner-notched (Figure 1). Other tool classes present at the site include preforms, blades, drills, endscrapers, sidescrapers, chipped stone celts or adzes, hammerstones, and various expedient tools. Apart from changes in projectile point morphology, the lithic assemblage shows strong continuity with Paleoindian assemblages in the region. The artifacts are almost exclusively manufactured from microcrystalline Wyandotte (Harrison County) chert derived from nearby exposures. Debris from artifact manufacture is abundant in each occupation zone.

The only features noted are shallow hearths which exhibited little preparation. In addition, there are indications of surface fires in every zone excavated thus far. Although three radiocarbon samples were submitted, they yielded inconsistent dates: either earlier or later than expected by thousands of years. Based on dated assemblages elsewhere it is assumed that the early Kirk period dates ca. 10,000–9,000 yr B.P. Some form of sample contamination is suspected.

The site appears to have functioned, at least in part, as a locale for the replacement of personal tool kits. In addition to a number of implements broken or aborted in manufacture, numerous worn tools displaying various degrees of resharpening/rejuvenation were discarded. This represents the highly curated tool assemblage typical of the early Archaic period.

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The deeply buried deposits of Swan's Landing have close stratigraphic and typological affinites with zones that have produced small Kirk points at a number of other stratified sites in eastern North America.

The Swan's Landing site is one of the most significant early Archaic sites recorded to date in eastern North America. It contains, in deep deposits sealed by alluvium, virtually the entire lithic assemblage of the early Kirk period; therein several episodes of industrial activities are represented. Unlike other major early Archaic sites in the East, Swan's Landing appears to be a functionally specific site type rather than a base camp. On the basis of these investigations, a National Register nomination form has been prepared and submitted.

A grant for test excavation was provided by the Indiana Department of Natural Resources, Division of Historic Preservation and Archaeology, from Survey and Planning funds. Additional support was provided by the Glenn A. Black Laboratory of Archaeology, Indiana University. Special thanks are extended to Dr. Patrick J. Munson and Dr. Christopher S. Peebles who served as co-principle investigators. They and Cheryl Ann Munson edited this manuscript. The illustration was prepared by Rachael Freyman.

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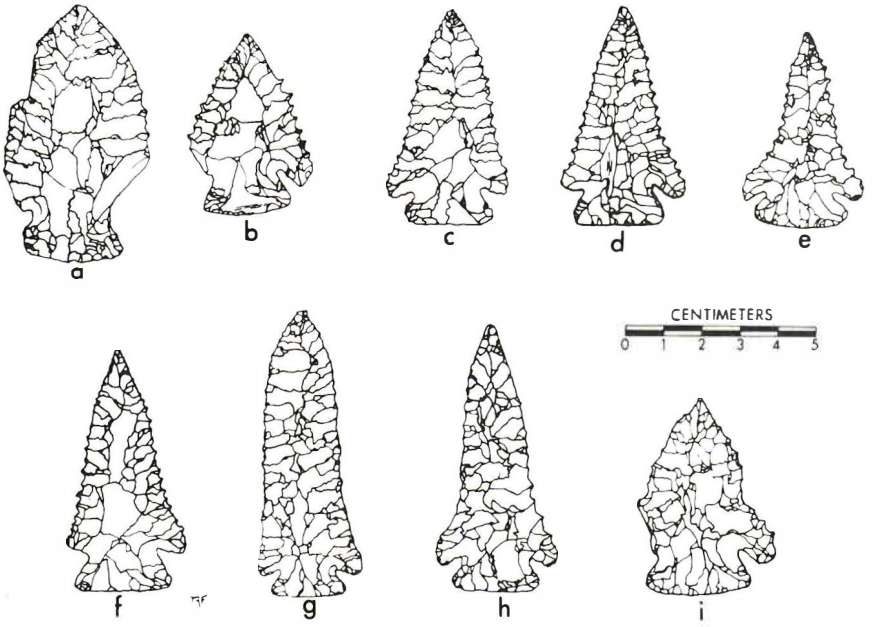

Figure 1. Representative projectile points from the Swan's Landing site (12Hr304): a,b, Kirk corner notched; c-h, Pine Tree corner notched; i, Charleston corner notched.

Taphonomy-Bone Modification

Trample Marks: Caution from the Cretaceous

Anthony R. Fiorillo

Clues to understanding the taphonomic history of a fossil deposit often can be provided by post-mortem processes modifying the original surfaces of the bones within a site. As a result, bone modification features have come under increasingly close scrutiny in recent years in an effort to understand bone modifying processes. One process which has been shown experimentally to be capable of altering bone surfaces is trampling (Fiorillo 1984, in press; Behrensmeyer et al. 1986).

Trample marks are characteristically small-scale, linear or sub-linear scratches on bone surfaces, which are V-shaped in cross section. These marks are easily distinguishable from the gnaw marks left by mammals which are common to many late Tertiary fossil sites. Sand grains pressed between the foot of an animal and the surface of a bone lying on the ground are the likely cause of trample marks (Fiorillo in press, Behrensmeyer et al. 1986). These sand grains act as minature "tools" leaving V-shaped striae on the bone surfaces they are ground against.

These marks have been documented from North American fossil deposits in the Quaternary (e.g. Oliver in press) and the late Tertiary (Fiorillo in press). Elsewhere these marks are known from the late Tertiary of Asia (Behrensmeyer et al. 1986). This study reports the oldest known trample marks, on bones from a locality in the Judith River Formation which is generally considered to be upper Campanian in age (Cretaceous; Dodson 1971; but see Lillegraven and McKenna 1986); or approximately 73–75 MYA (Harland et al. 1982).

Antelope Head Quarry in eastern Wheatland County, of southcentral Montana has yielded a rich fauna of dinosaurs, including hadrosaurs (duck billed dinosaurs), ceratopsians (horned dinosaurs), and large and small theropods (carnivorous dinosaurs). The site includes non-dinosaurian taxa as well, such as crocodiles and turtles. Of a randomly chosen sample of 142 bones and bone fragments, 31% had scratch marks on their external bone surfaces (Figure 1). Microscopic examination indicates these scratch marks are identical to the V-shaped grooves produced in trample experiments (Fiorillo 1984, in press; Behrensmeyer et al. 1986). There is a good deal of variety in the density of scratch marks on the bones from this site. The trample marks range from single grooves to multi-grooved sets which can appear in multiple

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superimposed generations. The percentage of trample modified bones in this sample is slightly smaller than other reported occurrences of trample marks in experimental bone or fossil bone assemblages. These other reported percentages range upward to approximately 50% of the respective samples (Fiorillo 1984, in press; Behrensmeyer et al. 1986). This difference in frequency of occurrence of marked bones may be due to the finer nature of the matrix at Antelope Head Quarry which is a sandy siltstone. In contrast, the matrix at at least two of the sites mentioned above is a fine to medium-grained sand or sandstone (Fiorillo in press).

In addition, the trample marks from Antelope Head Quarry are identical to those grooves which can be produced in the utilization of a carcass with stone tools by hominids (e.g. Shipman and Rose 1984, Figure 1), a process easily ruled out for the cause of the Antelope Head Quarry trample marks. Clearly caution is needed when interpreting the process of bone modification if one is examining a modification feature. Behrensmeyer et al. (1986) have elaborated on critera, such as scratch mark location on a bone, to aid in distinguishing between the two processes. At Antelope Head Quarry, as well as at Hazard Homestead Quarry (a Miocene mammal site in western Nebraska; Fiorillo 1984 in press), another criterion is suggested. In these latter two cases the age of the deposit can safely rule out hominid activity as a probable cause. The stratigraphic context of the site then, also seems a viable criterion in distinguishing between the processes of trampling and carcass utilization.

In summary, Antelope Head Quarry is a late Cretaceous dinosaur site in south-central Montana which has yielded trample marks on nearly one-third of the randomly sampled bones. This site is the oldest site yet known which has produced such bone modification features. Also, this site, in conjunction with a Miocene mammal site in North America (Fiorillo 1984, in press) suggests that the stratigraphic context of a site is a viable criterion for distinguishing between trampling and carcass utilization as processes responsible for scratch marks with this morphology.

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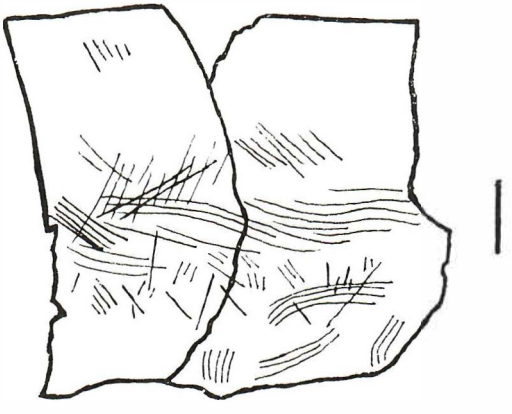

Figure 1. Diagrammatic illustration of a dinosaur limb bone fragment (Academy of Natural Sciences of Philadelphia 15935) from Antelope Head Quarry, showing fine, sub-parallel scratch marks. Note the intersecting sets of scratches. Scale bar represents one centimeter.

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Elephant-Butchering at Modern Mass-Kill Sites in Africa

Gary Haynes

To prevent habitat destruction in Hwange National Park, where elephant densities are high, the Zimbabwe Department of National Parks and Wildlife Management found it necessary to kill about 10,000 elephants between 1982 and 1987. I was attached to the culling project from its beginning, and my studies involved: 1) determining ages of elephants by reference to molar wear and progression, shoulder height growth curves, and measurements of limb-bone shafts and epiphyses; 2) the demography of herd groups and larger populations; 3) the effects of butchering on carcass/skeletal masses; 4) the end-effects of animal scavenging at mass-depth sites; and 5) long-term monitoring of bone scattering, weathering deterioration, and natural burial.

I butchered over 40 elephants, and closely recorded the butchering of more than 600 other carcasses by experienced teams working in the field. Skinning and meat removal were done in very patterned and efficient ways. Every carcass progressed through the same sequence of removal of skin, tusks, and meat. Bones were never cut, chopped, or otherwised marked. In contrast, elephant-butchering by less experienced people, who processed carcasses only occasionally, such as after a monthly hunt for ration meat, resulted in a high percentage of chopped, cut, and broken bones.

During the cull butchering, a research team took measurements and tissue samples from each carcass. Sex and age were estimated for every animal, and precise age was later determined by examination of tooth wear. Ovaries were examined, placental

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scars counted, fetuses weighed and measured, kidneys and attached fat weighed, and shoulder heights recorded.

Six cuts were made in each carcass, in order to remove the skin in several "panels." The first cut was along the midline of the animal's back, extending in a straight line from the head to the base of the tail. Other cuts extended from the feet to the first cut. The skin around feet was cut to encircle the legs about 10–15 cm above the bottom of the foot and toenails. The cut on the forelimb was made along the length of the rear of the leg, up along the thoracic cage in an extension of the leg cut, and joined the backline cut at the shoulder. The rear leg was also encircled above the toenails, and a lengthwise cut was made on the front of the leg, extending up the body to meet the backline cut at about the iliac. A final cut extended along the brisket and stomach, joining the leg cuts. As the skinners all said, and I fully agree after skinning so many elephants, there is basically only one way to skin an elephant.

No bones were ever cut during meat removal, either deliberately or accidentally. Butchering gangs were always in a hurry, and their meat-removing cuts were fast and powerful. Yet, in over six years I never saw a single cut bone at dozens of abandoned cull sites that I examined as part of my field studies. Elephant bones need not be disarticulated to remove the meat. If the bones themselves are needed, as in my studies of growth rates, they can be disconnected from each other quite easily without the necessity of cutting against hard surfaces.

Meat-cutters first filleted the hindquarters of each animal as the skinners exposed them, moving serially through the culled herd, then began again as forelimbs were exposed. The hindlimb meat was separated from bone by fast, deep cuts that encircled the femur above the knee, moved up the muscle masses the length of the femur, and finally circled around the upper end of the femur. So-called "waiters" pulled meat away from the bone using steel hooks, stretching it so that it could be cut and separated without forcing the knife against a bone surface. The meat was fully removed within a few seconds. When the meat had been taken off, I completely detached rear limbs and then separated the femur, in order to collect measurable specimens. These steps of bone disarticulation took about one minute of tendon and ligament cutting, and in fact went faster when done alone, since a second person's hands lifting the heavy bones were often in the way of the knife. The knee joint is held together with thick tissue that can be easily sliced when stretched by levering the leg up or to one side. Joint attachments are simple. No fine-scale maneuvering of a steel knife, stone flake, or stone biface was required to separate bone elements. Using a wedge of any sort (bone, steel, wood) to separate conarticular bones seems to be completely unnecessary, since the space between articulating elements is so wide, in comparison to bison, cow or other smaller animals, where bone separation is much more of a problem.

Forelimb meat was removed beginning at the scapula, and moving down the leg. Meat masses weighing over 50 pounds were carried off by waiters and taken to heavy lorries for transport to the final processing camp. The front leg usually was detached from the rest of the carcass, due to its much "looser" attachement compared to the rear limbs.

Meat was taken in blanket-like masses of the ribcage, and in long strips along the spine. When one side of the carcass had been stripped, the animal was turned over and the process repeated.

I have visited abondoned cull sites on a regular schedule since 1982. I visit only the sites where I participated in the hunt and butchering, so that I possess sketches,

photographs, and notes documenting what took place. In this way, I can match up skeletons with flesh and blood animals that I had seen killed and butchered, and I can trace the process of carcass and skeletal changes over time in mass death sites. In some sites I have stamped numbers into bones so that I can reassemble skeletons from different individuals following several years of bone dispersal by scavengers or trampling animals. At some sites I deliberately chopped and cut bones so that I could measure how such markings survive weathering and carnivore-scavenging. I visited sites three days after abandonment, ten days after, one year later, three years later, and (so far) up to six years later. These studies are continuing and ongoing, and will provide comparisons with the noncultural mass die-off sites under study in the western wilderness block of Hwange National Park, where no culling has ever taken place.

Significance of Bone Orientation Data for the Clovis-Age Bone Bed at the Lubbock Lake Landmark

Eileen Johnson, Vance T. Holliday, and Lee Kreutzer

Excavations into stratum 1 fluvial deposits at the Lubbock Lake Landmark (41LU1) in Yellowhouse Draw on the Southern High Plains have focused on a Clovis-age bone bed (FA2-1). Johnson and Holliday (1985; Holliday 1985) have argued that the bone bed was in place, disturbance by floodwaters was minimal, and the bone bed represented an archaeological feature (megafaunal processing station). These arguments were based on detailed analyses of individual bones for evidence of human modification (Johnson 1985; Johnson and Shipman 1986) and geologic deposits and geomorphic features (Holliday 1985); but only cursory examination of natural agency modification and limited sedimentary studies. Kreutzer's (1986) results show that preferred bone orientation was evident and that fluvial processes played a more significant role within the internal bone bed structure than previously thought.

A number of questions still are unanswered as well as new ones raised by Kreutzer's (1986) work. While this analysis does not resolve the basic interpretive differences between Johnson and Holliday (1985) and Stafford (1983), it does establish that the bones were reoriented. The results show preferred orientation which indicates water-orienting process but does not necessarily indicate transport. How was reorientation accomplished? Were bones pivoted in their original position (realigned); relocated away from their original position but within the confines of the bone bed; or were they transported from a distance and redeposited in an already existing bone bed or part of creating that bone bed? The stream velocity and competency data appear to indicate that neither the large caliche boulders (interpreted as the anvils/hammerstones needed in breaking the mammoth limb elements; Johnson 1985; Johnson and

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Holliday 1985) nor many of the megafaunal limb elements could have been brought in by the streams. Stream wear appears absent in the elements from FA2-1. However, bone (FA2-4) is present in the 1B sands above the point bar (1A). Kreutzer's (1986) analysis showed that the FA2-4 bone had been affected by fluvial processes occurring from the same directions as those affecting the FA2-1 bone and therefore the results could not be used to distinguish the two features. The relationship of FA2-1 and FA2-4 now is not clear.

As a cultural activity area, the internal structure of the FA2-1 bone bed no longer reflects pristine human behavior because that structure was disturbed by both carnivore and fluvial processes. Carnivore-modified bones appear minimal. But, is the reorientation so significant as to destroy all cultural meaning to the internal structure? A qualitative analysis of the bone orientation data should help resolve this question. In Kreutzer's (1986) analysis, all bone was treated alike. However, questions not resolved include: 1) how much (percentage) of the preferred orientation was with bone scrap versus larger limb elements; and 2) what elements are represented by the non-significant groupings? Even if the spatial patterning was destroyed, that destruction does not negate the bone bed as an archaeological feature. The individual bones contain data on human behavior.

Kreutzer's (1986) work demonstrates that the bone bed was disturbed by floodwaters through reorientation of bone. Although the disturbance is greater than the original conservative estimate and therefore more significant, the degree and extent of the disturbance is not yet known. Further taphonomic analyses are needed to address these matters. Nevertheless, the FA2-1 bone bed remains significant culturally for the evidence it provides of human interaction with a number of late Pleistocene extinct animal species, as both a food source and a raw material resource for tools.

This work is part of the on-going research of the Lubbock Lake Project. Funding for the data base has been provided by the National Science Foundation (SOC75-14857; BNS76-12006; BNS76-12006-A01; BNS78-11155), National Geographic Society, Texas Historical Commission (National Register Program), Center for Field Research (EARTHWATCH), Moody Foundation (Galveston), City and County of Lubbock, The Museum, Texas Tech University, West Texas Museum Association, and the Lubbock Lake Landmark Community Volunteers.

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Bone Orientation Data for the Clovis-Age Bed at the Lubbock Lake Landmark.

Lee Kreutzer

The oldest cultural activity area identified at the Lubbock Lake Landmark, in West Texas, is an extensive Rancholabrean bone accumulation (Feature area 2-1) on the point bar of a now defunct meandering stream. Excavations in FA2-1 have revealed more than 1,000 bones lying upon point bar gravels and contained within fine overbank deposits. Many specimens were culturally modified (Johnson 1983). Radiocarbon dating upon wood produced a date of 11,100 ± 100 yr B.P., SMU-548 (Holliday et al. 1983).

Johnson (1983; Johnson and Holliday 1985) interpreted FA2-1 as an in situ secondary processing area. The apparently random orientation of the bones, coupled with Holliday's (1985) interpretation of the sedimentological evidence, suggested that

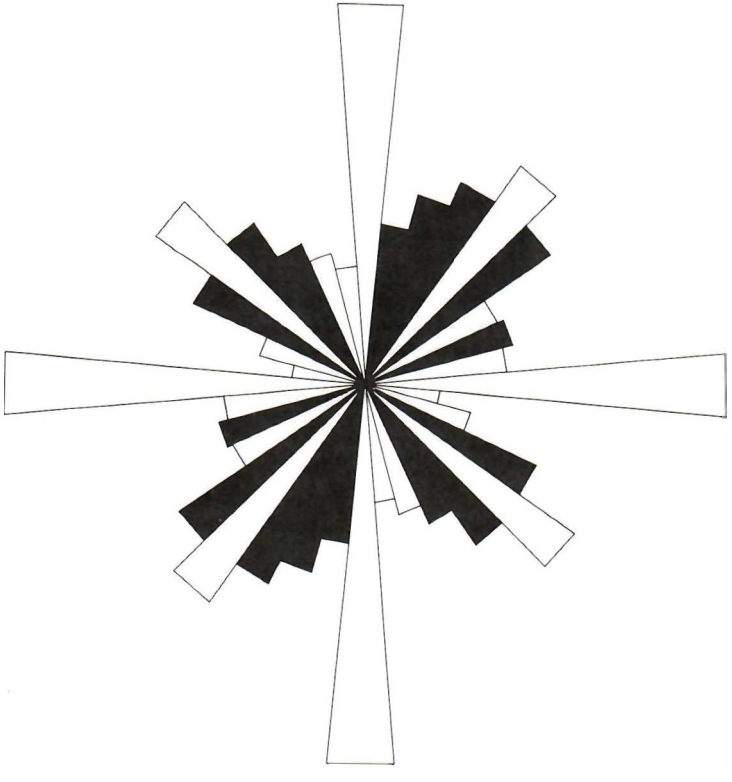

Figure 1. Mirror image rose diagram for FA2-1, Lubbock Lake site, Texas. White wedges represent statistically significant observed values; black wedges represent non-significant observed values.

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the feature was relatively undistrubed by fluvial activity. However, Stafford (1983) also cited sedimentological evidence in arguing that stream currents disturbed the accumulation to a significant degree.

Mirror image rose diagrams were constructed and adjusted residual analyses were undertaken to address the conflicting interpretations. Measurement data from 1,084 bones were used to construct a rose diagram (Figure 1), revealing two sets of transverse orientation axes. Transverse orientations are typical of bone reoriented by water. In this case, the double pattern suggests the bone was subject to two currents, flowing from different directions and representing separate episodes (Kreutzer 1986). This pattern corresponds to previous geological investigation which determined that currents at the meander bend did flow from the southwest (flood conditions) and the south-southwest (non-flood conditions) (Holliday 1985).

To identify specifically those orientation groups whose observed values are significantly different from expected, adjusted residuals were calculated. As Figure 1 illustrates, most of the observed values differ significantly from values expected by chance.

This investigation was supplemented by grain size analyses of sediments from and above the point bar. Results indicate that the current was competent enough to move bone fragments and to align larger bones. Point bar gravels (1A) were deposited by a stream that could carry pebbles up to 3.2 cm in size, while the overlying sands included particles as large as 2 cm (Kreutzer 1986).

The bone orientation study shows that fluvial disturbance is more significant than previously believed by Johnson and Holliday (1985). Lack of bone abrasion indicates that, although disturbed, the bone apparently was not carried far. The orientational and statistical analyses have established, however, that the overall pattern of the bone accumulation cannot be interpreted as reflecting cultural activities.

The author would like to thank Drs. Donald Grayson, Eileen Johnson, Vance T. Holliday, and Julie Stein. This investigation is part of the ongoing research of the Lubbock Lake Project. Funding for the data has been provided by the National Science Foundation (SOC75-14856; BNS76-12006; BNS76-12006-A01), National Geographic Society, Texas Historical Commission (National Register Program), Center for Field Research (EARTHWATCH), Moody Foundation (Galveston), City and County of Lubbock, The Museum, Texas Tech University, West Texas Museum Association, and the Lubbock Lake Landmark Community Volunteers.

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Methods

The Folsom Discovery and the Concept of Breakthrough Sites in Paleoindian Studies

Richard A. Rogers and Larry D. Martin

The discovery of a "breakthrough" site has been thought by some to be an important part of the methodology of Paleoindian studies. A breakthough site is one that is unique or so influential as to decisively change perceptions in the field of anthropology. The Folsom site, first excavated in 1926, has been considered to be a "breakthrough" in Paleoindian studies because previous claims for human association with Pleistocene fauna in the Western Hemisphere could not be validated (Willey and Sabloff 1974). However, the evidence suggests that it was neither unique nor decisive in changing perceptions about the existence of Paleoindians. The Folsom site was not significantly different from a series of similar sites that had been found earlier (Rogers and Martin 1986) such as the 12 Mile Creek site, Meserve site, and Lone Wolf Creek site. These sites, excavated by scientific personnel, indicated the association of humans with Pleistocene fauna, and had a validity that has stood up to modern scrutiny. It should be noted that the projectile points from the Lone Wolf Creek site had to be chiseled out of the bone bearing matrix (Figgins 1927), making them (literally) more solidly associated than the bones and artifacts at the Folsom site.

The Folsom site was not decisive in ending the controversy over the existence of Paleoindians. Six years after work had begun at the Folsom site, the discovery of projectile points in association with extinct animals at the Scottsbluff site was controversial enough to make the anthropologist at the scene wish to be elsewhere (Schultz 1983). The association of Pleistocene fauna and artifacts at Blackwater Draw was also greeted with skepticism (see Wilson this volume), and a prominent anthropologist could still publish in the 1940s that the attempts to demonstrate the existence of Paleoindians were "wholly wanting" (Hrdlicka 1942:53). Not only were sites such as the Folsom site not considered to be decisive, they were considered to be the "Achilles' heel" of the Paleoindian evidence because either the geological associations were in doubt or the animal remains involved were from taxa that had only recently become extinct (Hrdlicka 1942:54).

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This does not mean that the Folsom site was unimportant, or that it did not convince some individuals. All of the sites discussed were important and all of them convinced some individuals. However, none of these sites, including the Folsom site, was decisive by itself in ending the controversy. We agree with Wilmsen (1965) on the importance of radiocarbon dating in placing these Paleoindian sites in their proper temporal relationships. Radiocarbon dating provided further indications that Paleoindian artifacts and associated fauna were contemporaneous and ancient. It was at this point that Paleoindian sites became non-controversial.

The acceptance of a Paleoindian presence was not the product of the breakthrough discovery of a single valid site. The discovery of a number of valid sites and decades of controversy preceded this acceptance. The continuing debate about a pre-Clovis human presence in the Americas may represent a parallel failure of the concept of the breakthough site. Pre-Clovis sites such as Monte Verde (Dillehay 1984) and Boqueirão of Pedra Furada (Guidon and Delibrias 1986) appear to be far better documented than the sites which led to the acceptance of Paleoindians.

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Plains Paleoindian Red Ochre Use and Its Possible Significance

Donna C. Roper

The aboriginal use of red ochre on the Plains was not extensive. The use of hematite or ochre for face and body painting was observed ethnographically and the presence of lumps of rubbed hematite in archaeological context is usually interpreted to indicate a long history for this practice. A recent survey of the literature of hematite use in the Plains, however, indicates that the variety of uses of this mineral was greater during the Paleoindian period than it was later. The evidence presently is limited, but it is internally consistent, and may reflect the fundamental adaptive changes marking the end of the Pleistocene.

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Hematite in Paleoindian sites has been found in mortuary context at the Clovis age Anzick site (Lahren and Bonnichsen 1974) and at the ca. 9,700 yr B.P. (but taxonomically unassigned) Gordon Creek burial site (Anderson 1966). The important point is that the ochre covered both the skeletal remains and the tools at each site. Hematite also has been observed at Paleoindian habitation sites. Bison bones coated with red ochre were reported at the Clovis age Sheaman campsite (Frison and Stanford 1982). It has also been reported from the Folsom campsites at Agate Basin (Frison and Stanford 1982), Cattle Guard (Emery and Stanford 1982), Hanson (Frison and Bradley 1980), and Lindenmeier (Wilmsen and Roberts 1978). At Agate Basin and Hanson, it was found within what may have been houses; at Agate Basin, Cattle Guard, and Lindenmeier, it was observed coating grinding slabs; and it appeared as lumps at Lindenmeier. Thus, in non-mortuary context, red ochre has been found covering animal bone and in contexts that indicate its preparation was a domestic activity.

The connection among the contexts of Plains Paleoindian red ochre use is remarkable. Ochre is the color of blood, the substance of life, and can be common in mortuary context (although, except during the Paleoindian period, it is not common in Plains burials). Animals, the second context, through their deaths, provide life to humans; human recognition of and gratitude for this provision may be important to ensure the continued supply of animals. Tools, the third Paleoindian red ochre context, are used to kill animals and thus to provide the means to sustain human life. Anointing the tools, especially in a ceremonial context, signifies their crucial role in sustaining life. Red ochre does not appear in Clovis and Folsom kill sites, but is found in most investigated campsites. Perhaps the need at the kill site was to attend to the butchering, and, in any event, the hunt had been successful; there was plenty of time to perform rituals at the campsite to thank the animals for the successful hunt and to appeal for continued hunting success.

The reduction in variety of uses of hematite following the Paleoindian period may reflect the changing circumstances under which hunter-gatherers operated on the Plains. Clovis and Folsom hunters likely faced arctic or sub-arctic conditions, under which chances for encounter with large game were considerably lower than during most of the prehistoric period. Zvelebil (1984), among others, has recently considered the role of specialized stone tool technologies in permitting successful foraging within cold environments and the argument likely can be applied to North American Paleoindians. However, the best made, most reliable tool is relevant only after potential prey is encountered. Whereas the hunter may control technology, encounter is a product of the actions of two livings beings, with the hunter not necessarily in control. Assuring hunting success was an important theme in historic Plains Indian mythology and ritual; how much more important must ritual have been when encounter potential was lower and fewer alternative food sources were available.

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The Clovis Man Site: A Turning Point in Opinion

Robert W. Wilson

Blackwater Draw, south of Clovis, New Mexico, was one of several late Pleistocene sites investigated by Edgar B. Howard for the Museum of the University of Pennsylvania and the Philadelphia Academy of Natural Sciences. In the early summer of 1933, John C. Merriam, then Director of the Carnegie Institution of Washington, visited the site as part of a cooperative venture of the three institutions. He was sufficiently impressed by the probable association of early man with extinct mammals (elephant and bison) to ask Chester Stock, a research associate of the Carnegie, and professor of vertebrate paleontology at California Institute of Technology, for geological assistance. Consequently, later in the summer of 1933, a party of three graduate students (F.D. Bode, R.W. Wilson, and H.D. Curry) was sent to join Howard and map the geology. I, of course, was one of the three students.

I think all three of us were ambivalent about a positive association of man with extinct animals. American paleontologists were still largely under the influence of the work of O.P. Hay on Pleistocene vertebrates of North America. He had concluded that Rancho La Brea was Aftonian and that camels, the imperial mammoth, *Nothrotherium* (ground sloth), and others became extinct with the following glaciation, and horses became rare. Perhaps more important was his conclusion from the study of the "Aftonian" fauna that after the Aftonian, evolution in North American mammals virtually ceased, and correlation of the Pleistocene could be made only by recognition of extinctions. By Hay's arguments, most Pleistocene mammal sites of any magnitude would be Aftonian. In this connection, I recall that in 1929, Chester Stock took a class from Cal Tech to the Los Angeles County Museum to show them the Rancho La Brea collection. As to age, he spent some time demonstrating that Rancho La Brea was Pleistocene rather than Pliocene! His guide book of 1929 on Rancho La Brea also calls the fauna only Pleistocene, and only briefly referred to the opinions of some that it represented a late rather than an early stage. Hay, himself, was inclined to believe in the association of human remains with the earlier Pleistocene of North America, as at Vero, Florida. On the other side of the question stood Ales Hrdlicka. Anthropologists in general, led by Hrdlicka, were more or less agreed as to the late arrival of man on the North American continent. I heard Hrdlicka in 1931 tell his listeners at an American Association for the Advancement of Science meeting that 20,000 years, more or less, was all the time necessary to account for the Amerindians and their differentiation in the New World. If then, Rancho La Brea and its

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contemporaries were Aftonian, and man had been here only 20,000 years or less, there was no association, and sites where such associations were said to exist were greeted with scepticism or outright rejection by most paleontologists and anthropologists. There were some dissenters to this. A.S. Romer, at the cited meeting, pled for late survival (based on remains of muscle, hide, hair in dry caves). Several Californian geologists regarded Rancho La Brea, on the basis of geological evidence as late Pleistocene. Lastly, there were occurrences such as the 12 Mile Creek bison kill, Folsom, Dent, and the like where association had been advocated by the workers at these sites. The authenticity of these and others were discounted, I think, largely because of the lack of published geological documentation by a team of experts in various disciplines. This the workers at Clovis were to supply. I might add, however, that even after Clovis, and as late as the fall of 1936, at least one eminent anthropologist of the eastern establishment, maintained that association was a delusion based on the need of westerners to discover a past that made them feel less johnny-come-latelies and more in tune with the early settlement of New England by whites.

However all this may be, we arrived at Clovis and found the evidence for association already laid out to us by Howard, and his two high school helpers. We were convinced. All we had to do was to make plane table maps of two of Howard's sites, and await the arrival of our superiors in August to authenticate Howard's finds and our maps. These distinguished scientists were John C. Merriam, Chester Stock, Victor van Straelen, and not the least of our visitors, the ultimate authority in such matters, Sir Arthur Smith Woodward, accompanied by Lady Smith Woodward. They did agree with each other and with us: I find all this at least somewhat ironic in view of the Piltdown hoax, so closely associated with Smith Woodward.

Paleoenvironments: Plants

Contrasting Climatic Histories for Western North America During the Early Holocene

Owen K. Davis and William D. Sellers

Plant fossil and lake level studies have revealed an intriguing paleoclimatic contrast: the Pacific Northwest appears to have experienced early Holocene aridity at the same time the American Southwest underwent an early Holocene pluvial. North of ca. 40°N lakes dried and xeric vegetation expanded from 11,500 to 7,000 yr B.P. (e.g., Davis et al. 1986; Smith and Street-Perrott 1983), but at the same time lake levels rose and mesic vegetation expanded in the Southwest (e.g., Smith and Street-Perrott 1983; Spaulding and Graumlich 1986).

The approximate boundary between the regions of contrasting climatic history lies near the modern boundary of the "secondary summer precipitation maximum (Pyke 1972)," which extends north from the Pacific coast at San Diego, along the eastern slope of the Sierra Nevada to ca. Lake Tahoe, then northeastward to the Rawlins Gap in Wyoming (Figure 1). Today, summer precipitation increases south of this boundary, reaching a maximum in Arizona, New Mexico, and northern Sonora. North of the boundary, spring and winter precipitation predominate.

The fossil sites indicated in Figure 1 are primarily at low elevation or in intermountain basins except where such sites have not been studied. Since the vegetation at high elevation is limited by temperature more than by precipitation, high-elevation sites tend to reflect the mid-Holocene maximum in warmth rather than early Holocene precipitation (see Davis et al. 1986).

The climatic history for sites along the Pacific coast is complex. Coastal sites in Washington and British Columbia reflect early Holocene aridity (Barnosky 1984; Hebda and Mathewes 1984), while sites in coastal California indicate greater moisture then. In contrast, sites of the western Sierra Nevada show early Holocene aridity (Davis et al. 1985).

These patterns present a challenge to paleoclimatic models. The models indicate maximum extent of the Asian, African, and Arizona monsoons ca. 9,000 yr B.P. (e.g., Kutzbach and Guetter 1986), but they lack the resolution necessary to depict the early Holocene aridity of the Pacific Northwest or the coastal-interior contrast

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in California. Recently, the reciprocal relationship between the late Holocene climates of the Northwest and Southwest have been modeled. The results of this model are strongly affected by the chronology of deglaciation of the continental ice sheets, and by the history of global insolation.

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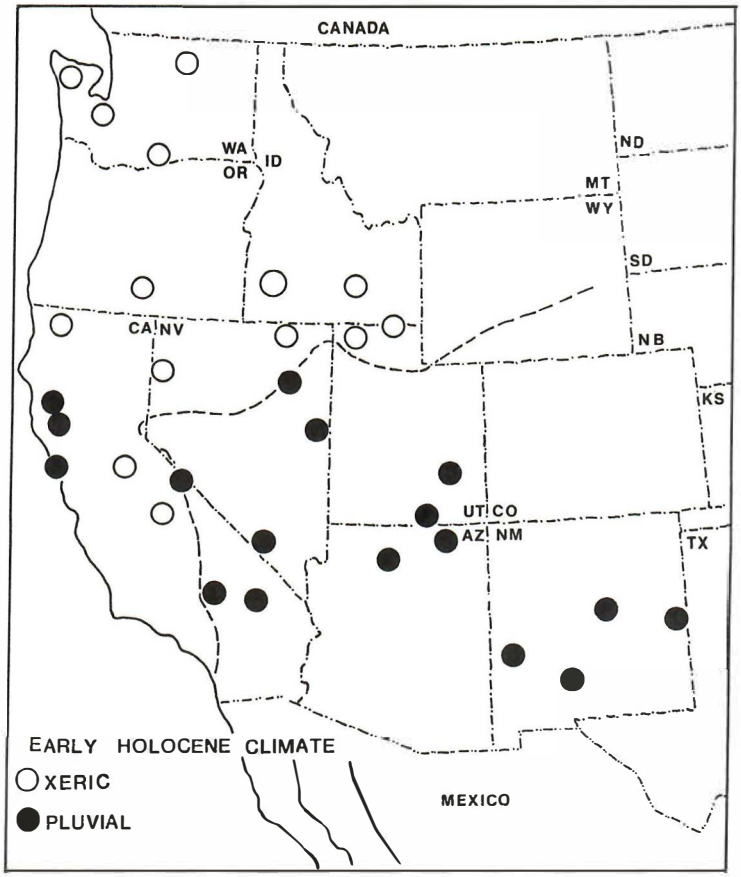

Figure 1. Locations of sites that were either drier (xeric) or wetter (pluvial) during the early Holocene (11,500–7,000 yr B.P.), dashed line indicates position of the "secondary summer precipitation maximum."

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A Pollen Sequence Associated with Paleoindian Presence in Northeastern Minnesota

James K. Huber and Christopher L. Hill

Palynological investigations of a five m core have provided information useful for research of the late Quaternary paleoenvironmental setting associated with the Paleoindian (Plano affiliated) Reservoir Lakes Phase (Steinbring 1974). A multidisciplinary research effort aimed at understanding the late Pleistocene and early Holocene prehistory and paleoenvironmental context of a section of the Cloquet River watershed in northeastern Minnesota has been undertaken through the Archaeometry Laboratory, University of Minnesota, Duluth. This study focuses on a well-documented surface collection believed to represent Paleoindian presence in this area. Steinbring (1974) has presented a preliminary assessment of these lithic assemblages, and the Archaeometry Laboratory is currently preparing a thorough study of these artifacts.

The core was extracted from Bog 2 south of Island Lake (a large reservoir that inundated the archaeological locality). Basal sediments in the core are probably related to outwash from the Automba glaciation of northeastern Minnesota, estimated to date prior to 12,300 yr B.P. (Mickelson et al. 1983). The pre-dam physiographic setting indicates that the archaeological localities were generally situated near preexisting rivers or lakes on glacial outwash.

Paleoindian presence in this area is estimated to date from ca. 10,500 to 8,500 yr B.P. Radiocarbon dates of 9,270 ± 190 yr B.P., UCR-1825 and 9,420 ± 180 yr B.P., UCR-1826 for the 350–355 and 350–364 cm intervals, respectively, provide a point of reference to compare local archaeological materials with the paleonenvironment indicated by the pollen record.

The pollen from Reservoir Lakes Bog 2 had been divided into four major zones (Figure 1). These zones have been interpreted as representing a vegetational progression from a shrub tundra-like to a mixed conifer-hardwood forest setting.

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Zone 1 is characterized by high percentages of sedge (Cyperaceae) (Figure 1). Ragweed (*Ambrosia*-type) and wormwood (*Artemisia*) are also relatively abundant, with willow (*Salix*) and spruce (*Picea*) as the dominant arboreal pollen types. This pollen assemblage is suggestive of a shrub tundra-like environment with occasional stands of spruce.

In zone 2 a large increase in *Betula* (probably dwarf birch) occurs with a significant decline in Cyperaceae and a *Picea* peak near the bottom (Figure 1). Dwarf birch (*Betula glandulosa*) was differentiated based on the size-frequencies of the pollen grains according to the measurements cited by McAndrews et al. (1973). The expansion of dwarf birch suggests the development of a forest tundra environment.

An increase in *Picea*, oak (*Quercus*), and pine (*Pinus*) percentages in zone 3 is accompanied by a decrease in *Betula* (Figure 1). Ending ca. 9,300 yr B.P., this zone is interpreted as representing a transition from a mixed pine-spruce forest to one dominated by pine and birch.

Zone 4 is dominated by pine and some birch (Figure 1). In the lower part of this zone red pine (*Pinus resinosa*) and/or jack pine (*P. banksiana*) are dominant, but in the upper part white pine (*P. strobus*) increases. This zone is interpreted as representing a mixed conifer-hardwood forest with environmental conditions similar to those found in the area today.

The pollen zones from Bog 2 are similar to those defined by Cushing (1967) and Wright and Watts (1969) for northeastern Minnesota, indicating that the Reservoir

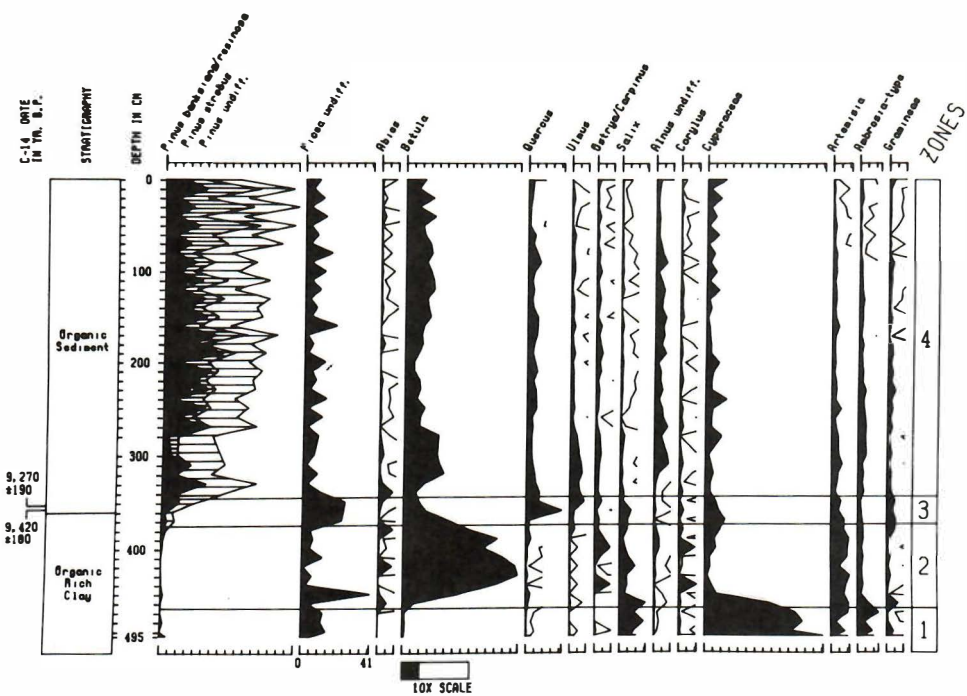

Figure 1. Pollen percentage diagram of selected taxa from Reservoir Lakes, Bog-2, St. Louis County, Minnesota.

Lakes watershed was undergoing vegetational change during the time of Paleoindian presence. When the results of the palynological, geological, lithic, and site locality studies are fully synthesized, they will provide a more complete understanding of Paleoindian occupation in this area.

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A Vegetational Reconstruction from Big Rice Lake, St. Louis County, Minnesota

James K. Huber

Pollen from Big Rice Lake has provided paleoenvironmental information for research undertaken in conjunction with archaeological investigations at the Big Rice Site. The presence of two points (a miniature Brown's Valley and an Agate Basin) indicates a Paleoindian (Plano affililiated) component as the earliest occupation of the site. Paleoindian presence in this area is estimated to date from ca. 10,500 to 7,000 yr B.P.

Big Rice Lake, about 20 km north of Virginia in the Big Rice outwash plain, is bordered by peat deposits to the northeast and southwest. Originally the watershed was covered by pine (*Pinus*), but 70–80% is now a mixed stand of aspen (*Populus*), spruce (*Picea*), balsam fir (*Abies balsamea*), and jack pine (*Pinus banksiana*) (University of Minnesota Agriculture Experiment Station 1971).

A 525-cm core was extracted from the lake. The core is composed of three sections: the upper section is peat; the middle is fine organic sediment; and the lower section is organic-rich clay. Three of six radiocarbon dates submitted are presently available for the core; they are: 102–107 cm, 6,840 ± 200 yr B.P., DIC-3319; 207–212 cm, 8,300 ± 190 yr B.P., DIC-3320; 242–247 cm, 9,510 ± 300–320 yr B.P., DIC-3321.

The pollen diagram from Big Rice Lake is divided into four regional and eight local pollen-assemblage zones representing a postglacial vegetational history for the watershed. These zones are similar to those defined by Cushing (1967) and Wright and Watts (1969) for northeastern Minnesota.

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Zone 1 is characterized by nonarboreal pollen values of greater than 40% of the pollen sum (Figure 1). The prominent nonarboreal types found at Big Rice Lake are sedge (Cyperaceae), wormwood (*Artemisia*), and ragweed (*Ambrosia*-type). This zone indicates a shrub tundra-like environment with occasional stands of spruce.

Zone 2 is a transitional zone with Cyperaceae prominent but declining (Figure 1). Birch (*Betula*) (probably dwarf birch) and *Picea* are the most abundant arboreal pollen types, suggesting the presence of a shrub parkland.

Within zone 3, two subzones are recognized (Figure 1). Subzone 3A and 3B have high percentages of *Picea* and *Pinus,* with *Picea* reaching its greatest abundance (35%) in 3A. *Abies* increases approximately 6% to reach its highest value of 7.1% in subzone 3B. Hardwoods, such as oak (*Quercus*) and elm (*Ulmus*), also become more abundant. The pollen spectra of this zone are representative of a conifer-hardwood forest.

Pinus, Betula, and alder (*Alnus*) are the dominant arboreal pollen types found in Zone 4, which is divided into four subzones (Figure 1). Subzone 4A is characterized by high percentages of jack pine/red pine (*Pinus banksiana/resinosa*-type) and an increase in grass (Gramineae), *Artemisia,* and *Ambrosia*-type pollen. Oak reaches its maximum abundance of approximately 8% in subzone 4B while *Artemisia* and *Ambrosia*-type both decline. Subzone 4C shows an increase in Gramineae pollen to 46%, from 8% in subzone 4B. This increase in Gramineae probably results from the expansion of wild rice (*Zizania aquatica*) in the lake. At the beginning of sub-

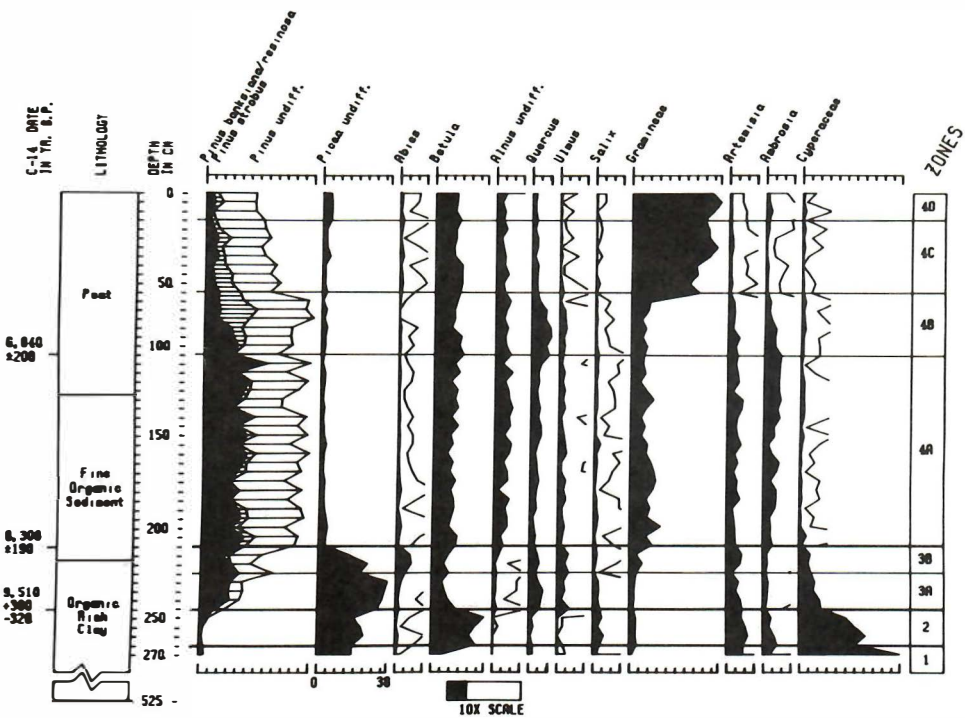

Figure 1. Pollen percentage diagram of selected taxa from Big Rice Lake, St. Louis County, Minnesota.

zone 4C, Rig Rice Lake may have become shallow enough to support increased wild rice growth. Subzone 4D probably represents the advent of European settlement. *Ambrosia*-type pollen (a disturbed ground plant) shows a small increase that may be the result of deforestation within the area. During Zone 4, a succession from red and jack pine to white pine occurred, as a mixed conifer-hardwood forest developed.

During the time of Paleoindian presence in the Big Rice Lake watershed, vegetation progressed from a shrub tundra-like environment to a conifer-hardwood forest. Further paleoecological investigations will aid in a more complete understanding of the environmental setting during Paleoindian occupation of northeastern Minnesota.

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Preliminary Growth Curve for *Rhizocarpon geographicum s.l.* in the Wind River Range, Western Wyoming

William C. Mahaney

Even though archaeological sites are not known in the alpine zone of western Wyoming, neoglacial sequences are common in many valleys about 3,000 m in the Wind River Range, western Wyoming (Mahaney 1984). Relative age determinations of glacial and periglacial deposits are possible using topographic position, lichen and other vegetation characteristics, weathering features on surface stones, and soil morphology (Mahaney 1978, 1984). Because it is only rarely possible to date these deposits using radiocarbon, very little is known about the exact time of neoglacial geologic and climatic events. In this paper a lichen growth curve, for *Rhizocarpon geographicum s.l.,* makes it possible, for the first time, to date deposits in the neoglacial sequence. With increasing interest in the archaeological record of mountain ranges in the western United States (Benedict 1981), it may eventually be possible to date prehistoric alpine sites using lichenometry.

The principles, problems, and applications of lichenometry to geomorphological and archaeological problems have been discussed by a number of workers (Benedict 1967/1968; Beschel 1961; Calkin and Ellis 1984; Curry 1969; Mahaney and Spence 1984). The two most common assumptions employed in lichenometry are: 1) lichen growth is indicative of elapsed time since deposition, and 2) the largest lichen thallus

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generally represents the oldest and fastest growing lichen on a substrate. Lichenometry may be used only for the lifespan of the lichen thallus, which is considered to be a maximum of ~3,000 years for *R. geographicum s.l.* (Benedict 1967, 1968).

Deposits in Stroud Basin and other high altitude drainages in the Wind River Mountains were sampled with the objective of measuring the largest thalli of *R. geographicum s.l.*. Measurements were made to the nearest millimeter. Only large thalli were measured and the largest of these were used to construct a tentative time-size curve. Thalli interfingering with one another were not measured to avoid problems of intraspecies competition. Those thalli found in depressions were not measured because snow-kill might reduce the lichen cover and impede the development of maximum diameters (Curry 1969).

The usual restrictions adhered to by other workers of rock type, ice crystal blasting, aspect, moisture, and substrate stability were followed in this study (Mahaney 1978). All thalli were sampled on moraine crests to avoid slope wash and frost creep effects. Maximum diameters were measured on granite and granodioritic stones to minimize differences in lithology. Further, thalli on northwest-facing boulder surfaces were not counted to avoid ice-crystal blasting effects; however, in most instances these surfaces were either devoid of lichen cover, or they contained a population with lower maximum diameters. No significant differences between maximum diameters were observed when north and south-facing aspects of boulders were compared.

The samples used for radiocarbon dating of substrates were collected from an outwash deposit in front of the inner Indian Basin morain in Stroud Basin at 43°09′30″N, 109°42′35″W. These samples were collected with metal implements, air dried on aluminum foil, and stored frozen for 10 weeks before shipment to Japan for radiocarbon dating.

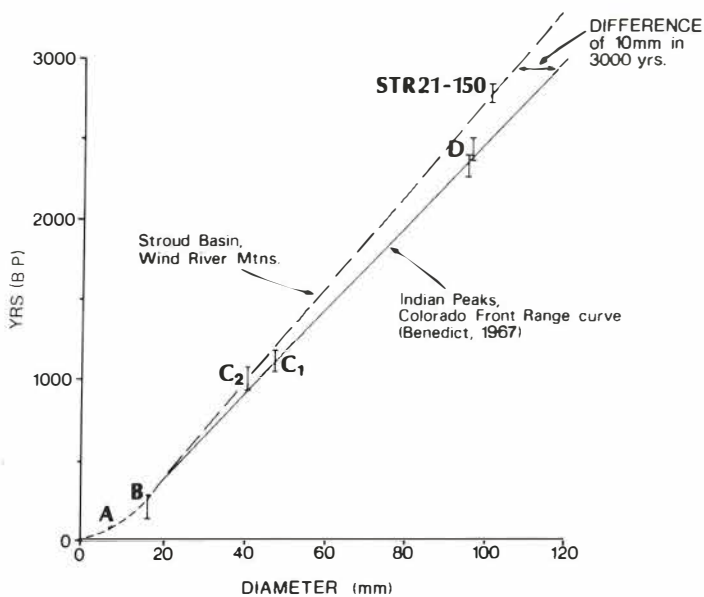

Figure 1. Time-size curves for *Rhizocarpon geographicum s.l.* for the Wind River Range (Wyoming) and Front Range (Colorado). Plots ABCD in Benedict 1967.

Indian Basin deposits in Stroud Basin are unusually well preserved and outwash deposits can be traced to moraine fronts in the area near Peak Lake. Just east of Peak Lake, between an outer and inner end morain of Indian Basin age (Mahaney 1984), an outwash deposit (STR21) emplaced 2,760 ± 110 yr B.P., GaK-9597, yielded enough organic material to provide a maximum age for the inner neoglacial moraine and a minimum age for the outer moraine. The organic material in this outwash consisted of detrital plant material with old roots and intact leaf material.

After sampling all thalli of *R. geographicum s.l.* on the inner and outer moraine crests, the maximum diameter observed was 104 mm (Figure 1). Several other thalli gave measurements close to 100 mm, suggesting that the largest thalli was not unusually large, and it represented the elapsed time since deposition 2,760 ± 110 yr B.P. Since the cross-valley axis here is sufficiently wide (500 m), clast transport (and hence lichen transport) from the surrounding valley walls over snow banks to the moraine crest, although possible, such as in other areas (Mahaney 1978), is not likely.

Having determined the maximum diameter and the age of the associated outwash deposit, it proved possible to construct a tentative growth curve for *R. geographicum s.l.* (Figure 1). The great-growth rate period (defined as that occurring over the first 100 years), while not known with precision for the Wind River Range, is suspected to be similar to the Front Range in Colorado (Mahaney 1978). Assuming that great-growth rates are similar, the differences in size after 3,000 years, when compared with the Front Range, is 10 mm. The average growth/100 yrs following the great-growth period is estimated at 3.0 mm, which is slower by 0.3 mm/100 yrs when compared with the Front Range, Colorado (Benedict 1967, 1968).

Construction of a tentative growth curve for *R. geographicum s.l.* will allow more refined dating of neoglacial deposits in the Wind River Mountains. The initial data suggest that lichen growth of 3 mm/100 yrs is somewhat slower than in the Front Range of Colorado (3.3 mm/100 yrs), 750 km to the southeast. As more deposits are radiocarbon dated, other workers should be able to test the timesize relationships discussed herein, and refine the curve to a considerable degree. In addition, if archaeological sites are discovered in the alpine zone, it may prove possible to date them using lichenometry.

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A 10,500-year Record of Environmental Change from Cape Cod, Massachusetts

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A 10 m core from Cape Cod, MA provides a regional pollen record that extends into the end of the Pleistocene. The core was retrived near Brewster, MA, from Owl Pond (41°45′24″N, 70°15′30″W, 7.3 m elevation), a 1.6 ha glacial kettle with a maximum water depth of 9.1 m. Knowledge of the vegetational history of Cape Cod is largely based on the pollen diagram from Duck Pond in South Wellfleet, MA, which had a basal data of 11,710 yr B.P. (Winkler 1985). The present study provides an additional record of postglacial vegetation change in Cape Cod. The core is mostly composed of organic mud (dy), but interlayering of organic mud and sand lenses characterizes the base of the core (Figure 1). The basal organic lens containing fibrous plant fragments corresponds to the basal "trash" layer described by Florin and Wright (1969). Four radiocarbon dates, the oldest being 10,270 yr B.P. (at 898 cm), provide chronostratigraphic control.

The diagram of pollen percentages (Figure 1) was divided into three pollen assemblage zones: 1) a spruce/pine/alder (*Picea/Pinus/Alnus*) zone (OP-1) from ca. 10,500 to 9,900 yr B.P. (915 cm to 860 cm), 2) a pine/birch (*Betula*) /oak (*Quercus*) zone (OP-2) from 9,900 to 7,800 yr B.P. (860 cm to 680 cm), and 3) and oak/pine zone (OP-3) from 7,800 yr B.P. to present (680 to 0 cm). Zone OP-3 was further divided into three subzones: OP-3a from 7,800 to 4,750 yr B.P. (680 cm to 480 cm), OP-3b from 4,750 to 330 yr B.P. (480 cm to 35 cm), and OP-3c from 330 yr B.P. to present (35 cm to 0 cm).

In zone OP-1, spruce pollen percentages are at a maximum (43%). Spruce pollen accumulation rates increased from 4,800 to over 20,500 grains/cm^2/yr, suggesting the presence of spruce trees in the landscape. Spruce pollen percentages declined at the end of the zone while pine values increased. Most of the pine grains (approximately 85%) were identified as jack pine (*P. banksiana*), while the rest were white pine (*P. strobus*). A peak in alder (*A. crispa*) pollen percentages occurred around 10,380 yr B.P. Birch pollen percentages also increased at the end of the zone. The pollen evidence suggests a boreal forest environment (Winkler 1985).

Zone OP-2 is characterized by peak values of pine (50–65%). White pine was the most important pine (up to 90% of all pine grains counted). The highest total pollen accumulation rates (90,000 grains/cm^2/yr) occur when white pine is the dominant forest tree. Jack pine decreased in importance until it disappeared after 9,000 yr B.P., while pitch pine (*P. rigida*) values increased to over 15% of the pollen sum by the

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end of the zone. A peak in birch pollen values occurs around 9,600 yr B.P. Oak pollen percentages increased to over 30% at the end of the zone.

Zone OP-3 is generally characterized by high values of oak pollen. In subzone OP-3a, peak values of oak occur (61%). Pine percentages decrease markedly from 39 to 15%. Hemlock (*Tsuga*) pollen percentages increase to 5%. Beech (*Fagus*) pollen occurs in significant quantities after 6,000 yr B.P. and reaches a maximum of 16% at 5,110 yr B.P. Subzone OP-3b begins with an abrupt decline in hemlock values to less that 0.5%. This "hemlock decline" is a synchronous pollen stratigraphic event in eastern North America attributed to a forest pathogen (Davis 1981). Oak pollen values remain high. Pine pollen values increase at the onset of the subzone and reach a high of 43%. After 3,000 yr B.P. oak pollen percentages increased, while pine values decreased. Hickory (*Carya*) pollen percentages increased during this period for the first time to levels of 2.5%. Hemlock percentages increased steadily after 3,300 yr B.P. and reached pre-decline values by 2,400 yr B.P. The pollen assemblages of the above two subzones reflect the increasing importance of deciduous forest trees around Owl Pond. This pattern is similar with vegetational changes occurring in southern New England (Gaudreau and Webb 1985). Persistently high values of pine pollen, however, are not generally encountered outside the Cape and reflect the influence of the sandy glacial soils on the Cape. In subzone OP-3c, herbaceous pollen increased

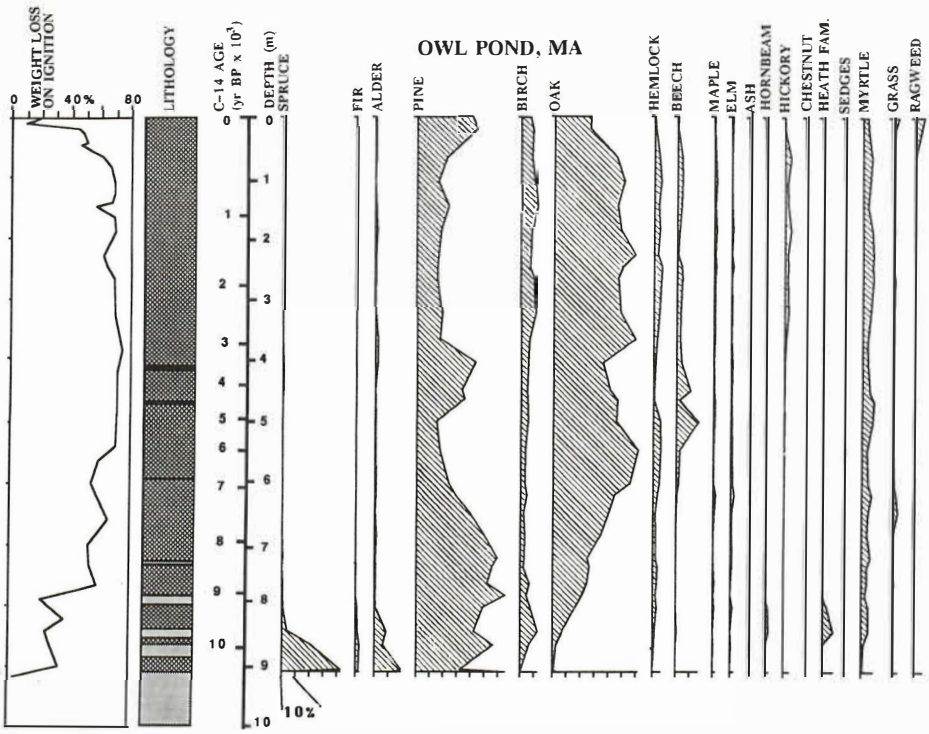

Figure 1. Percent fraction of organic material calculated by weight loss on ignition, lithology (cross-hachure; organic-rich sediment; stippled pattern: sand), and pollen percentages for selected taxa.

markedly to 10%, while oak percentages decreased. Pine values increased and then decreased, with the ratio of pitch pine pollen to white pine pollen becoming approximately 2:1. Organic content of the sediment decreased to less than 20% in the upper 10 cm of the core (Figure 1). The pollen changes in this subzone and the increase in inorganic input to the lake reflect land clearance practices after European settlement in the 17th century (Winkler 1985).

Archaeological evidence on Cape Cod during the Paleoindian and early Archaic is scarce. Low sea levels might have favored occupation of area that are now submerged or eroded away. Archaeological evidence for settlement during the Archaic and Woodland periods increases, but the search for pre-European disturbance of the landscape by humans remains a key goal of this and related pollen research on the Cape.

I am grateful to T. Webb III for his encouragement and advice. I also thank K. Anderson, P. Klinkman, P.C. Newby, and R. Webb for their assistance. This research was supported by grants from the Public Archaeology Laboratory in Providence, RI and by an NSF grant from the Climate Dynamics Program (ATM84-06832).

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A Paleoecological Reconstruction from August Lake, Lake County, Minnesota

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Paleoecological investigations from August Lake (93°37′33″N, 47°42′30″W), located 110 km north of Duluth, provide a post-glacial record for northeastern Minnesota. Pollen and diatom assemblages from a short core yield a vegetational sequence, pH reconstruction, and approximate sedimentation rate. The watershed included 70% upland second growth, conifer-hardwood forest, and 30% wetlands. Currently, the lake has a mean alkalinity of 305 μeq L^{-1} and a mean pH of 6.8.

A 75 cm freeze crust core extracted from near the center of the lake shows three distinct stratigraphic zones (Figure 1). The upper 65 cm consists of fine-grained, organic-rich sediments with the bottom 10 cm composed of light-gray clay interpreted

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as glacial material. A sample from 60-65 cm has been submitted for ^{14}C dating. The estimated sedimentation rate for August Lake, assuming the top of the clay layer represents 10,000 yr B.P., is 0.65 mm yr^{-1}. This compares well with the reported rate of 1.0 mm yr^{-1} for Weber Lake (Fries 1962), located 25 km south of August Lake.

The pollen spectra from the core are dominated by pine (*Pinus*), birch (*Betula*), and alder (*Alnus*), except in zone 1 which is characterized by spruce (*Picea*), ragweed (*Ambrosia*-type), wormwood (*Artemisia*), sedge (Cyperaceae), and grass (Gramineae) (Figure 1). Zones 2 and 3 are characterized by pine, birch, and alder. Zone 2 is dominated by red pine (*P resinosa*) and jack pine (*P. banksiana*), which become less abundant toward the top of zone 3 as white pine (*P. strobus*) increases. Zone 4 is characterized by decreases in red pine, jack pine, and alder, and increases in white pine, spruce, birch, and herb pollen.

Pollen zone 1 is interpreted as representing a spruce parkland similar to that found by Wright et al. (1963) in southeastern Minnesota. Zones 2 and 3 represent a mosaic of upland vegatation with alder locally abundant in wetland areas. During this time, a succession from red and jack pine to white pine occurred. The slight increase in ragweed, birch, and spruce in zone 4 may indicate a return to cooler, moister climatic conditions following the hypsothermal period, pioneer settlement, and logging.

The diatom portion of the diagram is divided into four diatom-assemblage zones (Figure 1). Only incomplete and indeterminable valves were found in zone 1. Zone 2 is dominated by clearwater benthic taxa, notably *Fragilaria construens* and *F. construens* var. *venter*, whereas zone 3 is characterized by planktonic species such as *Melosira ambigua, M. italica* subsp. *subarctica,* and *Cyclotella comta.* Zone 2 is also characterized by a lower species diversity (ca. 29 taxa/interval) compared with zone 3 (ca. 55 taxa/interval) and a lower concentration of valves cm^{-3} wet sediment. Zone 4 is comparable to present conditions in the lake, is dominated by planktonic species,

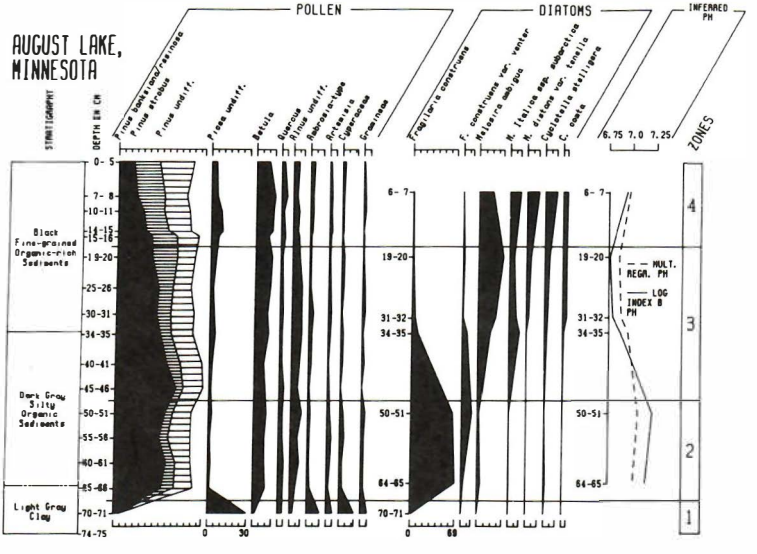

Figure 1. Percentage diagram of selected pollen and diatom taxa with inferred downcore pH.

has a slightly higher concentration of valves cm^{-3} wet sediment, and has a lower species diversity (30 taxa/interval).

Diatom taxa were assigned pH preferences derived from pH relationships observed in the northern Great Lake states (Kreis et al. 1986). Over 80% of the taxa from August Lake were classified as alkaliphilic or circumneutral. Downcore pH predicted from multiple regression and log index B equations (Kreis et al. 1986) indicates little variation in the post-glacial pH of August Lake (Figure 1). The major changes in the lake appear to have been a decrease in water transparency indicated by the transition from benthic to planktonic taxa and a corresponding shift in species diversity.

The zones delineated by pollen and diatom assemblages correlate well with the major stratigraphic change in the core and indicate a transition from an oligotrophic lake surrounded by spruce parkland and dominated by fine glacial outwash (zone 1) through successive vegetational stages (zones 2 and 3) to the present mesotrophic, circumneutral lake with a mixed forest in the watershed (zone 4). This paleoecological reconstruction has the potential for aiding in the interpretation of possible Paleoindian sites evidenced by several isolated finds of Paleoindian artifacts in the region. Furthermore, through reconstruction of the paleoenvironment, studies such as this may aid archaeologists in locating Paleoindian sites in northeastern Minnesota.

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Paleoenvironments: Vertebrates

Age Structure Analysis of *Mammuthus columbi,* Hot Springs Mammoth Site, South Dakota

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The Hot Springs Mammoth site, South Dakota, contains the largest fossil sample of Columbian mammoths, *Mammuthus columbi,* in a primary accumulation, in the Western Hemisphere (Agenbroad 1984). The mid-Wisconsin age mammoth skeletons were preserved in the environment in which they died (biocoenosis); they were not transported after death or disarticulation.

At the completion of the 1986 field season, a total of 39 individuals had been partially exhumed at the site, preserved in situ as a permanent exhibit. This sample of mammoths represents the remains encountered in excavation that approximate 15% of the total area of the site. In 1978 we estimated a total of approximately 100 mammoths would be exposed in the fill of this sinkhole natural trap, that estimate may be considered conservative.

Using mandibular and maxillary teeth of measurable specimens encountered in the 1974 through 1979, 1983, and 1986 field seasons, we have a sample of 26 mammoths for which the age at the time of death was determined (67% of the entire sample). Age determination for the specimens was completed using the methodology described by Laws (1966). Gary Haynes (pers. comm.; see G. Haynes this volume) indicated a second age determination system provides a slightly different result for a given population. Figure 1 displays the age distribution for mammoths sampled from the Hot Springs site.

Whether the age distribution was constructed using the Laws or Haynes method, the results are basically the same. There is a high frequency of age 15 AEY (African elephant years, *Loxodonta africana;* Haynes age 11) and age 27 (Haynes age 23) AEY individuals represented in the fossil assemblage. This age cluster (category) represents, respectively, nearly sexually mature (and vigorously growing animals attached to mixed-sex family units) or the outcast individuals and groups of sexually mature, young males (Haynes pers. comm.). These curious, adventurous adolescent elephants and young adults were the prime candidates to be caught in a natural trap such as that provided by the slippery, submoistened, steep-walled sinkhole at Hot Springs.

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Younger mammoths would be deterred from the trap by the guardianship and protection of the older individuals of the family group, as is the case with modern elephants. Older animals would have acquired sufficient experience to avoid the trap. The adolescent-young adult category would also possess sufficient body size and mass to make extrication from the sinkhole unsuccessful by family unit members.

Using the age structure diagram of the Hot Springs fossils in comparison to age group distribution diagrams for catastrophic and attritional mortality, the assemblage is atypical for either model (Deevy 1947; Reher 1978; Voorhies 1969). The conclusion is that the sinkhole trap was selectively effective for subadults and young adult elephants (77% of the sample, through the 1986 season). This high incidence of entrapment and mortality is most probably due to behavioral habits and activities of that age group of mammoths, as observed in modern African elephants.

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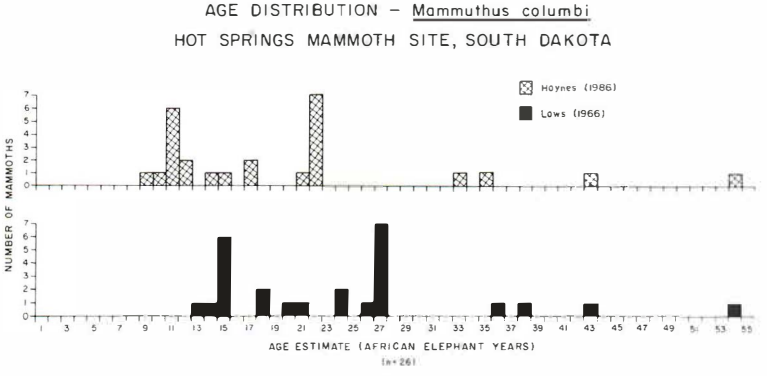

Figure 1. Age distribution of mammoth from the Hot Springs Mammoth site, South Dakota.

Wolverines: *Gulo gulo,* in Late Rancholabrean Deposits in Nebraska: First Records from the Great Plains

R.G. Corner and M.R. Voorhies

Remains of wolverines (*Gulo gulo,* Mammalia: Mustelidae) are rare in Pleistocene deposits of North America and have not been previously described from the Great Plains. Most North American fossil occurrences of the species are in the northern Rocky Mountains and in Alaska (Anderson 1977, 1984); the southernmost record, in the Chimney Rock Animal Trap, is just south of the Wyoming border in northern Colorado (Hager 1972).

Here we report the recovery of diagnostic dentitions of these highly predaceous animals in three late Pleistocene faunas in Nebraska. All specimens (N = 4) lie well within the size range reported for a large sample of late Pleistocene and Recent *G. gulo* studied by Anderson (1977). The most complete specimen is a well-preserved lower jaw with full dentition (Figure 1A) collected in November, 1986 at fossil vertebrate locality Kh 104, the Crappie Hole site (see Voorhies and Corner 1984, for locality description and faunal lists). Maxillary fragments of two different individuals (Figure 1B) were collected from a previously unreported site in northeastern Nebraska (UNSM locality Kx 140, "Wolverine Slide"). This site is on a cutbank of Merriman Creek in the SE 1/4, NW 1/4, NE 1/4, NW 1/4, sec. 25, T29N, R7W, Knox Co., NE. Fossils were collected here from a lens of poorly sorted alluvial gravel 1.5 m above the base of the highest exposed terrace fill of Merriman Creek at an elevation of 487.5 m. Associated taxa include pocket gopher (*Thomomys* sp.), red-backed vole (*Clethrionomys gapperi*), yellow-cheeked vole (*Microtus xanthognathus*), ground squirrel (*Spermophilus richardsoni*), mammoth (*Mammuthus* sp.), horse (*Equus* sp.), and bison (*Bison* sp.). A late Rancholabrean age is assigned to the Wolverine Slide local fauna on the basis of the faunal assemblage. The third occurrence consists of an isolated upper carnassial, UNSM 83263, collected from test pit no. 6 at UNSM locality Cr 110 (Smith Springs) in the SW 1/4, SW 1/4, SE 1/4, SE 1/4, sec. 25, T34N, R26W, Cherry Co., NE. This site is one of the principal sources of the Smith Falls local fauna, which is derived from the highest alluvial terrace of the Niobrara River (Voorhies and Corner 1985). Another mustelid of primarily boreal distribution, marten (*Martes americana*), also makes a rare Great Plains appearance in the Cr 110 collection.

Wolverines are primarily boreal in distribution with most modern populations inhabiting taiga and tundra (Hall 1981) where they prey on a wide variety of small and large Arctic mammals as well as consuming significant amounts of carrion. In early historic times they were more widespread; Jones (1964) postulated that western Nebraska was at the southeastern limit of the species' range in the nineteenth century, citing a specimen taken in Scotts Bluff Co. in 1887. Such apparent wanderers aside, the open plains are clearly not prime wolverine habitat today and we believe that their presence in a fossil assemblage strongly implies the nearby presence of boreal

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woodland habitat in the local paleoenvironment. All fossil occurrences known to us are in faunas bearing other mammals of boreo-montane distribution (Figure 1C). We suggest that the presence of wolverines in three widely separated, sparsely fossiliferous sites in Nebraska indicates that substantial populations of the animals were present in the central Great Plains during late glacial times.

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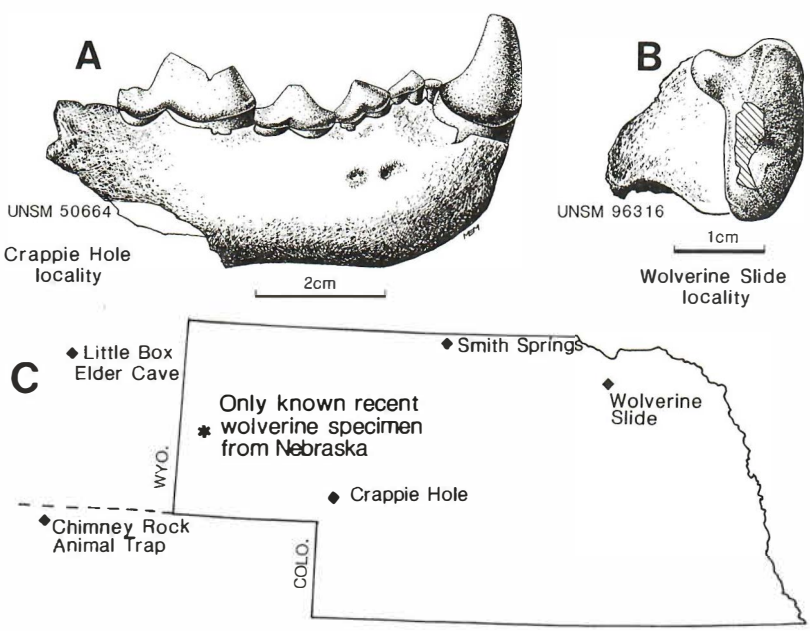

Figure 1. Wolverines (*Gulo gulo*) in Nebraska. A. Lateral view of right dentary with C, P/1-P/4, M/1, from late Pleistocene Crappie Hole Locality in Keith County. B. Occlusal view of left maxillary fragment with P/4, from late Pleistocene Wolverine Slid Locality in Knox County. C. Map showing location of five mid-continent Rancholabrean localities that have yielded fossil wolverine remains (diamonds), and the collection site (near Gering) of the only Recent Nebraska specimen known to us. *Figure by Mark Marcuson.*

Lemmus sibiricus from the Late Quaternary of the Midwestern United States

Robert L. Foley and Lyn Elizabeth Raue

The Prairieburg local fauna (l.f.), a newly discovered fossiliferous Wisconsin age cave deposit in eastern Iowa, has yielded hundreds of specimens of animals with strong arctic affinities, including the first report of brown lemming (*Lemmus sibiricus*) from the southern margin of the Laurentide ice sheet. The only other North American fossil *Lemmus* is from January Cave, an alpine site in the Canadian Rockies of southwestern Alberta (Burns 1980). The Prairieburg brown lemming (left ramus with m1-m2, left m3, right M3; MNI = 1 [Minimum number of individuals]), occurs with abundant remains of both collared lemming (*Dicrostonyx torquatus,* MNI = 46) and at least two vole species (*Microtus* spp., MNI = 35). The *Microtus* material includes m1s and M2s closely resembling *M. miurus* (singing vole), but these appear associated with unusual m3s and M3s, which prevents reliable diagnosis at this time. The "*Lemmus*" horizon of the Prairieburg l.f. also includes masked shrew (*Sorex* cf. *cinereus,* MNI = 1), artic ground squirrel (*Spermophilus* cf. *parryii,* MNI = 3), heather vole (*Phenacomys* cf. *intermedius,* MNI = 1), ermine (*Mustela erminea,* MNI = 1), and possibly plains pocket gopher (*Geomys bursarius,* MNI = 1).

With the exception of plains pocket gopher (which may be intrusive), the Prairieburg species occupy two areas of maximal sympatry (Figure 1); the western area does not include *Phenacomys,* the eastern excludes *M. miurus.* The arctic nature of either sympatry is demonstrated by the co-occurrence of three tundra endemics: arctic ground squirrel, brown lemming, and collared lemming. Singing vole, another tundra inhabitant, also defines the Alaskan sympatry if its presence is confirmed. The remaining species: masked shrew, heather vole, and ermine also are found in the artic, but range south into boreal forest as well. The entire local fauna is comparable to the Siberian steppe-tundra microfauna (Vereshchagin and Baryshnikov 1982) and the mammoth steppe microfauna (Guthrie 1982).

Although most late Wisconsin microfaunas from the midwestern and eastern United States are disharmonious, containing southern and northern species as well as presently native forms (e.g. Baker Bluff, Guilday et al. 1978; Peccary Cave, Semken 1984; Moscow Fissure, Foley 1984), two other nearly harmonious, but sparse, local faunas analogous to modern tundra occur in eastern Iowa. The Elkader l.f. (20,530 ± 130 yr B.P.; Woodman 1982; MNI = 17) produced fossils of the arctic ground squirrel, singing vole, collared lemming and yellow-cheeked vole. The Conklin Quarry l.f. (18,090 ± 190 to 16,710 ± 270 yr B.P.; Baker et al. in press; MNI = 9) includes *Dicrostonyx* sp. and singing vole and also represents a direct arctic analogue.

The Prairieburg fossils were recovered from 4–30 cm of red sediment which directly overlies the floor of a small cave on the Alden farm in Linn County. Lying disconformably above the red fill is a dark gray-brown layer. This horizon is also fossiliferous, but includes species currently indigenous to eastern Iowa.

The Prairieburg l.f. is significant because: 1) the large number of well preserved fossil specimens clearly establishes the presence of *Lemmus sibiricus* and the dominance

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of *Spermophilus parryii, Microtus miurus,* and *Dicrostonyx torquatus* in Iowa during presumed full-glacial time, 2) the fauna indicates that cold tundra (or steppe-tundra ?) habitats were present, 3) the presence of *Dicrostonyx torquatus* confirms the growing line of evidence that this was the collared lemming west of the Appalachians (*D. hudsonius* fossils occur from the Appalachians east to the Atlantic Coast), and 4) this site and the other two Iowa sites mentioned above indicate that "high stress, arctic microfaunas" were present during full-glacial times; the "high diversity, disharmonious faunas," described in the majority of the late Wisconsin microvertebrate sites, probably represent late-glacial conditions that occurred after some climatic amelioration. Specimens will be curated into the University of Iowa Paleontological Repository.

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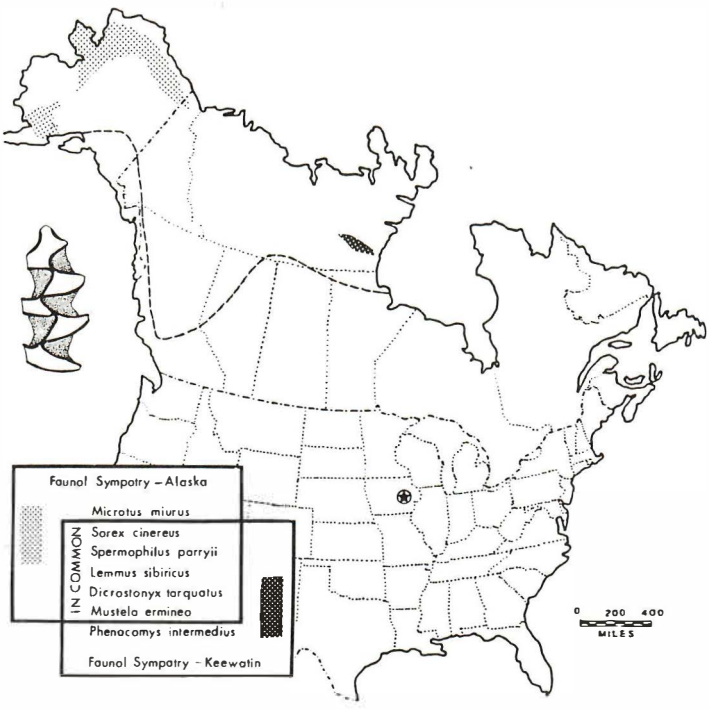

Figure 1. Areas of maximal sympatry (stippling), southern most range (dashed line) and left m1 of *Lemmus sibiricus.*

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Initial Investigation of Vertebrate Remains from Snake Creek Burial Cave, White Pine County, Nevada

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Snake Creek Burial Cave is located 4 km west of Garrison, Utah and 16 km east of Wheeler Peak Scenic Area at an elevation of 1731 m. The entrance is a 3 m diameter sinkhole that funnels down 2 m to a 1 m diameter hole. This hole leads to a 13 m drop into the middle of an 18 m diameter chamber, so the cave acts as a natural trap. The area directly below the entrance is wet, rocky, and littered with carcasses of animals that have fallen into the cave. Other parts of the cave contain finely stratified muds and dry dust deposits which also contain animal remains, probably due to transport by wood rats.

Halliday (1957) mapped the cave and described its geology. An unknown investigator has excavated three pits in moist sediments in the low western end of the entrance chamber where water collects. Barker and Best (1976) reported a wolverine (*Gulo luscus*) cranium from the cave. Mead and Mead (1985) excavated a test pit from which extinct camel (*Camelops*) and horse (*Equus*) were recovered, and they are currently planning a large-scale paleontological excavation.

This study describes a small sample of bones collected in 1981 from a cavity in the extreme southern corner of the entrance chamber. Bones were removed by hand from shallow dry dust in an elevated area. The following material has been identified and cataloged (Brigham Young University Vertebrate Paleontology 9629-9662). More complete descriptions of birds and mammals recovered from caves in Utah can be found in Emslie and Heaton (1987) and Heaton (1985).

Two birds have been identified from Snake Creek Burial Cave. Swainson's hawk (*Buteo swainsoni*) is represented by a complete right tibiotarsus and sage grouse (*Centrocercus urophasianus*) by a left tibiotarsus missing its proximal end. The vast majority of bones recovered are of mammals. The best represented animal is white-tailed

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jackrabbit (*Lepus townsendii*). Material consists of skull parts including two palates, four right dentaries, and eight left dentaries, most of which are too large to be black-tailed jackrabbit (*L. californicus*), the only other species of *Lepus* living in the area. Two P/3s are included which show very little crenulation, also indicative of *L. townsendii.* There is also a single toothless palate of cottontail that compares well in size with Nuttall's cottontail (*Sylvilagus nuttallii*) and desert cottontail (*S. audubonii*), especially with the smaller *S. nuttallii.*

Among the rodent remains is a single nearly complete skull of Townsend's ground squirrel (*Spermophilus townsendii*) including a complete palate without teeth. This species is distinguished by its small size and large masseteric tubercles. There is also a toothless right maxilla of marmot (*Marmota flaviventris*). The best represented rodent is wood rat (*Neotoma*). A nearly complete skull (both M1s) represents desert wood rat (*N. lepida*) based on its small size and very shallow anterior reentrant angle on M1. Two partial skulls, a palate, and two right dentaries represent the larger bushy-tailed wood rat (*N. cinerea*). Two M1s are included in this material, and both have a deep anterior reentrant angle characteristic of *N. cinerea.*

This collection contains an unusually high proportion of carnivores. Red fox (*Vulpes vulpes*) is represented by the posterior part of a skull including the complete braincase and probably by another skull cap as well. The distinct shape of the sagittal crest and diverging temporal lines identifies this species. The smaller kit fox (*V. velox*) is represented by a right dentary (p3-4, m1-2) and a juvenile left dentary (p3-4, partially erupted c1 and m1). The lack of a "step" on the posteroventral margin of the dentaries distinguishes them from gray fox (*Urocyon*), the other fox living in the region.

Weasel (*Mustela*) is represented by two nearly complete skulls (right P3-4, M1, left P2-4, M1/; right P4, M1/, left P2,4, M1) and the anterior part of another skull (right P4, M1). All compare best in size with long-tailed weasel (*M. frenata*) but are only slightly larger than short-tailed weasel (*M. erminea*). The ratio of maxilla length to skull length is slightly smaller in *M. erminea* than in *M. frenata,* and the skulls from Snake Creek Burial Cave compare best with *M. frenata* in this respect also. The largest specimen collected is a complete skull of bobcat (*Lynx rufus;* right I3, broken C1, P3-4, left I3, P4). This skull is slightly smaller than comparative specimens of *L. rufus* and distinctively smaller than lynx (*L. canadensis*).

No bones of extinct animals were found in this study, but a portion of the assemblage is typical of late Pleistocene cave faunas in the Great Basin. *Lepus townsendii, Marmota flaviventris, Neotoma cinerea,* and *Vulpes vulpes* were recovered which now tend to live only at higher elevations in the Snake Range but which definitely lived as low as the cave during the Pleistocene (Heaton 1985). Deeper sediments in the cave will certainly provide a rich Pleistocene fauna. One problem is that the area where most bone is deposited is also where rockfall and water are most likely to destroy it. But the large chamber containing a variety of depositional environments and active bone transporters (wood rats) holds great promise as a paleontological site.

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Ontario Paleoindians and Proboscideans: A Review

Lawrence J. Jackson

Radiocarbon dates and pollen associations for mastodon (*Mammut*) and mammoth (*Mammuthus*) in late glacial southern Ontario support the presence of these proboscideans between 12,000 and 10,000 yr B.P. (Jackson 1979; McAndrews and Jackson 1986). This age range embraces the millenium or more of early Paleoindian presence contemporaneous with Southwestern Clovis and Folsom fluted point sites about 11,500 to 10,300 yr B.P. Although some 110 proboscidean fossils (about 100 of these late glacial in age) have been found in Ontario since the mid-1800s, no association with human artifacts has been documented. Careful review of the history of fossil site excavations, however, reveals that adequate archaeological techniques have never been applied.

Ontario mastodon distribution by minor physiographic region (Chapman and Putnam 1973) shows a preference for proglacial lake beds which are today poorly drained sand and clay plains. About 46% of mastodon locations are on sand plains, 41% on clay plains, less than 10% on upland till plains, and less than 5% in ridge areas. This distribution agrees with inferred mastodon habitat in marshy lowland spruce environs (Dreimanis 1968). Significantly, 60% of assignable Ontario fluted point locations occur in the same physiographic regions, which account for 90% of total mastodon (Figure 1). Of eight regions with 5% or more of mastodon, all but two also include 5% or more of total fluted point locations (Jackson 1983).

Spatial and temporal co-distribution of Ontario mastodon and Paleoindian suggests that occasional reliance may have been placed on proboscideans as a food source, even if they were not deliberately hunted. This seems particularly likely in view of growing evidence for use of this animal in eastern and northeastern North America (Fisher 1984; Graham et al. 1981; Shipman et al. 1982).

As early as the 1920s, two fluted points were reported from a southwestern Ontario farm which produced mastodon remains (E. Jury pers. comm. 1978). Both were from a collection which W.J. Patterson, a geology student at the University of Western Ontario, brought to the attention of Jesse Figgins, Director of the Colorado Museum of Natural History. One was illustrated by Figgins (1934). The other, not known to Patterson, and reportedly found directly with the mastodon, was illustrated years later by Garrad (1971:14) and is a large well fluted point of Barnes type (C. Ellis pers. comm. 1986).

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To our great loss, this site was not researched for 40 years. Charles Garrad did investigate for the Ontario Archaeological Society in the late 1960s but found the locational details were in error. The association is still unconfirmed as a fluted point found in muck-silt beside a mastodon tusk and ribs in the Thames River valley (Garrad 1971; E. Jury pers. comm. 1978). The failure of archaeologists to investigate southwestern Ontario mastodon sites in the 1930s reflected a broader reluctance to engage in research on late Pleistocene man. W.J. Patterson was encouraged by Jesse Figgins to investigate known mastodon sites near London, Ontario but his efforts toward organizing field research on "Folsom culture" and megafaunal associations were discouraged by well-meaning but poorly informed "authorities" (Jackson 1986).

Other co-occurrences of mastodon and human artifacts have been noted. Ami (1898) recorded deer bones and arrowheads in peat above a mastodon near Marburg in Norfolk County, southwestern Ontario. Dreimanis (1967) noted mastodon molar fragments and Indian relics at a site in Norfolk County. Dreimanis (1968) also recorded a possible skinning tool from the Ferguson Farm mastodon site near Tupperville, southwestern Ontario. This item was discarded by relic collectors who excavated the mastodon (Dreimanis pers. comm. 1986).

Archaeologists have not investigated any of these associations nor has there been a single excavation at an Ontario proboscidean site specifically designed to recover archaeological information. This urgently requires correction since Dreimanis (1968) has suggested that human predation may have been a critical factor in the final collapse of Ontario proboscidean populations. Investigations of the role of human agency in megafaunal extinctions has been sadly neglected in a province with a wealth of proboscidean fossils.

McAndrews and Jackson (1986) record some 75 mastodon, about 28 mammoth, and 7 unspecified proboscidean reports for Ontario. Mammoth distribution does not

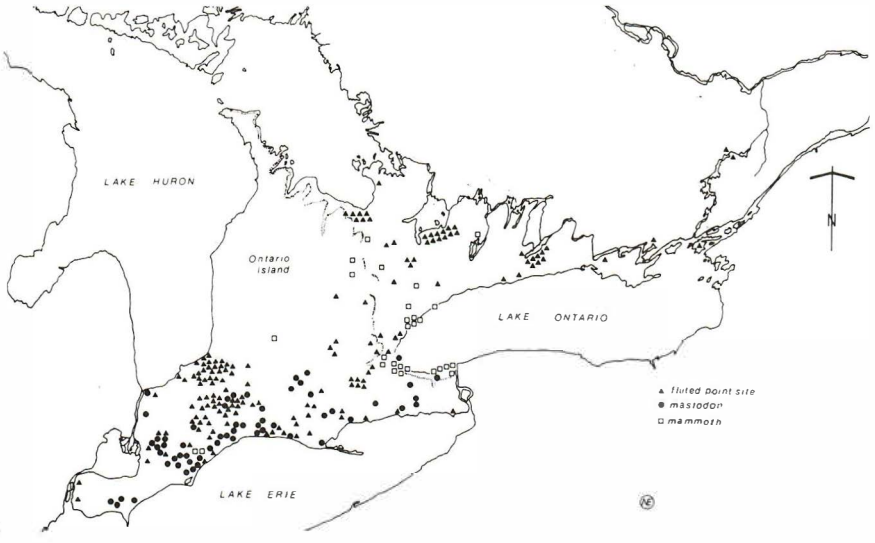

Figure 1. Distribution of fluted point, mastodon, and mammoth sites in southern Ontario, Canada known to provenience (unspecified proboscideans are included with mammoth).

coincide with areas of fluted point abundance. Principal regions of occurrence include the Ontario Island uplands of southwestern Ontario, adjacent parts of south-central Ontario, and the Iroquois shoreline along the western Lake Ontario basin. Mastodon are also absent from the two most important physiographic regions of Ontario fluted point occurrence, the Huron Slope of southwestern and the Simcoe Lowlands of southcentral Ontario. These regions account for over 30% of Ontario fluted point locations. The major Parkhill site (Roosa 1977) is located in the former and the Fisher site (Storck 1984) in the latter region.

Explanation of this distributional anomaly may derive from Deller and Ellis's (1986) theory of time-sequential occupation of Ontario by at least three fluted point using groups. In the Southwest, earliest Clovis hunters are best known from single and multiple mammoth kills while later Folsom hunters are best known from sites of communal bison hunting. I suspect that earliest Clovis analogues in Ontario may have hunted mastodon and/or mammoth. Communal hunting of other species by later Paleoindian groups could have been accelerated by dwindling proboscidean populations as spruce environs disappeared after 11,000 yr B.P.

All this draws attention to a need for investigation and should not be construed as a case for proboscidean hunting by Ontario Paleoindians. In fact, more attention needs to be paid to those species seldom reported but widely present in the fossil record such as deer (*Odocoileus*), elk (*Cervus*), and caribou (*Rangifer*). The only large and gregarious herbivore present in the Ontario fossil record for which there is evidence of exploitation in bordering Great Lake states is the caribou (Cleland 1965; Coleman 1899; Spiess et al. 1985). Both Parkhill and Fisher sites with large activity area complexes on proglacial strandlines could have been associated with communal hunting of caribou. Fluted points from both sites date near the end of the Pleistocene (Deller and Ellis 1986) when few proboscideans may have been extant.

Investigations of Ontario proboscidean sites using basic archaeological techniques is the minimum requirement for resolution of the role of these large herbivores in Paleoindian life and of the equally important question of the influence of human predation on megafaunal extinctions.

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A New Location of the Late Pleistocene Fauna in the Polish Carpathians

Adam Nadachowski and Mieczyslaw Wolsan

More than 50 cave localities of the late Pleistocene faunas have so far been found in Poland. Those located in the Cracow-Wieluń Upland are in the majority (e.g., Kowalski 1959; Bocheński 1974; Madeyska 1981; Nadachowski 1982; Szyndlar 1984). Several others have occurred in the Sudetes (Kowalski 1959; Wiszniowska 1970) and Swietokrzyskie Mts (Kowalski 1972). In the Carpathians, only a few locations entirely without or with poor stratigraphy have hitherto been recorded from the Tatras (Kowalski 1959).

In summer 1985 the Institute of Systematic and Experimental Zoology, Polish Academy of Sciences, and the Department of Archeology of Little Poland, Institute of the History of Material Culture, Polish Academy of Sciences, have started on excavations in a cave in the Oblazowa Rock. This rock is 670 m above sea level high, belongs to the Pieniny Klippen Belt, and is located on the north foreland of the Tatras, in the Nowy Targ Valley on the Bialka River (49°25′48″N, 20°9′36″E). The cave originated in the red nodular limestone, most likely through decay and washing away of a tectonic breccia (Kowalski 1954; Birkenmajer 1979). Its relatively small arched entrance is placed in the lower part of the south wall of the rock about 6 m above

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the recent valley of the Bialka River. Just before the excavations, the cave was composed of a small chamber close behind the entrance, passing into a short corridor going up to a small narrow aperture in the ceiling. At that time the cave was above 9 m long and 4 m wide. Its bottom was covered by a rubble and loamy-rubble sediment.

About 12 m^3 of the sediment has hitherto been excavated and scoured whole, involving both the inside of the cave and the outside in front of the entrance. Nine units, marked from up to down with numbers from 1 to 9, have as yet displayed. However, no rocky floor has so far been detected. All the units are abundant in the late Quaternary snail and vertebrate faunas and three of them (nos. 3, 5, and 8) are in fact the upper Palaeolithic cultural levels. The most abundant in artifacts is the lowest one (Valde-Nowak 1987). Hitherto, unit 8 provided 30 artifacts of stone and 8 made of organic material, including a fragment of mammoth (*Mammuthus*) tusk showing all the parameters of a complete boomerang. There were also remains of construction involving several large boulders in this level. This cultural layer also included the distal phalanx of the left thumb of a young man, being the earliest human find in Poland. According to Valde-Nowak (1987) this cultural level should be referred to the cycle of Central European backed points cultures, showing traces of the Pavlov culture which is dating to about 23,000 yr B.P.

A preliminary analysis of 4 samples (each sample = about 12 cm^3 of sediment) from unit 4, 10 samples from unit 6, and 14 samples from unit 8 has revealed the three late Pleistocene faunal assemblages.

In unit 4 small mammals comprise the majority of the assemblage: *Sorex* sp. (shrew), bats, *Ochotona* sp. (pika), *Lepus* sp. (hare), *Dicrostonyx gulielmi* (Arctic lemming), *Lemmus lemmus* (Norway lemming), *Clethrionomys glareolus* bank vole, *Arvicola terresris* (water vole), *Pitymys subterraneous* (European pine vole), *Microtus nivalis* (snow vole), *M.* cf. *arvalis* (common vole), *M. oeconomus* (root vole), and *M. gregalis* (narrow-skulled vole). Also included in the unit are gastropods, amphibians, reptiles, and birds.

In unit 6 small mammals are still abundant and indicative of the paleoenvironmental conditions. The fauna from this unit is the same as in unit 4 except for the absence of: reptiles, bats, bank vole, European pine vole, and snow vole. All the rodents with the exception of the common vole and the water vole have preference for a steppe-tundra environment. Snails are less frequent, while megafauna are represented by some carnivores (*Alopex lagopus* (Arctic fox) and *Mustela nivalis* (weasel)) and *Rangifer tarandus* (reindeer).

Unit 8 consists of an assemblage only slighlty different from the previous one; but it includes: reptiles, *Spermophilus* sp. (souslsik), and snow vole. Steppe-tundra rodents are still dominant, their content amounting to 70%. A variety of carnivores have been recovered including *Canis lupus* (wolf), *Alopex,* and *Mustela erminea* (stoat/ermine). Reindeer is well represented. This thanatocoenosis (death assemblage) is poligenic in its nature. Remains of small mammals were accumulated from pellets of raptorial birds. Large mammals are relatively abundant and could have been carried in by cave-dwelling man or by carnivores to be eaten, thus being food remains.

The discussed sequence of snail and vertebrate fauna shows similarities to the succession of faunal assemblages described from various late Pleistocene profiles in the Cracow-Wieluń Upland (e.g., Madeyska 1981; Nadachowski 1982). A distinguishing feature is the recovery of snow vole which inhabits at present higher elevations in the Tatras. It is clear, from the presence of many boreal mammals that the deposit

had accumulated during a cooler climatic episode of the last glaciation and was built up over a relatively short time.

The site provides the first late Pleistocene small mammal locality within Polish Carpathians. It has produced and will continue to produce outstanding samples of local, late Pleistocene microfauna and megafauna in the region.

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Archaeological Investigations at Haystack Cave, Central Colorado

David T. Nash

A four-month season of archaeological excavation recently was concluded at the late Pleistocene/Holocene site of Haystack Cave (5GN189), located outside the town of Gunnison, in central Colorado. The research conducted here was part of a multifaceted program designed to: 1) investigate the validity and nature of a possible Pre-Clovis occupation at the site, and 2) elucidate the cause and effect relationships of specific formation processes within a cave environment.

Haystack Cave is a tube shaped feature, almost circular in cross-section, with an average diameter of 2.5 m and a length of over 25 m. At an elevation of 2450 m, the cave overlooks the Gunnison River Valley. Situated in the southern cliff face of a 28 million year old formation of welded-ash flow tuff capping Haystack Mesa, it is hypothesized that this feature was formed from a water vapor bubble (Burns et al. 1987).

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In 1978, the site was tested by the Midwest Archaeological Center, Lincoln, Nebraska. The completed 1 × 2 m test pit revealed an extremely rich and varied collection of vertebrate remains and a highly ambiguous lithic assemblage (Euler and Stiger 1981). Two radiocarbon dates were obtained on bone recovered from the top half of the cave's deposits (14,935 ± 610 yr B.P., TX-3632, and 12,154 ± 1700 yr B.P., TX-3633). Due to the uncertainty concerning the cultural validity of the previously recovered remains and the potential for the site to yield a great wealth of new data, new excavations were begun in May, 1986.

To date, 20 m^2 have been excavated to varying depths. The sedimentary record documents a complex, poorly sorted, and variable stratigraphy present throughout the cave. Preliminary size, composition, and grain shape analysis indicates that the deposits (which reach a depth of 1.8 m) are derived from organics, the mechanical and chemical weathering of the surrounding bedrock, and windblown sediments (Ethridge 1987). The number of strata (which vary from 1 to 12) and their properties are, in large part, related to the varying amount of organics present, the degree of bioturbation, and the periodicity of bedrock breakdown.

Though analysis of the materials has just begun, several emerging generalizations can be offered at this time. During the 1986 excavations, over 40,000 bone specimens and over 4,000 lithic specimens were retrieved. Most of the faunal remains are comprised of mammals, but birds, reptiles, and fish are also present. Large mammals thus far identified (see also Emslie 1986) include: two species of horse (*Equus* sp.), deer (*Odocoileus* sp.), elk (*Cervus canadensis*), bighorn sheep (*Ovis canadensis*), bear (*Ursus americanus*) and pronghorn (*Antilocapra americana*). Carnivore remains are common and represented by several species of canids, felids (including *Acinonyx trumani*), and mustelids. By far, the greatest number of remains are presented by the rodents and lagomorphs. This faunal assemblage possesses the following properties: 1) presence of characteristic breakage and modification attributed to carnivores; 2) considerable variation in degree of weathering, fragmentation, and mineralization; 3) evidence which may suggest cultural utilization (i.e., burned bone, possible cut-marks, polish, percussion breakage); and 4) anatomical part frequencies which vary significantly among species of different body size.

Almost all of the lithic specimens recovered were either welded tuff or jasper (which is present in large veins within the cave). With the exception of several flakes with a secure cultural origin, this assemblage is highly equivocal. Much of this assemblage resembles the remnants of a culturally produced assemblage, if someone had systematically removed all formal tools and all debitage having platforms and bulbs of percussion.

The most suggestive evidence for early human visitation at the site has been the recovery of 160 pebbles/cobbles. These are found throughout the various strata (including the lowest levels) and in all areas of the cave. With the possible exception of the smallest of the pebbles, there is presently no natural mechanism to account for the presence of these items in the Haystack Cave environment. In many respects, these cobbles resemble those described by Collins and Dillehay (1986) from the site of Monte Verde, Chile. The Haystack cobbles vary in material type, size, modification, and evidence for type of utilization. These items may exhibit one or more of the following: polish, edge-battering, heat treatment, ochre staining, fracturing, pecking-abrading, or appear to have no functional value. As such, they may represent a North American example of an early human technology characterized by the

selection and use of naturally occurring stone with little or no modification (see also Collins and Dillehay 1986). These are items which have often been discarded or ignored in past research attempts.

Analysis is now underway which will hopefully clarify the origin of these putative artifacts and to gain a clear understanding of the complex interaction between the different agents and processes represented in the cave's deposits. An additional field season is planned for the summer of 1987, at which time samples will be submitted for dating and additional ancillary information.

The research reported here was supported by grants from the L.S.B. Leakey Foundation, the National Science Foundation (BNS8601945), and a Colorado State University Faculty Research Grant. Permission to excavate was approved by the Bureau of Land Management.

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A Specimen of *Bootherium bombifrons* (Artiodactyla, Bovidae) from Northwest Missouri

John F. Neas and Gilbert Parker

In January of 1966, a nearly complete left horn-core of *Bootherium bombifrons* (shrub ox) was found by one of us (Parker) in northwest Missouri. The horn-core was found approximately 7 km southwest of Fairfax, Missouri on the surface of a gravel bar along a tributary of Mill Creek (SE 1/4, SE 1/4, Sec. 36, T64N, R41W, Atchison County, Tarkio Quadrangle, U.S.G.S. 15 Minute Series). A cast of the specimen is deposited in the University of Kansas Museum of Natural History (KUVP cast number 345).

The horn-core is burred at the base, and it projects from a narrow strip of preserved frontal by a pedicel (Figure 1). The tip appears to be slightly damaged, and there may be some loss of surface rugosity from abrasion. A callous on the

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anteroinferior side (50 mm from the tip) suggests pathology, trauma, or developmental malformation. Measurements (mm) of the specimen are: anteroposterior diameter of base along burr, 72.3; dorsoventral diameter of base along burr, 68.4; circumference of base along burr, 224; length of posterior curve, 183.

The specimen is referable to the Ovibovini because the frontal sinuses are restricted to the basal third of the cornuate process; the remaining horn-core is composed of dense, finely cancellous bone (an extension of frontal diploe). Nelson and Neas (1980) recognized six genera of fossil musk-oxen from North America: *Ovibos, Symbos, Bootherium, Praeovibos, Soergelia,* and *Euceratherium*. With burred, pedicellated, and laterally directed horns, *Bootherium* most closely resembles the Missouri specimen. The type specimen of *B. bombifrons* has horizontal (70 mm) and vertical (67 mm) diameters and circumference (225 mm) of horns nearly the same as for the Atchison County specimen (Hay 1914). The Missouri specimen, however, has less posterior length than the smallest *Bootherium* previously reported (*B. nivicolens* type, 200 mm; Hay 1920); if the Missouri specimen is incomplete, its actual length would be 10 to 15% greater than given above. Some exostotic encroachment on the dorsum of the frontal, medial to the burr, is reminiscent of the condition in the type specimens of *B. nivicolens* and *B. sargenti*.

While *Bootherium bombifrons* has generally been regarded as a unique North American Pleistocene ovibovine, other species of the genus are usually considered to be female woodland musk-ox *Symbos cavifrons* (Kurtén and Anderson 1980). A comparison of cranial morphology of these ovibovines by Neas (1986) indicates that *B. bombifrons* differs from *S. cavifrons* mainly in sexually dimorphic traits that parallels those exhibited by the two sexes of the living tundra musk-ox (*Ovibos moschatus*). All previously named species of *Symbos* and *Bootherium* should, therefore, be regarded as the male and female, respectively, of a single species—*Bootherium bombifrons,* the prior name. The specimen from Atchison County and possibly one from Kimmswick, Jefferson County (Hesse 1942) represent the only female specimens of *Bootherium* known from Missouri; the male (*Symbos, sensu stricto*) is known from several localities in the state (Hay 1923).

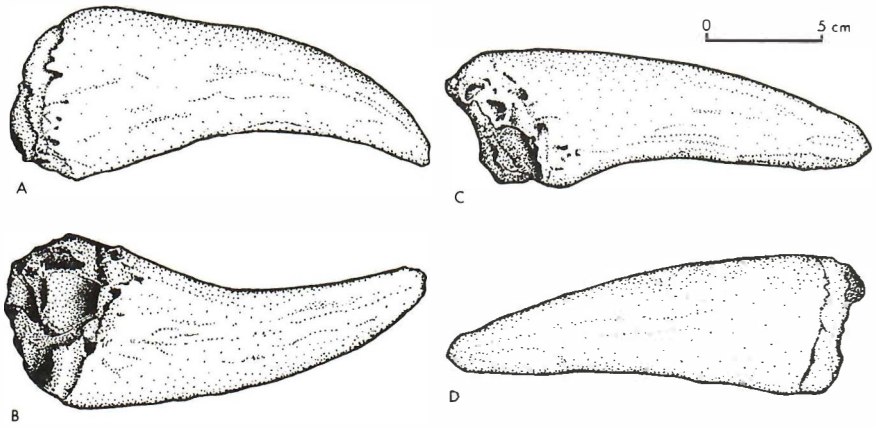

Figure 1. Dorsal (A), ventral (B), anterior (C), and posterior (D) views of *Bootherium bombifrons* left horn-core (KUVP cast number 345).

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New Paleontological and Archaeological Investigations at Dutchess Quarry Cave No. 8, Orange County, New York

David W. Steadman and Robert E. Funk

The Dutchess Quarry Caves are located in the town of Goshen, Orange Co., New York (41°22′N, 74°22′W). Situated at an elevation of 177 m on the northwest side of Mount Lookout, the Dutchess Quarry Cave complex consists of a large cave (no. 1; DQC 1) and lesser caves and fissures (nos. 2-9) that have formed in the early Ordovician Halcyon Lake calcitic dolostone (Funk et al. 1969; Funk et al. 1970; Kopper et al. 1980). Excavations by the Orange County Chapter, New York State Archeological Association in DQC 1 in the late 1960s yielded several projectile points of the Woodland and Archaic stages from the upper deposits (strata 1A and 1B), one point of the Archaic stage from the top of underlying stratum 2, and a fluted point similar to the Cumberland-type from the base of stratum 2 (Funk et al. 1969). Associated with these artifacts were bones of 44 species (fish, amphibians, reptiles, birds, and mammals) identified by Guilday (1969). Of these vertebrates, only the *Rangifer tarandus* (caribou), reported from both strata 1 and 2, but probably originally entirely from stratum 2, had not been recorded historically from New York. A radiocarbon date of 12,530 ± 370 yr B.P., I-4137, was determined on collagen in the caribou bones from stratum 2 (Funk et al. 1970).

We believe this date is not a valid age determination for the occupation of Orange County by Paleoindians, for two reasons. First, the date is about 1,000 years older than the oldest accepted dates for the Clovis fluted point tradition of the Great Plains and Southwest (Haynes 1969, 1982). Clovis points are the oldest of the Paleoindian

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series, but the point from DQC 1 is most similar to late Paleoindian styles, and is probably no older than 10,500 years. Even the Clovis-like points of the Northeast have been radiocarbon dated to an average age of 10,500 years, with a maximum of 11,000 years (Haynes et al. 1984). Second, there is some ambiguity concerning the association of the caribou bones with the fluted point in stratum 2.

In 1978 and 1979, using a resistivity meter, J.S. Kopper of C.W. Post College located eight more cavities in the dolostone of Mount Lookout. The most significant of these was Dutchess Quarry Cave no. 8 (DQC 8), a much smaller cave than DQC 1 and located about 15 m east of it. Subsequent excavations (Kopper et al. 1980) revealed five major strata in DQC 8, with Archaic projectile points in stratum 3, two fluted points at the base of stratum 3, and one fluted point in stratum 5. A radiocarbon date of 5,880 ± 340 yr B.P., DIC-1447 on charcoal from stratum 3 apparently refers to a late Archaic occupation. Unfortunately, Kopper died in 1984, and although most of the lithic artifacts from DQC 8 were deposited in the New York State Museum, Kopper had retained the charcoal, sediment samples, and bones, none of which had been studied thoroughly. After prolonged investigative efforts and the generosity of Steve Sadowski and John Froeschauer, both former students of Kopper, we obtained these materials in February 1987.

In November 1986, we visited DQC 8 with T. Brannan, V. Carter, R. Decker, W. Ehlers, Jr., T. Fuller, N. Pahlavan, and G. Walters. Nearly all of the sediments had been removed by Kopper. Cemented by flowstone to the walls of DQC 8 were remanants of a bone-breccia. Using a hammer and chisel, we collected 11 small samples of the bone-breccia, each ca. 1 l in volume. This breccia occurred at all depths from the original surface of the deposit to the deepest excavated level. Probably only the lowest portions of this breccia can be correlated with the breccia zone recorded by Kopper near the cave mouth between strata 3 and 4. The recently collected breccia samples have been etched with acetic acid, revealing bits of charcoal and hundreds of very small bones and bone fragments in each sample. A few plant macrofossils and crude, undiagnostic chert flakes also have been found in this breccia.

The identification of bones, from the recently collected samples as well as those of Kopper, is in very preliminary stages. The following taxa have been recognized thus far from various strata: fish, anurans (at least three species), salamander, turtle (at least two species), lizard, colubrid snake, *Crotalus horridus* (timber rattlesnake), *Olor* sp. (swan), *Colinus virginianus* (bobwhite), *Bonasa umbellus* (ruffed grouse), *Meleagris gallopavo* (turkey), *Ectopistes migratorius* (passenger pigeon), owl, woodpecker, passerines (at least four species), *Blarina brevicauda* (short-tailed shrew), mole, bats (at least three species), lagomorph, *Sciurus* (gray/fox squirrel), *Glaucomys* sp. (flying squirrel), *Marmota monax* (woodchuck), *Castor canadensis* (beaver), *Castoroides ohioensis* (extinct giant beaver), *Peromyscus* sp. (deer/white-footed mouse), *Microtus pennsylvanicus* (meadow vole), *Synaptomys cooperi* (southern bog lemming), *Neotoma floridana* (eastern woodrat), *Ondatra zibethicus* (muskrat), *Zapus hudsonius* (meadow jumping mouse), *Erethizon dorsatum* (porcupine), *Mustela* sp. (weasel), *Mephitis mephitis* (striped skunk), *Procyon lotor* (raccoon), Ursidae sp. (bear), Tayassuidae sp. (extinct peccary), *Odocoileus virginianus* (white-tailed deer).

Plans for the Dutchess Quarry Cave complex include the identication of bones and plant macrofossils, the radiocarbon dating of charcoal from Kopper's excavations and the recently collected breccia samples, additional field reconnaissance in 1987, and further excavation in 1988. This should permit a better understanding of rela-

tionships among the stratigraphy, chronology, cultural remains, flora, and fauna of this major site.

We thank T. Brannan, V. Carter, R. Decker, W. Ehlers, Jr., T. Fuller, D. Pahlavan, and G. Walters for assistance in the field. Steve Sadowski and John Froeschauer kindly made available the materials excavated by J.S. Kopper. N.G. Miller commented on the manuscript. Contribution number 519 of the New York State Science Service.

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A Study of Mammoth Tusks from Permafrost of Northeastern Siberia

N.K. Vereshchagin and A.N. Tikhonov

A recent study of 187 mammoth tusks [NNI = 180] collected primarily on the shelf of the Laptev Sea Strait and on the Berelekh "burial ground" of the lower Indigirka River has yielded new data. The tusks were measured and described according to the following scheme: 1) length along major curve, 2) length of the alveolus, 3) length of wear zone, 4) length of curvature radius, 5) diameter of alveolus, 6) weight, and 7) age. Sex, surface coloration, damage, breakage, and traces of dental tissue disease were also recorded. Microscopic analysis of mammoth tusks revealed no basic structural differences from modern elephents. Ninety (57 right, 33 left) tusks belonged to males, 97 (54 right, 43 left) tusks belonged to females.

Sexual dimorphism in shape and size of tusks is distinct. Tips of the tusks curved upward more strongly in males. The right tusk curved slightly left, the left one to the right, thus forming a gently sloping spiral. Deformed, overgrown tusks have been obtained from the New Siberian Islands. Paired tusks of males from the Kolyma River (Zoological Museum, USSR Academy of Sciences, Leningrad) are reported to be the largest. The left tusk is 366 cm long, the right 380 cm; alveolar length is 84 and 87

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cm; wear zone is 147 cm; curvature radius 52 cm; diameter of alveolus 145 and 142 mm; weight 74 kg; age 65 years. Tusks of female mammoths, as with modern elephants, are thinner and straighter. The maximum length recorded is 247 cm; alveolus length 62 cm; alveolus diameter 43 mm; weight 19.7 kg; age 65 years.

Collection of tusks in Yakutia in the 1980s for commercial purposes has provided the following data: Males—length, 148.1 cm min., 362 cm max., 249.5 cm average; weight, 11.1 kg min., 88 kg max., 46.35 kg average. Females—length, 100 cm min., 247 cm max., 162.8 cm average; weight 4.6 kg min., 19.7 kg max., 9.9 kg average.

Age of mammoths at time of death was determined by counting brown-orange and light yellow transverse bands on the tusk surface. These alternating bands were quite distinct on tusks from the Sartan loess loam cover (late Würm, late Wisconsin). Tusks redeposited in alluvial lake facies and stained with viviante have less visible bands. Orange and brown coloration of surface bands resulted from deposition of azoviskite mineral (phosphates) in the parts where seasonal (annual) cycle of tusk growth is formed. Such coloration allowed us to study the growth rate of tusks and lifespans of mammoths.

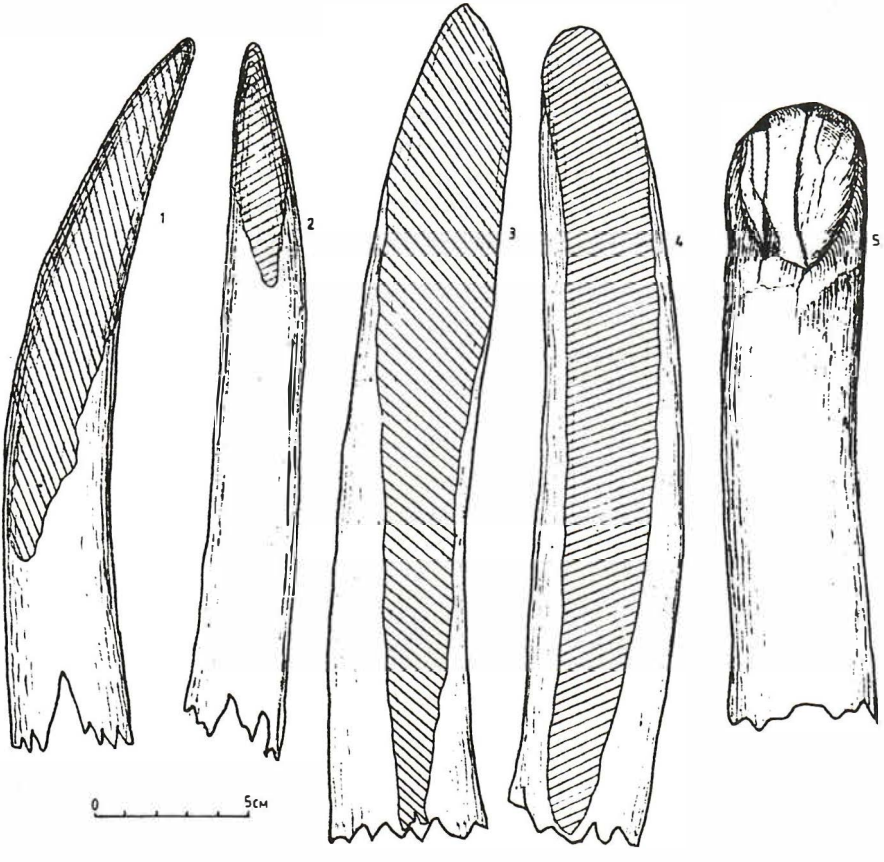

Figure 1. Schematic drawing of "wear zone" on mammoth tusks.

Tusks grew continuously throughout the animal's life, similar to the horns of even-toed horned ungulates. Deciduous tusks formed in calves as 50–60 cm long columns with an enamel cap and erupted through the gums at the age of 6–7 months. Deciduous tusks were replaced by permanent tusks at the age of 16–18 months. Intensive growth of tusks began at age 16–18 years, which evidently conformed to maturation. Rapid tusk growth continued up to the age of 45–50 years, and then slowed down. The amount of pulp was also reduced with age. The length of the alveolus in adolescent and adult males was from 33–88 cm, the average being 37.5% of the total tusk length. Fourteen to sixteen annual cycles can be traced on the alveoli. The maximum age of mammoths inferred from the tusks was 73 years, however some individuals may have lived up to 80 years.

Wearing of tusk tips and formation of the "wear zone" began as soon as they erupted through the gums. Tusk tips of young mammoths invariable bear traces of wear on the external side. With age, "wear zones" 30–40 cm long were formed (Figure 1). Eight specimens (4.3%) were found which appeared to have broken during the mammoth's life, with wear occurring on the secondary tips. Analysis of "wear zones" and degree of wear on broken tips from adult individuals indicates the mammoths used their tusks for peeling tree bark in summer and for breaking ice at temperatures of −60° to −80°C, out of crevices in winter, in the absence of water or snow.

The main morphometric data on tusks and life indices of mammoths are as follows:

1. Maximum length - 380 cm in males, 247 cm in females.
2. Diameter of alveole - 170 mm in males, 93 mm in females.
3. Maximum recorded weight - 88 kg in males, 19.7 kg in females. Average trade commercial weight - 46 kg in males, 10 kg in females.
4. Length of alveole - 27–31% of the total tusk length, taking 14–16 years to form.
5. Tusks grew throughout life, most intensively from age 18–50 years.
6. Sex ratio was 1:1.
7. Maturation occurred by age 18–20 years.
8. Maximum lifespan was 75–80 years.
9. Mammoths of all ages used tusks for peeling bark in summer and scraping ice off vertical walls and breaking it out of ground crevices.

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Paleoenvironments: Geosciences

Problems of Glacial Sequence and Chronology in the Terminal Zone of Northeastern Kansas

Wakefield Dort, Jr.

An increasingly rapid pace of exploration is resulting in the discovery of many new exposures, mostly in transient artificial excavations of limited extent, of glacial, proglacial, and interglacial sediments in the general terminal zone of the continental ice sheets that reached farthest into northeastern Kansas. Study of these sections is leading to numerous modifications of previously formulated historical summaries.

On the basis of gross megascopic characteristics, there appear to be "red tills" and "gray tills." At more than a dozen localities, the presence of two red-till units is demonstrated by the development of a paleosol in the upper part of the lower till or in an intervening unit of apparent non-glacial origin. However, in all of these instances the section is thin (1–3 m), the paleosol is not strongly developed, and the temporal significance is therefore not clear, though at the very least there is evidence of ice withdrawal from the zone of farthest advance. The color of these units is a consequence of a high percentage of iron oxide as concretions, in spongy masses superficially resembling gossan, and in disseminated grains and staining. It is believed that this is the product of an interval of intense weathering, but not that which produced the thin paleosol mentioned first.

At other localities, there is exposed a thicker, gray till. That this is not simply an unoxidized equivalent of the red tills is demonstrated in one exposure where a red till overlies a gray till, and by dissimilar lithologies. At that site, the red till contains boulders of Sioux quartzite, but no igneous rocks; the underlying gray till has numerous clasts of granitic rocks, and almost no quartzite. It has not yet been possible to show clearly whether the few scattered exposures of gray till are of one or more than one unit.

Through much of the 100 km distance from Lawrence through Topeka to Wamego, what appears to be the exact limit of ice advance is marked by the southernmost extent of erratic boulders of Sioux quartzite, derived mainly from southwestern Minnesota. In some places, this alignment angles across slopes of the present topography, seemingly very little modified by postglacial mass wasting or erosion. The presence of concentrations of quartzite boulders on certain ridgecrests and hilltops has led to vigorous debate regarding interpretation. It may be that 1) these boulders are a

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lag concentrate remaining after erosional removal of a considerable thickness of bouldery till, or 2) the boulders were left by themselves on the ice-scoured bedrock surface. Presently recognized field evidence does not satisfactorily dispose of either alternative.

Advance of the ice front caused temporary, local impoundments of northerly-flowing streams. When the ice crossed the eastward-flowing Kansas River, a large lake formed, extending about 100 km upstream. All drainage overflowed eastward through spillways located near or against the margin of the ice.

Attempts to match the glacial sequence in Kansas with previously accepted, classical Pleistocene terminology encounter insurmountable problems. To provide absolute ages is presently impossible. Recognition of highly complex, multi-till sections, especially in Iowa, has led to calls for abandonment of the old names "Nebraskan" and "Kansan" and, consequently, of "Aftonian." Reassignments or redefinitions of these terms would only add to the confusion. It is now possible to say only that the glacial units in Kansas are of pre-Illinoian age. Until wide-ranging, highly detailed studies have been completed, it is not reasonable to suggest correlations with any of the units recently identified in Iowa, or even those in eastern Nebraska.

Radiocarbon Dates at Willcox Playa, Arizona, Bracket the Clovis Occupation Surface

C. Vance Haynes, Jr., Austin Long, and A.J.T. Jull

Willcox Playa, a closed basin in the Sulphur Spring Valley, southeastern Arizona, held pluvial Lake Cochise during the late Quaternary (Meinzer and Kelton 1913; Sayles and Antevs 1941). The attraction of the lake to man and animals is manifest in the fossil mammal bones that have been found in and around the lake deposits (Bryan and Gidley 1926; Lindsay and Tessman 1974) as well as Paleoindian artifacts found in the area (Di Peso 1953; Haury et al. 1953). The stratigraphy and sedimentation of Willcox Playa have been studied by Schreiber and students at the University of Arizona (Schreiber 1972); fossil pollen studies were conducted on the Pleistocene lake beds by Hevly and Martin (1961) and Martin (1963). Geochronological studies on carbonates were conducted by Long (1966) and a reconnaissance geologic map was prepared by Cooper (1960). The results reported here, while supporting the chronological sequence proposed by Long (1966), provide more precise radiocarbon dates because they are derived from stratigraphically controlled materials more suitable for accurate radiocarbon dating.

Excavations by the Arizona Electric Power Company at their Apache Power Station near the southwestern edge of the playa exposed an important stratigraphic section (Figure 1) revealing a sequence of laminated lacustrine sands and muds (units B_0-B_1) overlain by current bedded near-shore sand and fine gravel (units B_2-B_{13}) with

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interbedded thin mud layers containing charcoal flecks, some of which from unit B_3 date 12,970 ± 480 yr B.P., AA-866. In 1977, the skull of an adult mammoth (*Mammuthus*) was recovered from a current-bedded, white, medium to coarse sand (unit B_5) 30 cm above the dated clay band, by E.H. Lindsay and crew from the Department of Geosciences, University of Arizona.

The current-bedded sands and gravels are conformably overlain by a poorly-sorted, pebbly, light gray, loamy sand and gravel (unit B_{13b}) with a basal contact that is gradational over approximately 10 cm. At the westward end of the pit the poorly-sorted unit becomes better sorted (unit B_{13a}) and is overlain by 10 to 20 cm of gray to black, clayey organic sand (unit C) that has yielded a bulk soil radiocarbon date of 8,910 ± 280 yr B.P., A-1848 (Figure 1). This unit is similar to the Clanton Ranch Member (black mat) of the Lehner Ranch Formation that overlies the Clovis occupation surface at several Clovis sites in the neighboring San Pedro Valley (Haynes in press). The bulk soil date reported here is considered to be a minimum value, therefore, the underlying surface is believed to be the most likely one for Clovis occupation of the area around Willcox Playa.

The correlation with the San Pedro Valley is further strengthened by the similarity in lithology and color of the overlying unit (D_{1a}) (not shown in Figure 1) to the Donnet Ranch member of the Lehner Ranch Formation. In both areas the unit is a poorly-sorted, massive, gray, calcareous sandy silt loam. Down slope (eastward) from the west end of the Apache Power Station pit the black mat is truncated and its place is taken by a poorly-sorted, gray silty sand loam (unit D_{1b}) that is gradational to the gray silt loam overlying the black mat as well as to the underlying poorly-sorted sand (unit B_{13}) (Figure 1).

Westward, the black mat apparently was truncated by the mechanical excavations, but it appears to have overlain a pale gray sandy marl (unit B_{15}) and marly sand (unit B_{14}), in turn overlying coarse sand and fine gravel deposits of unit B_{13}.

Our interpretation of these data suggest that the sands, fine pebble gravels, and interbedded muds of units B_0-B_{13} represent littoral deposits of pluvial Lake Cochise coincident with deglaciation of North America. The southwesterly dipping foresets suggest northeasterly storm winds with the mud bands (units B_1, B_3, and B_9) representing the settling of suspended sediments following individual storms. Pollen analysis by Vera Markgraf has unfortunately failed to yield adequate grains for meaningful counts. A pronounced beach ridge, 3 km to the NNW and extending past the pit ca. 400 m to the west, although less pronounced, is probably a facies penecontem-

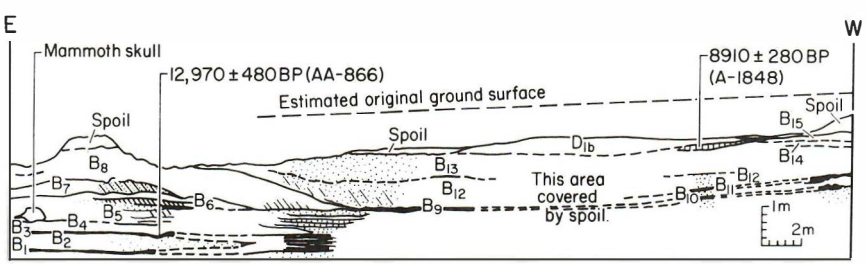

Figure 1. Stratigraphic profile of Apache Power Co. excavation showing Pleistocene units B_1 through B_{15} overlain by Holocene units C (indicated by the position of radiocarbon sample A-1848) and D_{1b}. The Clovis occupation surface is the basal contact of unit C.

poraneous with these littoral sediments. Another waste-fill pit 7 m lower and ca. 1 km to the SE exposes olive green, laminated, calcareous silty clays that probably are deeper water facies.

Units B_{14} and B_{15} appear to represent shoaling of the lake and increased evaporation in response to warming climate. The truncation of unit B_{15} and bioturbation of units B_{13} and B_8 indicate partial desiccation of the lake, deflation, and pedogenesis between 11,000 and 12,000 yr B.P. when Clovis people are known to have been in the area. Unit C suggests a brief return to more effective moisture conditions and a higher local water table that supported phreatophitic growth around the edges of the playa basin between 10,000 and 11,000 years ago. Further desiccation after 10,000 yr B.P., as indicated by the calcification and intense bioturbation apparent in unit D, probably led to playa conditions that have persisted, with fluctuations, since ca. 8,000 yr B.P.

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Late Pleistocene to Middle Holocene Depositional Environments at Mustang Springs, Southern Llano Estacado

Christopher L. Hill and David J. Meltzer

The Mustang Springs site is located at an unusually wide section of Mustang Draw, on the southern Llano Estacado, west Texas. Until recently, natural springs emerged there from a local bedrock fault and provided a source of freshwater on an otherwise dry landscape. Surface archaeological collections indicate these springs have attracted almost continuous human settlement since the late Pleistocene, even during Altithermal times when the springs ceased flowing.

Geological investigations conducted during 1985 and 1986 within the draw have revealed a detailed late Pleistocene and Holocene stratigraphic sequence. Analysis of the sediments, associated organic and archaeological materials, and radiocarbon and thermoluminescence (TL) dates provide a valuable foundation for understanding human adaptations and paleoenvironments in this region. Here we present a preliminary summary of the late Pleistocene to middle Holocene depositional events at the site, and compare Mustang Springs with other Llano Estacado archaeological localities.

Seven stratigraphic zones have been observed at the site. Textural parameters, radiocarbon and TL dates reported here are based on samples from trench 2. The sedimentological samples were pretreated by the removal of organics and carbonates and analyzed using the sieve and pipette procedure. For a discussion of the dating procedures, see Meltzer and Collins (1987). Sediment colors follow the Munsell system.

Testing and preliminary electrical resistivity surveys within Mustang Draw indicate that the underlying bedrock (caliche caprock) is within 1 m of the surface just up-draw from the site. From this point the depth of the caliche surface plunges; the *minimum* depth 100 m down-draw is at least 20 m below surface. The total linear extent of this basin is yet undetermined. We suspect that by 1 km down-draw the caliche again rises close to the surface. The origin of the Mustang Springs basin is unknown; it might result from subsidence and collapse, not uncommon in this region (Gustavson and Finley 1985). The depositional units described here occur within this basin.

Zone 1 and zone 2 (Figure 1) represent greater spring and fluvial activity in Mustang Draw during the late Pleistocene. The lowest unit, zone 1, is composed of a grayish orange pink (10R 8/2) calcareous sandy gravel of unknown depth. The uppermost gravel in zone 1 has a size range from pebbles to boulders which are subangular to rounded and subprismoidal to spherical. The sand fraction is medium to very fine and is composed to sub- to well rounded, subprismoidal to discoidal, polished and frosted quartz grains. The overlying zone 2 is a yellowish gray (5Y 7/2) silty sand (mostly medium to very fine sand). The sand fraction is composed of sub- to well-rounded, subspherical to discoidal, polished and frosted quartz grains.

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Zone 3 (Figure 1), a 1 m unit of lacustrine deposits laid down during the final Pleistocene and early Holocene, represents a shift from fluvial activity to ponding (possibly spring-fed). There is substantial facies variation within zone 3, and in trench 2 it is divided into seven subzones characterized by different colors, textures, fossils, and carbonate and organic contents. These subzones, of alternating cienega, diatomaceous, and marl deposits, indicate fluctuations in the water table and changes in water chemistry.

Radiocarbon dates in this unit are stratigraphically consistent and range from 10,130 ± 30 yr B.P., SMU-1585, for the lowest subzone (3A), to 8,260 ± 50 yr B.P., SMU-1587, for the penultimate subzone (3G). Macrofossils of Juncaceae (rushes), and Cyperaceae (sedges) are present in the cienega deposits; while diatoms and scarce remains of *Typha* (cattail) are present in the pond deposits. Sediment textures range from sandy mud (3A) to silts (3B-E,G,H) and mud (3F).

The deposition of zone 3 was followed by a period of severe aridity (a local manifestation of the Altithermal), the onset of which is marked by an erosional unconformity between subzone 3H and zone 4. This erosional event was followed by a period of aeolian deposition, when over 1 m of silts and fine sands, zone 4, accumulated in the draw. Two TL dates suggest that zone 4 was deposited beginning around 4820 yr B.P. Vance Holliday (pers. comm. 1986) has recognized a soil developed on zones 4 and 5 in trench 5 at the site. This likely represents a period of landscape stability and increased moisture, perhaps the "late Altithermal soil" of Haynes (1968).

As of 1986 a total of six prehistoric water wells have been found in these deposits. The wells are clearly Altithermal in context, having been originally dug from the top of zone 3, down through that unit, and into the underlying more porous zone 2. These wells, and those from other Llano Estacado sites, provide a precise measure of an

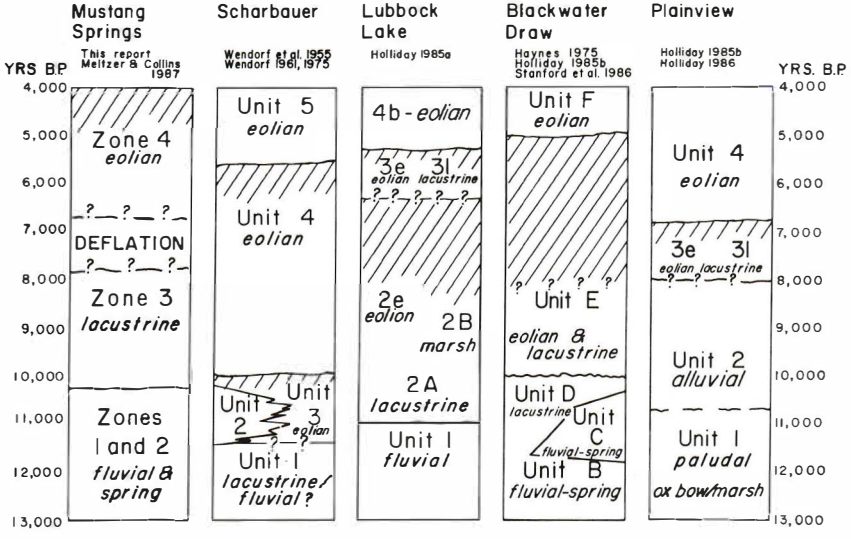

Figure 1. Late Pleistocene to middle Holocene stratigraphic units and associated depositional environments for the Llano Estacado sites discussed in the text.

Altithermal water table drop of between 1 and 3 m (Meltzer and Collins 1987). All wells at Mustang Springs filled naturally with aeolian silts of zone 4.

The late Pleistocene to middle Holocene record from Mustang Springs can be correlated with other localities on the Llano Estacado. This includes, to the north, the type Clovis site on Blackwater Draw, the Lubbock Lake site in Yellowhouse Draw, and the Plainview site on Running Water Draw, and, to the south, the Scharbauer site on Monohans Draw near Midland (Figure 1).

Zones 1 and 2 at Mustang Springs are similar to the Unit B and C spring and fluvial related deposits at Blackwater Locality No. 1 (Haynes 1975; Stanford et al. 1986), the Stratum 1 stream deposit at Lubbock Lake (Holliday 1985a), and the Unit 2 valley fill at the Plainview site (Holliday 1985b). They may be comparable to the Unit 1 white calcareous sands at the Scharbauer site (Wendorf et al. 1955).

Zone 3 at Mustang Draw can be related to lacustrine strata in the northern Llano Estacado sites: at Blackwater Locality No. 1 the Unit D diatomite (Haynes 1975) and at Lubbock Lake Stratum 2, primarily a lacustrine and marsh deposit (Holliday 1985a). Prehistoric water wells were dug at Blackwater Locality No. 1 from the erosional surface atop and through the diatomite (Evans 1951; and Hester 1972). Lubbock Lake held water throughout the Altithermal (Holliday 1985a) and no wells have been found.

Unit E at Blackwater Locality No. 1 overlies the diatomite (Unit D) and is composed of aeolian sediments (Stanford et al. 1986). Aeolian deposition at Lubbock Lake is evident in Stratum 3e (Holliday 1985b). At the Plainview site, the aeolian facies of Unit 3 (3e) contains a soil horizon dated to about 6,800 yr B.P. and is overlain by an aeolian deposit (Unit 4), containing a soil dated to <4,000 yr B.P. (Holliday 1986). A middle Holocene aeolian event is marked at the Scharbauer site by a tan sand, Unit 4 (Wendorf 1961, 1975).

The stratigraphic sequences from Mustang Springs and the Scharbauer sites on the southern Llano Estacado, and the Blackwater Locality No. 1, Lubbock and Plainview sites on the northern Llano Estacado, indicate roughly uniform depositional settings which may reflect similar paleoclimatic conditions across the Llano Estacado during the late Pleistocene and middle Holocene.

Research at Mustang Springs has been supported by grants to DJM from the Potts and Sibley Foundation, Midland, Texas, and the Institute for the Study of Earth and Man (SMU). Drs. Vance T. Holliday and Roger J. Phillips visited Mustang Springs and gave freely of their expertise in soils and geology. Phillips, a Planetary Geophysicist now working on Venusian tectonics, organized and directed the electrical resistivity survey at Mustang Springs—our field area. We hope he doesn't expect us to return the favor on his.

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Emergence of an Alluvial Geoarchaeological Model for the Kansas River Basin

William C. Johnson and Charles W. Martin

Buried paleosols and surfaces have long been recognized as indicators of episodic change in stream systems. Paleosols, which represent formerly stable surfaces, identify periods of alluvial stability. The degree of paleosol development, as evaluated from A1 horizon thickness, organic matter content, and presence of translocated clay, is used as a surrogate for the duration of floodplain stability. Because periods of relative floodplain stability would certainly have provided the opportunity for long-term cultural occupation, a model that articulates the temporal and spatial distribution of stable surfaces should greatly facilitate discovery of cultural material.

Recently, a survey of available information for Kansas, Nebraska, Missouri, and Oklahoma produced over 50 studies that provide interpretable alluvial stratigraphic information (Figure 1); note, however, that individual site data are unevenly distributed, both spatially and temporally, and of varying detail. Data from the Kansas River basin indicate that discrete, well-defined periods of stability (soil formation) occurred throughout the Holocene. The periods, individually defined by three to seven ^{14}C dates, include 10,600–10,200, 8,900–8,300, 7,250, 5,100–5,000, 4,300–4,000, 2,600–2,400, 2,100–1,600, and 1,200 yr B.P. Most intervals likely include more than one period of soil development. Pedogenesis, and hence presumed duration and stabil-

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ity, was greatest for the periods 10,600–10,200, about 8,300, 5,100–5,000, 2,100–1,600, and 1,200 yr B.P. Further examination of the data indicates that well-developed paleosols are laterally more extensive than moderately or poorly developed paleosols; in fact, no period of stability, short or long duration, appears to occur exclusively in isolated portions of the drainage system. This suggests that entire stream systems have been uniformly stable for extended periods of the Holocene, although problems of scale, widely disparate data points, and complexity of fluvial response limit such a statement.

When data from the Kansas River system are compared with those from Nebraska, Missouri, and Oklahoma, significant correlations are obvious: regional synchrony is indisputable, despite the nonuniform distribution of the data. Such a relationship implies climatic forcing of the fluvial system, a concept promoted by many, especially Knox (1976, 1983).

Articulation of the temporal and spatial distribution of stable surfaces in the lower Kansas River basin has demonstrated that much of the cultural record from the Paleoindian and Archaic periods has been removed through erosion or deeply buried during subsequent periods of instability (Logan and Johnson 1986). Further, paleosols developed during an extensive period of stability between 2,100 and 1,600 yr B.P. have, in many instances, been deeply buried by late Holocene fill. Emergence of regional alluvial models, such as that of the Kansas River basin, will facilitate definition of high probability areas (surface and subsurface) for cultural material. Consequently, archaeological surveys of alluvial landscapes are now de-emphasizing the pedestrian survey in favor of expanded subsurface exploration (Bettis and Thompson 1982).

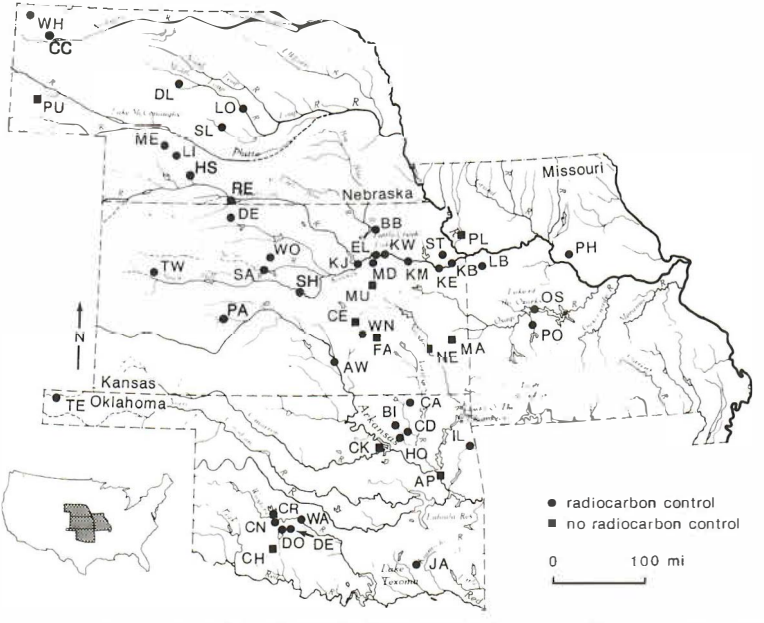

Figure 1. Location of study sites in the east-central Plains that provide stratigraphic data useful in development of a regional alluvial model. Except for the addition of five recent studies, codes are identified and sites briefly summarized in Johnson and Martin (1986).

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Geoarchaeological Investigations at Lake Creek Valley, Southeastern Texas

Rolfe D. Mandel, Leland Bement, and S. Christopher Caran

Geoarchaeological investigators were undertaken at Lake Creek Valley in southeastern Texas approximately 50 km north of Houston by the University of Texas (Austin) Archeological Research Laboratory. Previous archaeological work in this area of the Gulf Coastal Plain has documented few Archaic or Paleoindian sites. The major objective of the present study was to identify geomorphic settings with a high potential for recovery of intact archaeological sites, especially those dating to the Archaic and Paleoindian periods.

The results of this study defined four terraces in Lake Creek Valley. They are, in order of decreasing elevation and age, the Willis, Lissie, Older Deweyville, and Younger Deweyville (Figure 1). The modern floodplain is the lowest and youngest surface exposed in the valley. The Willis and Lissie terraces dominate the "uplands" of Lake Creek Valley. The Willis is a coastwise (i.e., coast-parallel) terrace that is thought to be mid-Pliocene to very early Pleistocene in age (Solis 1981). The fill of the Lissie Terrace rests upon a strath cut into Willis sediments. Based on time-stratigraphic data from the Gulf Coastal Plain (Van Siclen 1985), the Lissie is a pre-Wisconsin terrace. Both of these high terraces consist of deeply weathered sands and gravels. In many locations the eroded surfaces of the Willis and Lissie terraces are mantled by 1–4 m of sandy, weakly weathered colluvium. Pedological and archaeological evidence indicates the colluvium was deposited during the late Holocene. Thick deposits of aeolian sands also occur on portions of the high terraces. Although a buried archaeological site (41MQ99) was discovered in a deposit of aeolian sands

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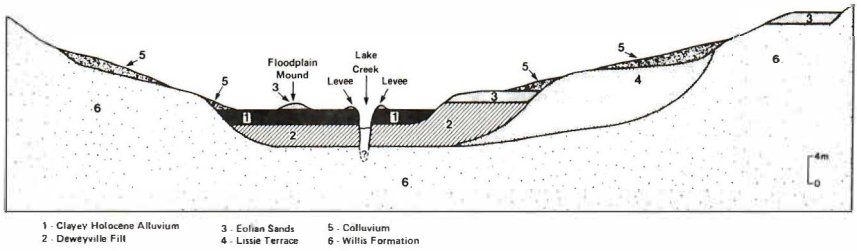

on the Willis surface, the cultural materials were not diagnostic and the age of the artifact-bearing sediments could not be determined.

There are two Deweyville terrace sequences in Lake Creek Valley, with the younger entrenched into the older. The Older Deweyville Terrace consists of discontinuous remnants 2–3 m above the modern floodplain that are mantled by 1–2 m of late Holocene aeolian sands. The surface of the Younger Deweyville Terrace is entirely buried by Holocene floodplain deposits. The ages of the Deweyville terraces and the deposits beneath them have been determined with radiocarbon assays. A buried paleosol on the Younger Deweyville surface at a locality in Lake Creek Valley was dated 9,380 ± 190 yr B.P., Beta-18276. An organic-rich floodplain deposit immediately above this paleosol yielded a ^{14}C date of 8,530 ± 110 yr B.P., Beta-18275. Deweyville terraces under Galveston Bay (Rehkemper 1969) and Sabine Pass (Nelson and Bray 1970) are capped by approximately 9,000-year-old peats. Aronow (1967) reported ^{14}C dates ranging from ca. 13,250 to 25,700 yr B.P. for wood recovered from Deweyville deposits along the Trinity, San Jacinto, and Sabine Rivers.

Most of the floodplain of Lake Creek consists of thinly veneered Younger Deweyville deposits. Clayey flood-basin deposits overlying the Deweyville surface at two localities were dated 3,080 ± 60 yr B.P., Beta-18274, and 2,170 ± 60 yr B.P., Beta-18273. The most prominent features on the floodplain surface are low, circular to elliptical mounds composed of loose, unstratified, fine sands. These mounds typically are 20–50 m in diameter and rarely more than 1.5 m high. Sedimentological and archaeological data from the mounds indicate they formed by aeolian processes, perhaps as coppice dunes, during the late Holocene.

The results of these investigations provide a temporal-spatial framework for future surveys in the Lake Creek Valley. The combination of radiometric, geological, pedological, and archaeological data indicates that most of the landscape of the valley is mantled by late Holocene deposits that could contain only late Archaic and more recent sites, thus explaining the paucity of earlier Archaic and Paleoindian sites. Future attempts to locate Paleoindian and Archaic sites should focus on the buried surfaces of the Deweyville terraces. Higher terraces, Willis and Lissie, have undergone severe erosion during the Holocene and are likely to contain few Paleoindian sites.

Lake Creek Project funding has been provided by the U.S. Bureau of Reclamation (6-CS-50-05340).

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Soil-Sediment Relationships at the Lamont Mastodon Locality, Wyoming

Michael McFaul and William R. Latady, Jr.

The first reported occurrence of mastodon (*Mammut*) in Wyoming was unearthed in 1986, during a geoarchaeological survey of State Highway 73 in central Wyoming, between Lamont and Bairoil. A single second thoracic vertebra, cf. *Mammut americanum* (American mastodon) (McFaul et al. 1986; preliminary identification by Danny Walker, Wyoming) was found within the Quaternary alluvial fan sediments of Lost Soldier Flat. Lost Soldier Flat is a low relief basin at 2,045 m elevation on the southern flank of 2,812 m Green Mountain. Cultural materials were not associated with the bone nor did the vertebra show evidence of cultural modification. The weathered appearance of the bone, its orientation, and its alluvial context indicated it was not in situ.

The bone was recovered 150–155 cm below the ground surface at an elevation of 2,043.5 m within one of many thin (< 10 cm) graded beds of poorly-sorted coarse sands (Folk 1980). It was oriented N23°E with the thoracic spine dipping 18° to the southwest. The soil developed upon the alluvial sediments is similar to the Tresano Series tentatively classified as a fine loamy, mixed, frigid Typic Haplargid (Soil Conservation Service 1986). The soil was characterized by an A/Bt/Bk1/Bk2/C horizonation. Thin clay films were found along the interstitial pores of the Bt horizon and the Bk1 horizon contained 19.4 to 21.9 ± 1.0% calcium carbonate. Approximately 80% of the Bk1 horizon was white and engulfed in soft masses of non-laminated carbonate.

The soil of Lost Soldier Flat supports a sagebrush steppe vegetation. Above 2,812 m on the slopes of Green Mountain the sagebrush steppe is replaced by a conifer forest. Two perennial streams, Lost Soldier Creek and Able Creek enter the basin and join west of the site. The northern stream, Able Creek, heads with the margin of the conifer forest. Both catchment basins are underlain by the Tertiary Battle Spring Formation (Love and Christiansen 1985).

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Description of the alluvial sediments at the bone locale correlates well with that for the sediments of the Battle Spring Formation (Reynolds 1968). This correlation implies the upper reaches of Able and/or Lost Soldier Creeks was the source for alluvial sediments at the bone locale. The textures and the graded bedding seen in the bone locale's alluvial sediments indicate they were deposited by rapid pulsational fan-like events (Folk 1980; Krumbein and Sloss 1963) some distance from the fan apex (Knighton 1984).

A minimal age of latest Wisconsin for these alluvial events is suggested by *Mammut* extinction. However, the carbonates seen in the Bk1 horizon resemble Stage III accumulations (Gile et al. 1966) which are dated 25,000 to 75,000 years at their New Mexico type locality. Some support for the older age for the sediments is implied by the vertebra's weathered appearance and the suggestion that the headwaters of the drainages were subject to erosion during dryer climatic periods (McFaul et al. 1986).

The description of the bone matrix sediments implies the mastodon vertebra is not in situ and that it was carried to the find locale by alluvial floodwaters. *Mammuthus* (Mammoth) thoracic vertebra are easily transported in a fluvial environment (Todd and Frison 1986) and it seems that if other *Mammut* remains are present at the Lamont locality they may lie in the alluvial deposits further west.

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Stream Terraces and Surface Derived Paleoindian Material on the Neosho River Drainage

Richard A. Rogers

The Paleoindian record of large regions of the United States is characterized by surface collected data rather than sites with stratified data. Stream terrace analysis offers the archaeologist one method of gaining additional information from this material. Research on the Neosho River drainage in Kansas demonstrates how stream terraces can serve as a relative dating technique, a predictive model, and a sampling technique for surface collected data.

Alluvial terraces represent a series of ancient floodplains abandoned by a downcutting stream. At any one locality, higher stream terraces are generally relatively older than lower stream terraces. This results in a series of surfaces (including fills that established those surfaces) that are chronologically ordered and are therefore useful in studying archaeological material associated with them.

The Neosho River drainage has two Holocene terraces (the floodplain and terrace 1) and two Wisconsin terraces (terraces 2 and 3). Only two of these terraces provided surfaces on which Paleoindians could have possibly resided. Some Holocene native Americans could have lived on all four. Surface collections of 101 archaeological sites on these terraces were made. Artifacts found on terraces 2 and 3, but not on the floodplain and terrace 1, can possibly be Paleoindian artifacts. This is because the lower two terraces were not available in Paleoindian times. Statistical tests can be performed to test the significance of artifact distributional differences on the terraces. The terrace system can therefore work as a relative dating technique even for surface sites.

Spurred end scrapers, an artifact type suggested to be diagnostic Paleoindian tool kits in some regions, were found to occur no lower than the Wisconsin terraces. This provided tentative evidence that spurred end scrappers were diagnostic of the Paleoindian time period in the Neosho River drainage (Rogers 1986). It has also been argued that gravers typified Paleoindian tool kits. However, the distribution of gravers on the Wisconsin terraces was not significantly different from the distribution of gravers on Holocene terraces. This suggested that possibly gravers were not a distinctive trait of Paleoindian sites on the Neosho Drainage (Rogers 1985). Certain large bifaces were found only on the Wisconsin terraces, which suggests they were likely to be distinctive Paleoindian artifacts in this region (Rogers 1984). These studies illustrate the usefulness of stream terraces as a relative dating technique for surface archaeological material.

Stream terraces can be used as a predictive model. Because geological processes change the landscape over time, only certain portions of the landscape will be old enough to have Paleoindian sites. Stream terrace analysis will inform the researcher which terraces would have been available for Paleoindian occupation, and which terraces would not be. This is a very significant research advantage, in areas such as the Neosho River drainage where large portions of the Wisconsin terraces have been destroyed by erosion. Where surfaces of the appropriate age are rare, a predictive

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model is needed to direct the researchers to areas potentially able to yield Paleoindian sites.

Stream terraces can be used as a sampling technique. Archaeologists wish to make controlled comparisons. Statements about scarcity or abundance of archaeological sites are useful theoretically only when they are made using controlled comparisons. Paleoindian sites have been considered to be extremely scarce in Kansas. Any scarcity of Paleoindian sites in the river valleys of the Neosho River drainage is best explained by the scarcity of Wisconsin terraces. When Wisconsin terraces were examined, the percentage of sites with diagnostic Paleoindian artifacts was approximately 28% (Rogers 1987). Thus, Paleoindian sites are not rare in the Neosho River drainage, if the proper terraces are examined.

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Investigations of the Pleistocene Geological History in the Vicinity of the South Everson Creek and Black Canyon Creek Archaeological Sites, Southwestern Montana

Mort D. Turner, Joanne C. Turner, and Robson Bonnichsen

During the summers of 1985 and 1986, we conducted geological investigations for several kilometers around the South Everson Creek and Black Canyon Creek archaeological sites, southwestern Beaverhead County, Montana. Our objective in using a geoarchaeological approach is to develop an understanding of the physical factors, including chert origin and distribution, and glacial history, that will help in understanding the context that humans would have encountered in this area during different time periods.

The field area covers most of the drainage areas of the east-flowing tributaries of upper Horse Prairie Creek. Extensive outcrops of Precambrian meta-sedimentary and meta-igneous rocks of the Belt Series occur along the crest of the Beaverhead Mountains (Ross et al. 1963). To the east of the crest, the Belt rocks are overlain, usually

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with fault contacts, by early Tertiary-age Challis Volcanics and middle Tertiary-age lake-bed sediments (Staatz 1972; Ross et al. 1955). The Belt rocks are extensively cut by faults, including many thrust and transverse faults. The Challis and lake-bed rocks are less extensively cut by a system of near-vertical, normal (?) faults. Silica-bearing hydrothermal solutions, probably derived from Challis-related magma and rising along fault-related permeable zones, have resulted in elongated, steeply pitched bodies of silicified rock within the Challis and lake-bed sediments. The alteration ranges from slight silicification to complete modification into jaspers, chalcedonies, cherts, and opals. It is these rocks that were extensively mined by prehistoric peoples.

During the Pleistocene, major climatic fluctuations resulted in the development of glaciers in the heads of some of the tributaries in the area. If the Pleistocene climatic fluctuations here followed the pattern that prevailed in many other areas of the mountainous west (Richmond 1965), and there is no evidence to indicate otherwise, then these extended periods of greater moisture, lower temperatures, and glaciation were broken by shorter periods of warmer and drier climate. Extensive research to the west in Idaho has indicated that major alluviation occurs during the early stages of the wet/cool periods, and that erosion and partial removal of these alluvial deposits occur during the waning stages of the wet/cool periods and during the dry/warm periods (Dort 1962; Knoll 1972; Pierce and Scott 1982). Erosional remnants of more than 12 and possibly as many as 16 periods of alluviation and lateral erosion have been preserved along South Everson Creek. Each of these terraces should represent a wet-cool/dry-warm climatic cycle during the Pleistocene.

Our preliminary research agrees with Alden (1953), who states that no glacial deposits of latest Pleistocene (Pinedale) time have been found in the region. The geomorphologic evidence of cirques and moraines found at the heads of Black Canyon and Trail Creeks indicates, however, that the youngest glaciers in the cirques were present during Bull Lake (?) time or earlier. Very subdued and weathered moraines are found down-valley from the cirques, suggesting even older, more extensive glaciations. South and North Everson Creeks head a few kilometers east of the range crest. This places them topographically at a lower elevation and in the precipitation shadow of the crest of the Beaverhead Range. Their cirques seem not to have supported glaciation since approximately the middle Pleistocene.

In addition to these local glaciations in the Beaverhead Range, there is evidence of an earlier, larger glaciation in the area. We have found massive deposits of glacial drift along upper Horse Prairie Creek and at the crest of Bannock Pass, the head of the drainage basin. The elevations, locations, and shapes of the surface forms of the drift deposits, as well as the rock types occurring in them, indicate that in the early to middle Pleistocene, lobes of large piedmont glaciers of continental glaciers advanced repeatedly from the north. Staatz (1972) saw evidence for a similar northward source of older till along Pass Creek, in the Lemhi Pass Quadrangle, immediately to the west. The southward flow of glacial ice in the Horse Prairie Creek valley implies a large mass of glacial ice located in the north with a surface well above the elevation of Bannock Pass (2,360 m). Although the main drainage may have been filled periodically with glacial ice, no evidence has been found to indicate that this ice flowed up South Everson Creek. It probably dammed South Everson Creek, thus raising the base level of the creek to the elevation of the higher terraces in the vicinity of the archaeological sites. Further fieldwork is planned during 1987 to investigate these problems.

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Southwestern Montana Prehistoric Quarry Aerial Reconnaissance Survey

Edward J. Zeller, Gisela Dreshhoff, Mort D. Turner, and Joanne C. Turner

Sites utilized by early Americans for quarrying lithic materials are known from several localities in southwestern Montana. Most of these quarries are in a high, intermontain environment. They are usually located in relatively treeless, sagebrush and grassland areas, primarily on arid alluvial fans, outwash terraces, and eroded Tertiary lake beds. In August 1986, we conducted aerial reconnaissance on the South Everson Creek prehistoric quarry site, using a Cessna 180. Goals were to 1) carry out visual overview in order to integrate the pattern of quarry locations and the geomorphology of the area, 2) locate quarry sites within the main site area, that had not been recognized from the ground, 3) obtain oblique photos of the area, 4) obtain low-level vertical stereo-coverage aerial photography, and 5) conduct aerial reconnaissance of the surrounding area. The vertical aerial photography was done using two aerial cameras, with electronically-timed synchronous exposures to yield a minimum of 60% overlap along flight lines, and a 20% overlap between parallel flight lines. One camera was loaded with black-and-white film and the other with infra-red film. The differing

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spectral responses of the films are being used to analyze location, distribution, and degree of weathering of the individual quarry sites. In addition, the photography is being used to produce a photo mozaic and a planimetric map of the site for use as base maps for the on-going archaeological and geological surveys. To our knowledge neither aerial study of known sites nor aerial search for new sites has been carried out in this area previous to our field research.

During our photographic reconnaissance of the South Everson Creek site, we discovered another area that appeared from the air to be a very large quarry site on the north side of Black Canyon Creek, about 5 km south of the Everson site. After the flight, we immediately ground checked the area. Archaeologists from the University of Maine and U.S. Bureau of Land Management also field checked the site and confirmed it as an entirely new and previously-unknown quarry site. Other new, as well as previously-known, quarry sites were observed from the air south of Livingston and in the Three Forks area near Bozeman. This combination of visual aerial observation, ground-truth check, and low-level aerial stereo-coverage photography appears to be particularly effective in finding and investigating quarry sites in southwestern Montana. We plan to continue our aerial search and identification of prehistoric quarry sites in southwestern Montana during the 1987 field season. Our aim will be to study the geomorphology and geology of quarry-site areas already known and to search for additional, unknown sites. We plan to expand our photographic data by using four linked cameras, loaded with black-and-white, color-reversal, infra-red, and false-color film, respectively, in order to yield maximum photo-interpretation data for the site surveys.

This project is being carried out in close cooperation with the Space Technology Center, University of Kansas, and the Center for the Study of Early Man and the Institute for Quaternary Studies, University of Maine.

Special Focus – South America

Further Excavations in Limestone Caves in Interior Bahia, Brazil

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Excavations of caves and rockshelters containing Pleistocene fauna continued in 1985 near the town of Central in the arid *caatinga* zone of interior Bahia, about 500 km northwest of the city of Salvador. The Projeto Central is under the overall directorship of Profa. Maria Beltrão of the Museu Nacional in Rio de Janeiro. With a research grant from the Social Sciences and Humanities Research Council of Canada, the authors excavated two separate portions of the same cave system near the village of Guaxanim about a kilometer west of the Rio Verde, a permanent stream which flows northward into the Rio São Francisco. The sites are located about 40 km west of the town of Central and an equal distance east of the town of Xique-Xique in the latter *municipio*.

The Toca da Gameleira, named for a huge fig tree (*Ficus doliana*) that looms out of the nearly vegetationless limestone plain because its vast root system extends far into the moist cave, is a limestone solution cavern with a partially collapsed roof which created a cone of rubble over a portion of the clayey silt floor. The cavern is made up of two parallel passageways, interconnected to form the main chamber. We discovered the cave in 1984, and chose it for excavation because many heavily permineralized and deeply iron-stained giant ground sloth (*Eremotherium*) bones were found lying on the surface in apparent association with stone and bone artifacts.

Excavation revealed that the lithic artifacts were not in primary association with the dark brown rock-hard sloth bones. Flood waters had eroded, deflated, and redeposited the sloth remains and a few toxodon (*Toxodon*) teeth and bones, most of which were broken and none of which were articulated. Later human occupants evidently picked up and utilized the broken ends of two bones and the non-occlusal edges of four sloth teeth found in a weathered unsorted gravel deposit containing many sloth bones. Altogether, we excavated more than half a metric ton of sloth bones from this zone, washed them, examined them carefully for alteration marks, and transported them to the State Museum in Salvador. The bulk of the bones, which lack visible alteration marks of any kind, either natural or cultural, await analysis

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by vertebrate paleontologists. All artifacts, including the flaked sloth bones and teeth, were deposited in the Museu Nacional in Rio de Janeiro.

Beneath the gravel but still in redeposited contexts in the upper part of the clayey silt, we found not only more sloth bones but also several broken bones and teeth of different large mammals, which had permineralized to a white chalky consistency under quite different environmental conditions. Llamine remains include a complete left mandibular molar of *Paleolama* and another of *Macrauchenia* both found in the same level and square. Such ungulates would not have climbed down into the vertical-walled cave entrance on their own volition; and the bones lacked any canine chewing marks, indicating that they had not been transported by carnivores. No evidence of human alteration of the two teeth were noted, but one large fragment of unidentifiable thick-walled bone exhibits several cuts and gouges. Two cylindrical objects, one of which exhibits scrape marks, probably were partially shaped broken bone projectile points. We concluded that people had transported these anomalous bones and teeth into the cave. Lack of evidence of spiral fractured green bone breaks or of butchering marks suggests that they had been picked up outside the cave at natural kills and carried into the cave after the bones had desiccated, but before permineralization within the upper portion of the deep clayey silt deposit. These utilized bones of extinct animals were stratigraphically associated with 3 quartzite hammerstones, 5 flakes, 3 split quartz pebbles; and 18 minimally trimmed quartz, quartzite, and chert scrapers and choppers with intentional noses, spurs, and denticulations.

It is important to note that these simple stone artifacts were never intentionally shaped, but some nevertheless contain projections and denticulations created by minimal retouch on their working edges. These kinds of stone artifacts continue throughout the entire local sequence in the Central area, and we had become quite familiar with them in analyzing the lithic material in later preceramic and ceramic assemblages. With that experience, it was not possible to dismiss the similar simple industry found in Pleistocene contexts as crude naturefacts. The local flaked stone industry remained undeveloped even in ceramic times; the rare stone artifacts that had been shaped intentionally are not only late in the local sequence, but eventually imported. It was incumbent upon us to study carefully all evidence for any kind of alteration marks on the edges of all stone and bone artifacts, regardless of age. We believe that such careful analysis and detection of alteration patterns provides significant insight into what kinds of simple non-formal "nondiagnostic" stone and bone artifacts might be expected elsewhere in the Americas in late Pleistocene contexts where intentionally shaped artifacts are rare or absent.

Our interpretation of the evidence from the Toca da Gameleira is that the giant sloths had lived and died in the cave long before the arrival of man; however, the earliest human occupants evidently arrived before local extinction of the *Paleolama* and *Macrauchenia.* When available, people selected and utilized the useful edges of bones and teeth of these animals as well as the more ancient sloth. The simple minimally retouched flaked stone tools were probably used for processing vegetal materials, including the fabrication of wooden artifacts. These activities continued into recent times after heavy erosion and deflation of the old clayey silt deposit in the Toca da Gameleira had exposed numerous large sloth bones on the surface.

The other site excavated in 1985, a rock shelter at the eastern margin of a large collapse area about 100 m northeast of and connected by tunnel with the Toca da Gameleira, was named by us the Toca do Cosmos because the spectacular pictographs

gracing the flat white ceiling represent a comet, several star bursts, and other probable celestial bodies. The recovery of several hematite crayons and other ochre-stained artifacts in the lower half of the deposits suggests that artistic endeavors, possibly accompanied by rituals, were major activities in this shelter. As well, many woodworking tools, including fist-sized chert scraper planes with denticulated working edges, indicate that people also performed other tasks, such as fashioning wooden objects, in the cave.

No definite evidence was found for Pleistocene occupation of the Toca do Cosmos. The only suggestion of antiquity was two large fragments of heavily permineralized iron-stained bones showing evidence of utilization (flaking the ends probably by use as choppers) after permineralization. As they were in the same artifact-bearing silt deposit just above the cave floor that yielded a basal date on charcoal of 3,230 ± 210 yr B.P., Beta-13929, we concluded that they probably were fossil sloth bones selected for their usefulness and transported from the neighboring Toca da Gameleira.

Evidence for a different kind of utilization of the broken edges of large mammal bones was reported earlier (Bryan and Gruhn 1985) for the Toca dos Buzios about 50 km east of the Rio Verde and north of the town of Central. These small fragments exhibited quite a different pattern of use, as the edges had not been flaked after permineralization, but instead exhibited a pattern of parallel scratches applied at right angles to the straight broken edges. At that site, careful cleaning and macroscopic examination of several thousand small fragments of permineralized large mammal bone, recovered from a basal yellow silt deposit beneath a shell and ash midden, revealed 31 examples which exhibited patterned incisions and scrape marks extending from the edges of desiccation breaks before permineralization. Evidently, already desiccated bone fragments had been selected for their straight but rough edges, which made efficient scraping tools. The utilized bone fragments in the Toca dos Buzios were unidentifiable; but single teeth of two species of horse (*Equus*), *Paleolama?* and giant peccary (*Tayassu*) were associated. The only bird bone recovered was a fused upper beak of a parrot. The only artifact exhibiting any evidence of deliberate shaping was a fragment of a long cylindrical bone rod with barely discernible scrape marks, probably applied to fashion a projectile point. Also associated were seven chunks of exotic vein quartz with steep flakes removed from high angled edges. The bone fragents with macroscopically visible scratches and the quartz chunks were taken to the University of Alberta to be examined with a scanning electron microscope (SEM). High magnification confirmed that there was considerable patterned use wear (scrape marks, fine parallel scratches, and polishing) extending from the broken edges onto the outer convex surfaces of the bone fragments. Confirmation that these alteration marks were caused by intentional use was found when flaked surfaces of two quartz chunks revealed a pattern of parallel striae extending perpendicular to the edge. A similar pattern was produced experimentally on quartz flakes by Sussman (1985). The SEM technician also discovered that another chunk retained an otherwise invisible coating of silica, evidently acquired when the object was used to cut or prepare some type of vegetation with high silica content. We conclude that the desiccated bone fragments as well as the flaked quartz chunks had been altered by human activity and not by trampling or other natural causes.

None of the excavated Pleistocene contexts in the Central region yielded any evidence for green bone breaking. In fact, the only evidence for butchering of large Pleistocene mammals was found in the Toca de Manóel Latão, which, in addition to other ar-

tifacts, and teeth of giant armadillo (*Pampatherium*), ground sloth (*Nothrotherium*), and *Paleolama,* yielded an equid podial with two short deep knife cuts. We conclude that, with this possible exception, we found no evidence for intentional killing of Pleistocene mammals in the Central region, although there is considerable evidence that contemporary and later people utilized the bones and teeth of several species of extinct Pleistocene mammals. At the time of excavation, we thought it strange that we recovered an isolated parrot beak and single teeth of different species of extinct animals quite close to each other at three different sites. Although none showed evidence of use, we speculate that these objects may have been collected for inclusion in medicine bags.

Unfortunately, none of the sites that yielded evidence for human occupation during the late Pleistocene contained any associated charcoal, and evidently all bones have been leached of collagen, so we have been unable to date occupations earlier than 9,400 yr B.P. The earliest dated occupation with hearths and unfossilized bones of small and medium-sized mammals was found north of Central in the Abrigo do Pilão, which yielded stratigraphically older stone tools but no bones. The lack of megafaunal remains in radiocarbon-dated levels supports our assumption that the megamammals had become extinct at the end of the Pleistocene.

All archaeologists and geologists concerned with the contentious question of the early human occupation of the Americas should be alert to the possibility that bone fragments and teeth of large Pleistocene mammals were used as tools before as well as after permineralization. Sites yielding bones and teeth of extinct animals exhibiting evidence of utilization on useful edges are known from Washington State (Manis mastodon), Mexico, Panama, and Colombia, as well as Brazil (Bryan 1983). The patterned evidence for use on the edges of these tools should not be confused with random incisions and scratches due to trampling that are found on spirally fractured green broken bones from natural kill and wallow sites so convincingly described by Haynes (1986). Early Americans picked up bones as well as stones with useful working edges and transported them to use in their occupation sites. Painstaking observation and analyses in the field and laboratory, with the assistance of SEM photography, is essential to identify these various kinds of distinctive and clear indications for early human activity, and to distinguish them from natural alteration marks. Archaeologists should not give up the possibility of distinguishing human from natural modification of bones as well as stones. It is not logical to argue that if modification of an object can be attributed to either man or nature in certain contexts, then nature was most likly responsible under all conditions, and the object can thereby be discounted as evidence for human activity. A more exacting scientific approach to the analysis of marks of fabrication and use on simple stone and bone artifacts of all ages is essential if we are going to disern the truth about when people first arrived in the Americas and what level of technology they brought with them.

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Paleoindians in the Patagonian Region: Los Toldos Archaeological Locality, Santa Cruz Province, Argentina

Augusto R. Cardich, Laura L. Miotti, and Alicia S. Castro

Few archaeological sites are reliable evidence of Pleistocene human occupation in the Patagonia Region (see Figure 1); the sites which comprise the Los Toldos archaeological locality had offered the most complete cultural sequences with abundant archaeological, faunal, and sedimentological records, and reliable radiocarbon

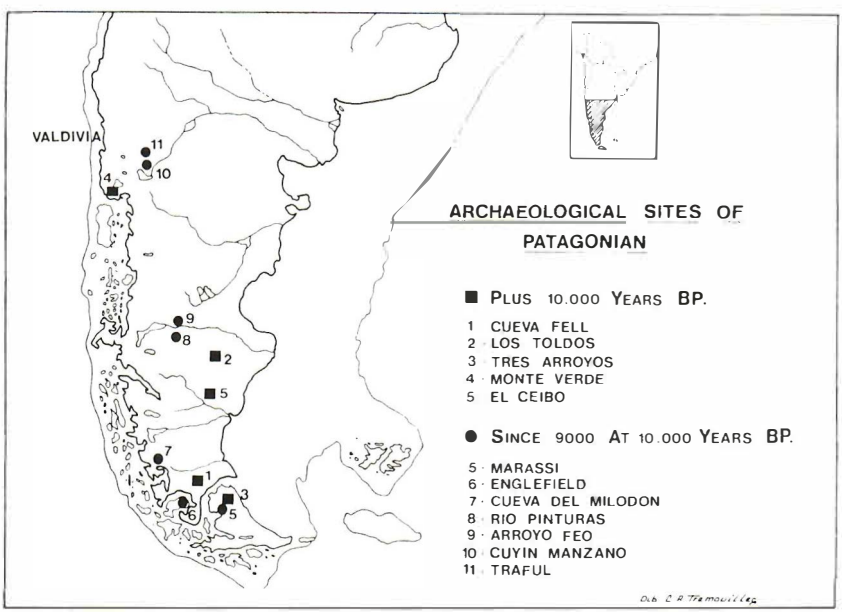

Figure 1. Archaeological sites of Patagonia.

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dates. These sites are key to understanding the early peopling of Patagonia. Los Toldos is placed in the south middle Deseado River (Santa Cruz province). This locality is composed of 14 caves and additional rock shelters, arranged along a dell of approximately 1 km; localized at 47°22′S and 68°58′W. Almost all caves show interesting paintings on their walls including "negative" hands and scarce animal representations. This paper is focused on "Nivel 11" and "Toldense," two early cultural components of late Pleistocene and early Holocene hunter-gatherers, which were detected in cave 3 of this locality (Menghin 1952, 1957, 1965; Cardich 1973, 1977, 1978, 1984).

The first human occupation component is represented by Nivel 11. Its lithic industry is illustrated by an assemblage of elaborate tools, basically side scrapers, made on large flakes and shaped by unifacial retouch. Zooarchaeological studies demonstrate the presence of Pleistocene species of megamammals and autochthonous local fauna. Charcoal samples from level 11 b (see Figure 2) dated by ^{14}C to 12,650 ± 600 yr B.P., FRA-96. So far, this is the oldest reliable date for the human presence in the region.

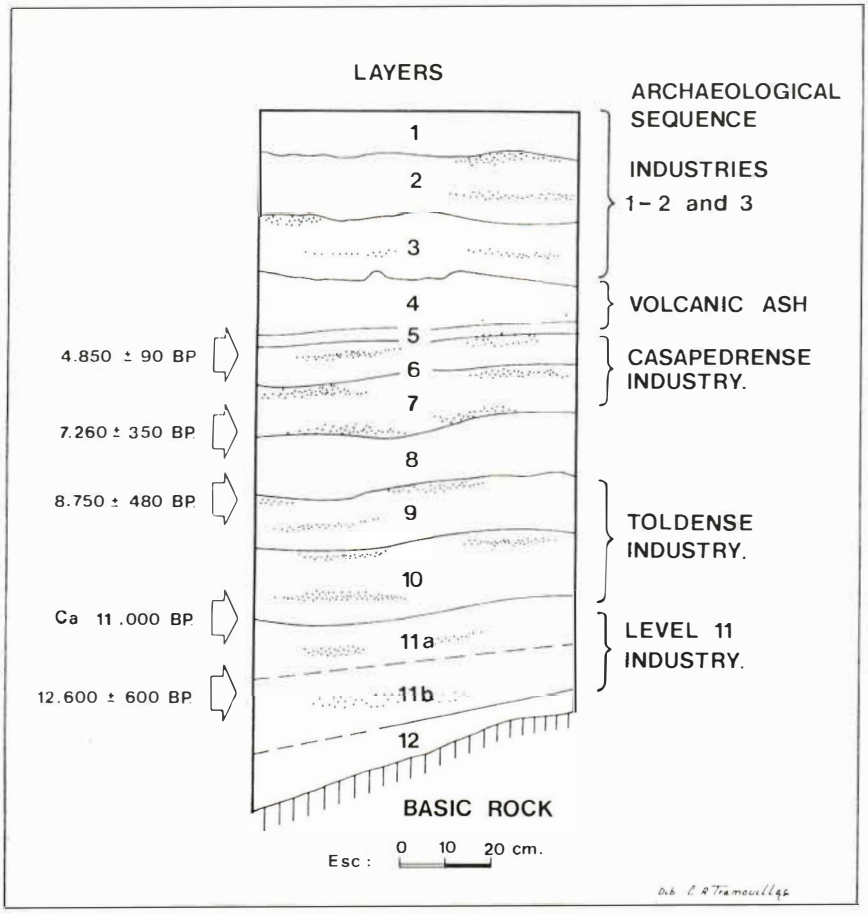

Figure 2. Profiles from square 1, Los Toldos, cave 3.

The second component, Toldense, includes late Pleistocene and early Holocene remains. The most recent Toldense date is 8,750 ± 480 yr B.P., FRA-97, and at the beginning it was estimated at 11,000 yr B.P., and compared with the Magallanes I industry. The Toldense lithic industry is characterized by instruments with medium and large size flakes; the predominance of knives and side scrapers; and, most importantly, the introduction of bifacial projectile points.

The abundant bone remains associated with these components provide information about available palaeoenvironmental and faunal resources important to the economy of the first hunter-gatherer groups who inhabited the central plateau of South Patagonia. This relationship can be summarized as: Kind of prey (A)→Hunting techniques (B) = Adaptive patterns (C).

The extinct species associated with the Nivel 11 and Toldense industries are *Onohippidion (Parahipparion) saldiasi* (horse) and *Lama gracilis* (llama). However other species are found in the stratigraphic sequence of Los Toldos including *Rhea americana* (rhea or nandu de las pampas) in the lower levels, and *Pterocnemia pennata* (Darwin's rhea or nandu petiso), a related bird, in the upper levels. These findings can be explained by a migration of *R. americana* to the north. Their ecological niche was subsequently occupied by *P. pennata,* the species presently living in the region (Cardich and Miotti 1983; Tambussi and Tonni 1985). This situation may be explained by possible environmental deterioration.

From an economic point of view, the *Lama guanicoe* (guanaco) supported human groups who occupied the region in different times of the late Pleistocene and Holocene. Abundant bone remains of this species along the entire cultural sequence of cave 3, as in other sites of the Patagonia region document this faunal exploitation pattern.

In summary, the faunal samples from the site can be used to reconstruct, at least in part, the paleoenvironments inhabited by aboriginal groups. It is also possible to raise some alternative hypotheses about cultural-ecological adaptations and the role played by early people on Pleistocene megafaunal extinctions, but human activity is not considered the most important of the many factors that led to on Pleistocene extinction.

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Recent Research at Localities Cerro La China and Cerro El Sombrero, Argentina

Nora Flegenheimer

Two localities under study in the Argentina pampas have yielded projectile points corresponding to Fell's Cave Stemmed type. This type of point was first recovered in the south of Chile by Bird (1938) and has been reported from the area under study on several occasions as fishtail point or "cola de pescado" (Madrazo 1972; Silveira 1978; Eugenio 1983) and from nearby regions. Even if these points are usually assigned great antiquity, based upon their morphological and technological similarity with the early specimens recovered at Fell's Cave, we still have very little information about their chronological distribution. Furthermore, the characteristics of this supposedly early South American occupation are hardly understood. Localities Cerro La China and Cerro El Sombrero, situated in the Tandilia range of the Argentine pampas shed new light on both these subjects.

Cerro La China is a very low hill (37°57′S and 58°37′W), where three sites, not more than 300 m apart, were excavated. Site 1 corresponds to a small shelter and its surrounding area, sites 2 and 3 are open air sites instead, located at that foot of the rock outcrop. Two levels were identified in site 1 according to the position and characteristics of the archaeological remains. A fluted stem, possibly corresponding to an unfinished artifact (Flegenheimer 1980; figure 1), and a preform of a Fell's Cave Stemmed point (Flegenheimer 1986; figure 2I) were distinguished among the remains recovered from the lower level (L2). Organic preservation is extremely poor, yet a scute of an extinct armadillo (*Eutatus seguini*), determined by Dr. Tonni of the Paleothology Department at La Plata Museum, was also recovered from this level. A charcoal sample from L2 yielded a ^{14}C date of 10,730 ± 150 yr B.P., I-12741, which has already been reported (Flegenheimer 1986). Another very small charcoal sample dated by accelerator mass spectometry at the University of Arizona has been processed recently giving a ^{14}C date of 10,790 ± 120 yr B.P., AA-1327.

At site 2, two fertile stratigraphic units, separated by a geologic unconformity (Zárate, pers. com.) were identified. The lower unit (B) presents a very low artifact density. It includes two complete Fell's Cave Stemmed projectile points (Flegenheimer 1986; Figure 2G,H), one of them fluted on one face. Site 3 presents a similar stratigraphic profile. An occupational level with a high artifact density was recorded in unit B. Even if a great typological diversity was registered, no instruments commonly found in other assemblages of the area were uncovered. Although some of the debitage has been identified as produced by bifacial reduction, the assemblage does not include either projectile points or other bifacial instruments. Therefore it cannot be correlated with certainty to the earliest occupations of sites 1 and 2 on typological grounds. As mentioned above, the stratigraphic position of the artifacts is the same as that of the earliest remains in site 2. Also, rocks employed as raw materials in the early occupations in sites 1 and 3 are similar: allochthonous fine grained quartzite has been mainly used and there is a smaller proportion of local coarser quartzite. Other rocks present at both sites in a very low frequency are: chalcedony, opal,

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quartz, and basalt. Raw materials registered at site 2 are not comparable due to the small size of the sample. As all charcoal fragments available from site 3 were very small and not suitable for conventional dating, a sample from unit B was dated using accelerator mass spectometry and yielded a ^{14}C date of 10,610 ± 180 yr B.P., AA-1328.

The datings, the stratigraphic situation of the remains, and the characteristics of the raw materials employed indicate that there is a close correlation among the earliest occupation at the three sites.

The other locality under study is Cerro El Sombrero (37°49′S and 58°34′W), where Fell's Cave Stemmed points have been collected, on a high topographic position, from the hill top (Madrazo 1972). Recent finds made by the local museum's staff, have revealed that this open air site still contains a great density of remains thinly covered by sediments. A brief analysis of the collection showed that apparently it does not include recent artifacts. It consists mainly of: a) small debitage with a high proportion of bifacial thinning flakes, b) bifacial blanks and point preforms at different stages of manufacture, c) fragments of unifacial and bifacial instruments, and d) fragments of Fell's Cave Stemmed points, most of which are stems. Based upon these data the site is considered as a workshop where at least the last stages of point manufacturing activities were carried out and where broken points were being replaced from their shafts. Point fragments recovered present a wide range of sizes and morphological variation. Of 29 fragments with stems preserved, 6 present fluting on one face and 4 on both. Although quartzite predominates as a raw material, quartz, chalcedony, and opal have also been employed. All of these rocks are available in the region and probable sources are being identified.

Non-analyzed artifacts recovered in January 1987 include the largest and the smallest points known so far. This last point has a total length of 1.4 cm and has been shaped as a Fell's Cave Stemmed point simply by grinding its edges, with no true flaking. Its function is unknown but it obviously could not be used as a hunting weapon. The largest specimen, which is the only complete point of "regular size" recovered from the locality, is 9.4 cm long and presents fluting on both faces. Fieldwork at Cerro El Sombrero and the analysis of the lithic collection will continue during this year.

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Paleoclimates of the Southern Argentine Andes

Vera Markgraf

The section of the Andes that comprises the latitudes between 22° and 55°S shared by Chile and Argentina, represents a very heterogeneous mountain range, in terms of geological evolution as well as modern features. For most of this latitudinal range, the Andes run north-south, but west-east towards their southernmost end in Tierra del Fuego. From south to north, the number of individual ranges increases, from two ranges between latitudes 55°S and 35°S (Cordillera de la Costa and Cordillera Occidental) to four to five ranges north of latitude 35°S (Cordillera Oriental C. Exoriental, Serranias Subandinas, in addition to the previous two). Simultaneously the width of the Andes increases from about 50 km in Tierra del Fuego to 900 km north of latitude 35°S. With the increase in width increases the mean elevation of the mountains, from about 2,000 m south of latitude 35°S to over 6,000 m north of 35°S. In addition there are marked structural and tectonical differences in different parts, resulting among other features in different zones of volcanic activity, both, in terms of intensity and age of volcanism. The strongest and most continuous volcanic activity lies north of latitude 25°S and between 30° and 45°S. In addition to these described geological differences (Zeil 1979), there are climatic and environmental differences (Hueck and Seibert 1981). In terms of atmospheric circulation features, latitudes between 22° and 35°S lie under the subtropical high pressure zone with easterly airflow and mostly orographic precipitation, originating from the distant Atlantic. Modern environments are typically deserts with exception of the east-facing slopes of the Andes that receive sufficient precipitation to result in a band of subtropical forests. South to latitude 35°S the westerlies become the dominant circulation feature, resulting in a west-east precipitation gradient across the Andes, ranging from 5,000 mm to less than 500 mm of mean annual precipitation, from the central Andean chain to the eastern foothills. The corresponding environments range from cool evergreen rainforests to deciduous forests and xeric woodlands, depending on the location along the gradient. Towards the southernmost tip of South America the influence of the circumantarctic low pressure trough becomes more and more prominent and the frequency of storms, coupled with low temperatures, results in treeless vegetation, a moorland type tundra, especially in the more exposed parts of the region.

Given this diversity of geological, climatological, and environmental features, the paleoenvironmental history of sites in this latitudinal crossection is expected to demonstrate differences as well, even for a time interval as short as the last 14,000 years. But because these differences are the local response to a hemispheric (or even global) forcing function (climate) a congruent paleoclimatic chronology should emerge from a large-scale data network along the Andes.

This paper summarizes the present available palynological information for the Argentine Andes, most of which is published (Markgraf 1980, 1983, 1984, 1985a, 1985b, Markgraf et al. 1986a), or is in press (Markgraf 1987a, 1987b, 1987c, 1987d). Eleven records are described in the following and interpreted in terms of paleoclimatic signal, first on a local and subsequently on a regional scale.

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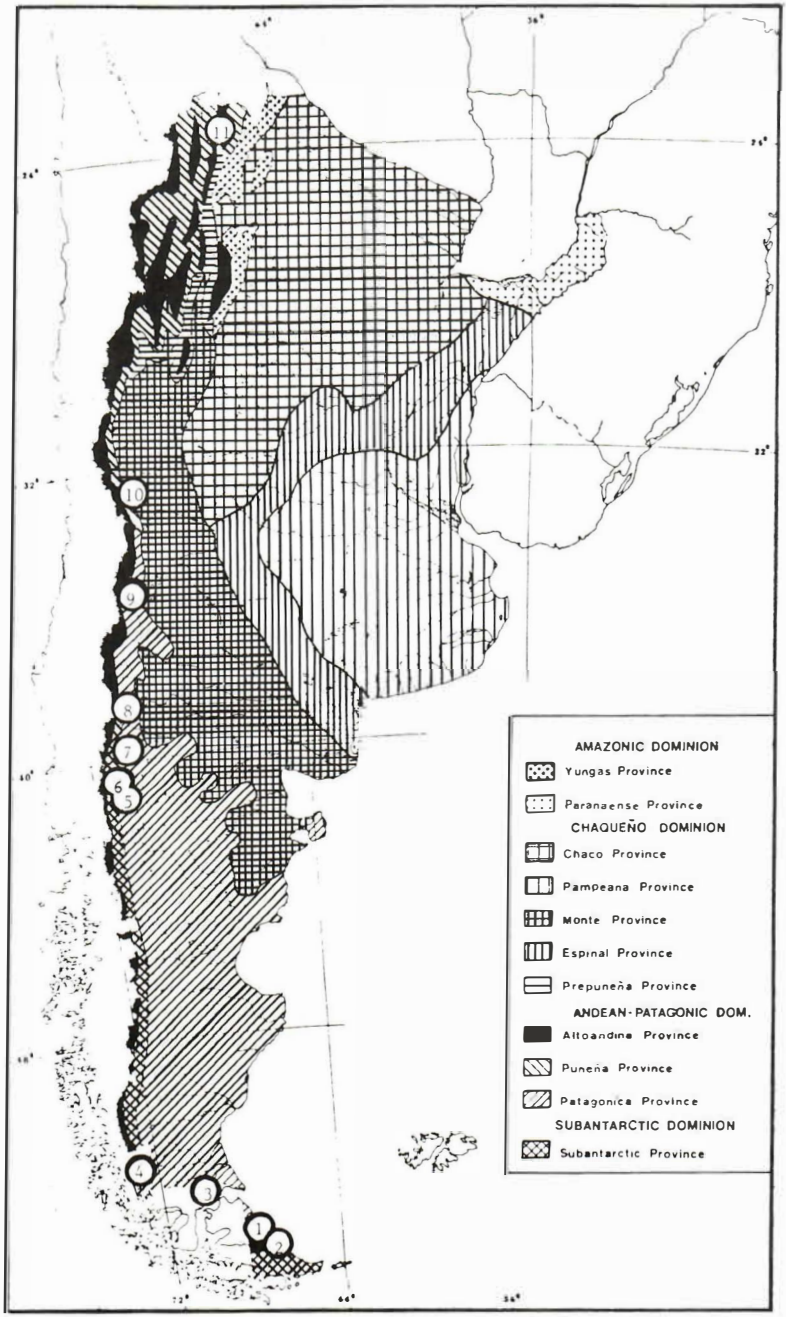

Figure 1. Map of Argentina with location of palynological sites described in text. 1) La Mision, 2) Lago Yehuin, 3) Fells Cave, 4) Mylodon Cave, 5) Mallin Book, 6) Lago Morenito, 7) Rahue, 8) Vaca Lauquen, 9) Gruta del Indio, 10) Salina 2, 11) Aguilar.

Tierra del Fuego and southern Patagonia. The location of the sites is indicated in Figure 1. From Tierra del Fuego I analyzed two records, La Mision (Markgraf 1980, 1983) and Lago Yehuin (Markgraf 1983). Both records date back to about 10,000 yr B.P. The earliest paleoenvironmental change detected in La Mision occurs prior to 9,500 yr B.P. when a herbaceous grassland gives way to a more shrubby, xeric grassland with *Berberis* (barberry), *Empetrum,* and *Acaena* (Rosaceae), suggesting a shift from cold and dry climates to warm and dry climates. The following major change in those latitudes occurs at 8,500 yr B.P. when the herb-rich, shrubby grassland is replaced by *Nothofagus* (western beech) woodland, suggesting increase in precipitation to modern levels and a precipitation gradient across the Andes. During this early Holocene interval, conditions appear to have been warmer and wetter than today, judging from the proportion between evergreen and deciduous *Nothofagus* species. Between 6,000 and 5,000 yr B.P. cooler and drier climates returned to these high latitudes, documented by a steppe expansion in the eastern, woodland region, and a replacement of evergreen *Nothofagus* species by deciduous in the rainforest region (Isla Clarence, Auer 1974). After 5,000 yr B.P. forest conditions returned, but because proportion of steppe and deciduous *Nothofagus* species remained higher than during the early Holocene, the late Holocene probably was slightly cooler and drier than the early Holocene. The steppe expansion recorded only in the La Mision record dated 270 ± 120 yr B.P., AA-1286. This suggests that the forest decline, that gave rise to the hypothesis of aridification in southern South America since about 2,000 years ago (Auer 1933; Kalela 1941), is unlikely due to climate, but rather to intensified human activity with the European colonization.

From southern Patagonia (Figure 1) two records were analyzed, Fells Cave (Markgraf 1985a, 1987b), and Mylodon Cave (Markgraf 1985a). Both records contain the last 11,000 years, but from Mylodon Cave I only analyzed the 14,000 to 10,000 yr B.P. interval the remainder of the record having already been analyzed by Moore (1978).

Pollen data from the archaeological excavation in Fells Cave (Figure 2) show a strong paleoenvironmental shift between 11,000 and 10,000 yr B.P. from herbaceous grassland to shrubby, xeric grassland, interpreted as a marked temperature increase. During this time, several large grazers such as giant ground sloth (*Mylodon*) and native horse (*Onohippidium*) became extinct and Paleoindian hunting grounds appeared. Apparently the magnitude of this paleoenvironmental change was such that it can be detected also in the diet of the giant ground sloth leading to the hypothesis of an environmentally caused extinction of the large grazers in this part of the world (Markgraf 1985a). Between 9,000 and 6,000 yr B.P. paleoenvironmental conditions appear slightly less arid than before, based on the slight increase of grasses in the Fells Cave record. During the late Holocene, however, starting at 6,000 yr B.P. xeric shrubs again return to dominate suggesting return to arid conditions.

For both, Tiera del Fuego and southern Patagonia, the paleoenvironmental chronology described reveals a consistent pattern. Cold and dry climates characterized the late glacial prior to 12,000 yr B.P. The earliest shift to postglacial climates apparently was a temperature and precipitation increase that resulted in mesic, herbaceous grassland, followed by a further temperature increase that in turn eliminated the mesic grassland in lieu of scrub vegetation. This most likely must have made life difficult for obligatory grazers, such as the ground sloth and horse, especially along the eastern parts of Patagonia that even today are the most arid regions. Precipitation increase

to today's levels did not happen until 8,500 yr B.P., most strongly felt in the western Andean zone, where the *Nothofagus* forest expansion was strongest. Forest and woodlands remained the dominant vegetation in this western zone throughout the Holocene, even though perhaps the early Holocene was somewhat warmer and wetter than the later Holocene.

Mid-latitudes 37° to 41°S. Records from this latitudinal zone (Figure 1) range from the northernmost *Nothofagus* forest islands in Neuquen Province to mixed evergreen-deciduous forests in the Rio Negro Province. From latitude 41°S two records were analyzed: Lago Morenito (Markgraf 1984) and Mallin Book (Markgraf 1983), both from low elevation in *Nothofagus dombeyi/Austrocedrus* forest. Both records cover 14,000 years and show that prior to 12,500 yr B.P. (13,000 yr B.P.) the forest area east of the Andes was greatly reduced and steppe expanded instead. Open forests may have existed along the shores of lakes and rivers only, and included the trees *Nothofagus dombeyi, N. obliqua*-type, Myrtaceae, *Maytenus.* Climate must have been drier than today, more continental with colder winters but with summers, perhaps even as warm as today. By 12,000 yr B.P. *Nothofagus dombeyi* began to expand throughout with *Podocarpus nubigenus* as minor component in the forest, but few

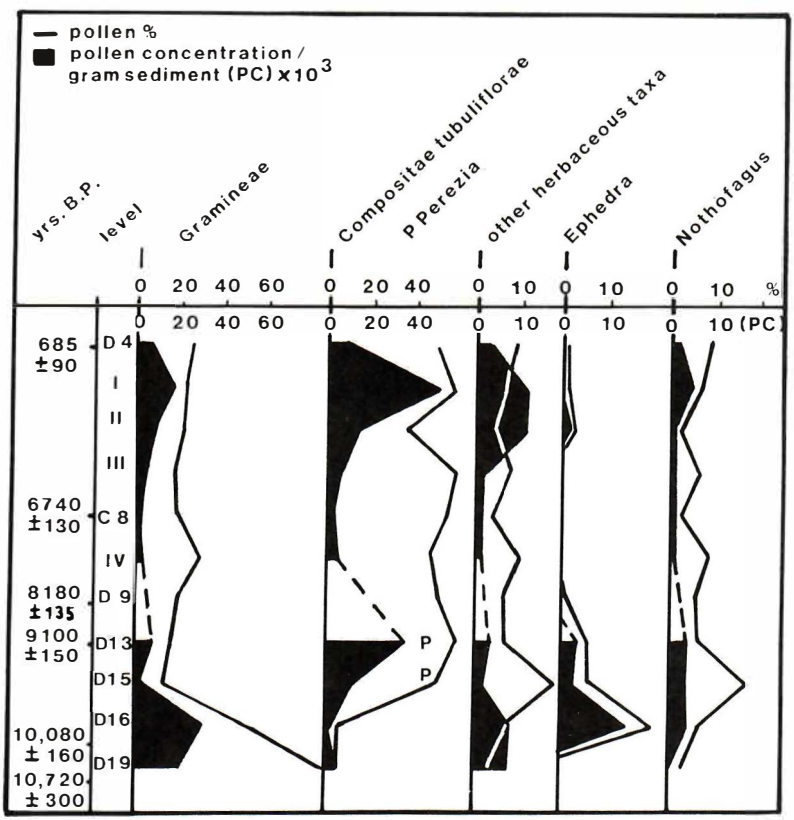

Figure 2. Pollen diagram from Fells Cave, southern Patagonia (Markgraf 1987b).

Austrocedrus chilensis, that today is co-dominant. This implies that climatic conditions must have been different from today, presumably wetter than today with no seasonal moisture stress. Between 8,500 and 5,000 yr B.P. steppe and other xeric shrub elements increased, indicating that the forest had become more open, probably in response to a decrease in precipitation, especially in summer. From 5,000 yr B.P. onwards modern conditions gradually become established and co-dominance of *Nothofagus dombeyi* with *Austrocedrus* exists since 3,000 yr B.P. That the later part of the Holocene is somewhat warmer and drier than the earlier part is also suggested by the absence of *Podocarpus nubigenus* since 5,000 yr B.P.

From the mid-latitudes between 37° and 41°S, only one high elevation record has been found that dates back into late-glacial times. Vaca Lauquen is from 1,550 m elevation in the Neuquen Province, where the northernmost islands of *Nothofagus* forests are found (*N. pumilio, N. antarctica,* and *N. nervosa*). About 11,000 years are present in this 280 cm long section (Markgraf 1987a). Pollen analysis reveals that during the whole interval *Nothofagus* forests were never more extensive than today. Prior to 10,000 yr B.P. in contrary, *Nothofagus* was far less abundant than today, suggesting that the forest islands were even smaller then. Of interest is the occurrence of *Prumnopitys andinus* (Podocarpus) at that time. This tree today has a very scattered distribution between 1,000 and 2,000 m elevation in rather arid locations, between latitudes 35° and 41°S in Chile. Its ecological significance is uncertain, but during late glacial times it appears to have been much more widespread than today (Heusser 1983). The fact that *P. andinus* co-occurs with Gramineae steppe and high amounts of Compositae points not so much in the direction of cooler temperatures, but aridity. Between 9,000 and 8,000 yr B.P., *Prumnopitys andinus* disappears, *Nothofagus pumilio* becomes much more abundant and the Gramineae steppe is characterized by a far greater herbaceous component than before. Precipitation must have increased to cause such changes. From 6,000 yr B.P. onwards, *Nothofagus nervosa* (*N. obliqua* pollen type) increases, together with other *Nothofagus* species, indicating even further increase in precipitation towards modern levels.

This pollen data indicate, that during the past 11,000 years *Nothofagus* forests did not expand their limits beyond the modern situation; on the contrary, the modern distribution appears to be the widest it has been in the past.

It is from this mid-latitude zone that we have the first paleoenvironmental data on a pre-full glacial episode from Argentina. A section from the west slope of Sierra Catan Lil in Neuquen Province was dated to represent a period between 27,000 and 33,000 yr B.P. Pollen and diatom data indicate that modern environments existed at that time, with the forest/steppe ecotone approximately at the same place as today (Markgraf et al. 1986). From the few other existing paleoenvironmental records that cover the same period, only one, Tagua-Tagua in Chile (Heusser 1983) shows a similar environmental pattern of modern conditions, while other (Heusser 1974, 1981; Heusser et al. 1981) show glacial type conditions for this interval.

Desert region latitudes 32° to 34°S. Only one record from the western Argentina desert region (Mendoza Province) extends back into late- and full glacial times (D'Antoni 1980), showing a major environmental shift from cooler and wetter glacial climates to warm and dry desert climates at about 12,000 yr B.P. During the postglacial a shift at 8,500 yr B.P. to extreme arid conditions can be seen in the lowland as well as in the Andean records (Markgraf 1983). Between 5,000 and 3,000 yr B.P. high river runoff in the lowlands, high water tables and depauperate Andean vegetation

in the uplands suggest increased winter precipitation and consequently lower temperatures. By 3,000 yr B.P. modern climates became established. Even at this stage of rather coarse paleoclimatic resolution the records are quite sensitive to climatic change, especially to shifts in seasonality of precipitation. This, in turn, forms the basis for interpretation of circulation features, winter rains representing the westerlies, summer rains the subtropical easterlies. Under this circumstance it is tempting to correlate the paleoclimatic patterns east of the Andes (Gruta del Indio) with that west of the Andes (Tagua-Tagua), because winter rain episodes should be seen on both sides, while summer rains would primarily be seen on the east side. Even though the Tagua-Tagua record is not adequately dated during the postglacial interval (Heusser 1983), there seems to be an interval dated during mid-Holocene times of increased water levels, which could relate to the winter rain increase between 5,000 and 3,000 yr B.P. east of the Andes. In contrast, the preceding summer rain period east of the Andes seems to relate to an arid period west of the Andes. To further develop such exciting paleoclimatic correlations a far better data network and dating control is needed. The ongoing research in Argentina (Wingenroth pers. comm.) may soon provide the much needed detail.

Northern Argentina. From the province of Jujuy, one paleoenvironmental record, El Aguilar, has been analyzed for paleoclimatic changes during the last 10,000 years (Markgraf 1985b). Preliminary pollen analysis of another nearby site, Barro Negro, where extinct horse was dated to 12,000 yr B.P. (Fernandez 1986) documents the lateglacial conditions in the Puna environment at about 4,000 m elevation. Prior to 10,000 yr B.P. the proportion and diversity of herbaceous taxa and Compositae was greater than after 10,000 yr B.P., suggesting Paramo vegetation that is characterized by greater effective moisture than the Puna vegetation. During the Holocene, three paleoclimatic phases can be distinguished. Between 10,000 and 7,500 yr B.P., the high proportions of Gramineae, but lesser amounts of Compositae and herbaceous taxa, resembling the Altoandean vegetation, suggest increase in continentality, colder winters than before. Between 7,500 and 4,000 yr B.P. Prepuna components increased (*Ephedra,* Chenopodiineae, Euphorbiaceae, etc.) suggesting greater aridity than before. Because the long distance pollen component from the mountains to the east is missing at that time, the increased aridity is probably due to lesser amounts of summer rains. From 4,000 yr B.P. onwards basically modern conditions had become established, with some Paramo components, indicating greater moisture than before, but sufficient Prepuna components as to suggest that summer drought occurrences continued. From 500 yr B.P. on, human impact can be detected in the environment that undergoes a rapid succession characteristic of overgrazing.

This record from the Altiplano as well as those from the Argentine desert zone relate well with those from Bolivia at latitudes 16° to 17°S and even those from Peru at latitude 11°S (Graf 1979; Hansen et al. 1984), even though the influence of lowland tropical forest pollen increases substantially towards the equator, making correlations more problematic.

Paleoclimatic synposis based on paleoenvironmental changes. Although there still are only relatively few records from southern South America that extend into the full glacial times, a paleoclimatic pattern emerges. West of the Andes, south of 40°S latitude, the forests were more open than today, interpreted by climate transfer functions as due to a 60% decrease in precipitation, and 3°C lower summer temperatures

(Heusser et al. 1981). North of latitude 40°S on the other hand, mean annual precipitation is interpreted as to have been twice the modern (Heusser 1983). East of the Andes, the pattern of full glacial climates is similar, but more pronounced (D'Antoni 1980; Markgraf 1983). Thus, at latitude 41°S the predominant vegetation was steppe and shrub, and some of the arboreal taxa from more northern latitudes. At latitude 35°S grassland dominated instead of the modern desert environment.

To explain this paleoclimatic scenario, Heusser (1983) suggested that the westerlies, that today are responsible for the winter rains south of latitude 40°S had shifted towards the equator during full glacial times. More likely, however, the westerlies had shifted toward the pole, and the increased subtropical moisture is related to a similar shift of the subtropical circulation (Markgraf 1983, 1987a).

Not only was there latitudinal differences in the character of the full glacial environments at different latitudes, also the onset of postglacial environments was not synchronous at different latitudes. Throughout the mid-latitudes, on both sides of the Andes, the shift from glacial to postglacial vegetation occurred at 12,000 yr B.P. At high southern latitudes, south of latitude 50°S, this shift only occurred at 8,500 yr B.P., as the preceding paleoenvironmental changes were not sufficient to produce the modern environmental setting. This suggests that the subantarctic circulation remained longer in the glacial mode than the mid-latitude systems.

It emerges from this large scale paleoclimatic comparison, that in southern South America the regional differences are neither due to the records' different sensitivity, nor to migrational delays, nor to delayed response of plants to climatic changes ("plants in disequilibrium with climate": Markgraf, 1986). Instead, regional differences are the expression of the regionality of climate patterns, observed today (e.g., Pittock 1980), and therefore certainly also important during the past.

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Cueva Del Medio: A Significant Paleoindian Site in Southern South America

Hugo Gabriel Nami

In the Argentine-Chilena Patagonia (southern part of the provinces of Santa Cruz, Argentina and Magallanes, Chile) a cultural sequence about 11,000 yr B.P. was found. This sequence begins with the co-existence of humans and extinct fauna and ends with hunter-gatherer societies and Europeans. Two important sites were the axis of the sequence: Fell's and Pali Aike Caves. These periods, called Magallanes, Fell's

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or Bird, range from the first (I; the earliest) to the fifth (V; the latest). According to Massone M. (1981), they can be included in the following cultural units: early (Bird I and II periods), middle (Bird III) and later (Bird IV and V periods).

The first period is characterized by the well-known "fishtail" projectile point and extinct fauna: Pleistocene american horse (*Hippidium onohippidium*), ground sloths (*Mylodon darwini*), and extinct camelids. The chronology of the first period has been dated to: 10,080 ± 160 yr B.P., I-5146; 10,720 ± 300 yr B.P., W-915; 11,000 ± 170 yr B.P., I-3988 (Fell's Cave) (Bird 1983) and 8,639 ± 450 yr B.P. at the Pali Aike Cave (Bird 1951). Therefore Bird II period has some typological differences with the former, lacking the fishtail projectile point and extinct fauna. In Fell's Cave it has been dated to: 9,100 ± 150 yr B.P., I-5144; 9,080 ± 230 yr B.P., I-5145; 8,480 ± 135 yr B.P., I-5143 (Bird II, ending-Bird III initial) (Bird 1983). Based on modern lithic analysis, Bird II probably needs a typological and technological revision.

The middle cultural unit in the Fell's Cave has, among others, the following dates: 8,180 ± 135 yr B.P., I-5142; 6,740 ± 130 yr B.P., I-5138; 6,560 ± 115 yr B.P., I-5141; 6,435 ± 115 yr B.P., I-5140 (Fell's Cave) (Bird 1983). This cultural unit is characterized by the triangular projectile points and extant camelids: guanaco (*Lama guanicoe*).

These remarks are very important to take into account because Fell's and Pali Aike Caves' foundings became the only two sites where this cultural sequence was clearly documented (Bird 1938, 1946; Emperaire, Laming and Reichlen, 1963).

In 1986, during the months January and December, the Patagonia's Institute, Magallanes University from Punta Arenas, Chile, sponsored two archaeological field works at the Ultima Esperanza region. Preliminary notes about the first field work came out in Nami (1985). This area is very famous around the world due to Mylodon Cave. In it was found a great number of Pleistocene fossil remains (bone, dung, hide) in excellent preservation. The same fauna that existed in Fell's and Pali Aike Caves, located 135 km to the southeast. Several expeditions carried out by Bird (1951), Emperaire and Laming (1954) and Saxon (1976) did not find evidence of human co-existence with this extinct fauna, in spite of some clues of existence (see Borrero 1982).

The archaeological expedition, directed by the author, carried out an excavation in the Cueva del Medio (Middle Cave), approximately 1 km from the Mylodon Cave. This recent archaeological research is part of the expedition that the Instituto de la Patagonia is carrying out in southern Patagonia, Chile. This expedition has discovered a great number of unknown archaeological sites. Some of these sites range from archaeological historical sites (e.g., Dinamarquero) to aboriginal sites (e.g., Juni Aike). One of them is the rediscovered site of the Cueva del Medio, at which, by the end of the 1800s, palaeontological excavations had been carried out by Hauthal (1899) and Nordenskiold (1900).

Cueva del Medio is located 135 km NW of Fell's and Pali Aike Caves. It is about 51°35′S lat and 72°38′W long. The opening of the cave is about 90 m long, 40 m wide and 6 m high. The cave has been formed into the Cerro Benites conglomerate, consisting of rounded pebbles, including many vulcanites, which are also used as lithic raw materials by the ancient inhabitants. At the moment two clear cultural components are known. One of the is Bird I (Fell's I); the other can be clearly assigned to Bird III (Fell's III).

Geological, palynological, sedimentological, petrological, and faunal analyses are in process by different specialists. The technological analysis with experimental stress, together with the typological and functional of the lithic artifacts, are now being studied

by the author. Further excavations, radiocarbon dates, and analyses will give a deeper knowledge about the Paleoindians of Cueva del Medio.

I would like to give special thanks to Adriana Martin for having corrected the English draft of this manuscript.

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Man and Pleistocene Megamammals in the Argentine Pampa: Site 2 at Arroyo Seco

Gustavo G. Politis, Eduardo P. Tonni, Francisco Fidalgo, Monica C. Salemme, and Luis M. Meo Guzman

One of the first places where human occupation during the Pleistocene was postulated was the Pampean region of Argentina. At the end of the 19th century, F. Ameghino (1880) discovered several sites where he observed the association of man and megamammals, and claimed a great antiquity for their association. It was not until the discovery and excavation of La Moderna, a glyptodon kill site, that the presence of early man of Argentina in late Pleistocene times was reconsidered and generally

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incorporated into cultural sequences (Madrazo 1973, 1979; Palanca et al. 1972; Palanca and Politis 1979; Politis 1984, in press; Zetti et al. 1972).

The recent investigation of the Arroyo Seco site 2, 135 km south of La Moderna, has also confirmed the presence of early man in the Pampean region and provided additional valuable information about the nature and chronology of the late Pleistocene-early Holocene human occupations. The purpose of this paper is to present a summary of the data recovered from the lower component of site 2 at Arroyo Seco.

Site 2 at Arroyo Seco is a multicomponent open-air site located on an extensive plain between the Tandilia and Ventania hills of the Pampean region (Figure 1). The site is situated on a loess ridge between the Seco Creek and a small lagoon. First excavated in the early 1970s, to date, approximately 140 m² have been excavated, about 20% of the total estimated area of the subsurface deposit.

The early man level (lower component) lies mainly in the lower part of layer Y (Figure 2; 30 to 40 cm thick, coarse silt to fine sand), but some lithic and faunal remains have been recovered from the underlying level layer S (5 to 10 cm thick of a calcium carbonate concentration). In the lower component, 83 artifacts have been recovered exhibiting primary and secondary flaking in addition to an abundance of undifferentiated flaking debris. Some artifacts exhibit bipolar percussion and narrow bifacial retouching. Tool types include frontal-scraper, micro-scraper, extended-

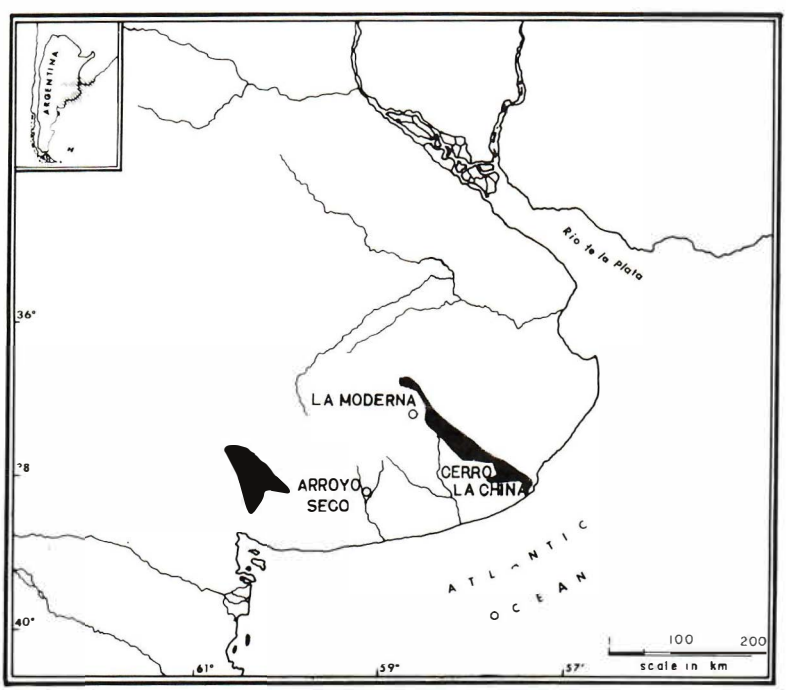

Figure 1. Location of the Pampa region and the Arroyo Seco site 2, La Moderna, and Cerro la China archaeological sites.

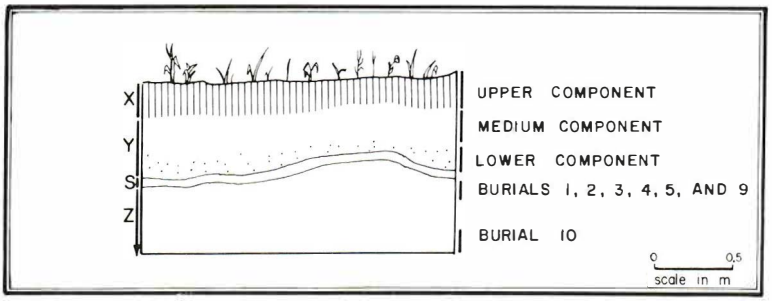

Figure 2. Schematic profile of the geological stratigraphy of test pit 46 at the site 2 of Arroyo Seco. Note the location of the burials below the lower component.

edge scraper, simple and double-scrapers, "piece esqueille," a half bola stone, and two pieces of grinding stones.

Faunal remains in this unit consist primarily of *Lama glama guanicoe* (guanico), *Ozotoceros bezoarticus* (Pampean deer), *Rhea americana* (rea), *Zaedyus pichiy* (armadillo), and *Chaetophractus villosus* (armadillo). In addition to the extant species, several extinct Pleistocene mammal species were recovered: *Megatherium americanum* (giant ground sloth; minimum number of individuals: MNI = 2), cf. *Mylodon* (ground sloth; MNI = 1), *Glossotherium robustum* (ground sloth; MNI = 1), *Macrauchenia patachonica* (macrauchenid; MNI = 1), *Paleolama* cf. *wedelli* (llama; MNI = 1), cf. *Equus (Amerhippus)* sp. (horse; MNI = 3), *Hippidion* or *Onohippidium* (horse; MNI = 2), and *Eutatus seguini* (armadillo; MNI = 1). The presence of certain breakage patterns, the spatial and contextual association, and the biased selection of some skeleton parts suggest that *Megatherium* and *Equus* were probably exploited by people at the site.

One of the outstanding characteristics of the site is the presence of 16 human skeletons found in the upper part of layer Z, below the early man component. The La Plata Radiocarbon Laboratory (LATYR) has processed two radiocarbon samples from bone collagen from this unit. A date of 8,390 ± 240 yr B.P. (Tonni et al. 1982) was derived from a piece of *Megatherium* bone from the lower component, and a date of 8,560 ± 320 yr B.P. (Politis 1984) came from the human skeleton number 6 (burial 2).

If the suggested links, associations, between the human skeletons and the lower component are confirmed, Arroyo Seco will provide important information for the study of the physical characteristics of early man and will allow us to explore the mortuary practices during the late Pleistocene-early Holocene. The data presented here suggest that early human occupation in the Pampean region was developed during at least two cultural periods. However, since so few sites are recorded in the region, this supposition must still be regarded as tentative. Site 2 at Arroyo Seco provides important information on the relationships between early hunter-gathers and the extinction of Pleistocene megamammals in the Pampean region. Extinctions should be examined and explained primarily in regional terms and not on a worldwide basis.

This paper is a revised version of the one read by Politis at the 50th meeting of the Society of American Archaeology, Denver, Colorado, 1985. We gratefully acknowledge the assistance of Tom Dillehay, Jim Mead, Anibal Figini, and Scott O'Mack, who commented on earlier drafts of this paper.

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Alluvial and Palynological Studies in the Venezuelan Guayana Shield

Carlos Schubert and Maria Lea Salgado-Labouriau

Late Pleistocene aridity in northern South America has been fairly well documented (Prance 1982); since 1984, an effort to evaluate the extent of this aridity in the Venezuelan Guayana Shield (Figure 1) has been in progress (Schubert 1986). Nineteen radiocarbon dates of highland peat, located on quartzite table mountains, suggest a maximum age of about 8,000 yr B.P., corrected for modern contamination (Schubert et al. 1986). Thus, peat deposition, characteristic of present-day humid conditions (≥4,000 mm yearly rainfall), began in the early Holocene, and that unfavorable climate for peat formation prevailed in the late Pleistocene.

Alluvial deposits along several rivers in the piedmont area of the table mountains (mainly Auyán), in the form of at least four terraces, consist of unbedded sandy gravel and conglomerate in a ferruginous matrix. Angular to subrounded clasts are composed of quartzite, jasper, chert, and diabase (Precambrian Roraima group) derived from the table mountains. Older terraces have been partially buried by Holocene alluviation, an indication of negligible uplift. These alluvial deposits suggest a previous episode of intermittent, torrential sedimentation under a drier climate than today. Several wood and charcoal samples are being radiocarbon dated.

Because little pollen morphological data exists on the plants of the table mountain summits, and species diversity is high in the region, a preliminary catalogue of highland

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pollen types was prepared (Salgado-Labouriau and Villar de Seoane, in press), and the palynological analysis of peat cores from the summits is now in progress. Highland peat was cored and sampled from outcrop in the Chimantá and Guaiquinima Massifs; the contact between the peat and the Precambrian quartzite was found at a maximum depth of 2 m. According to the radiocarbon age above, the pollen analyses will cover most of the Holocene. Lowland (savanna) peat was cored at Arapán River and at three localities near the middle Kukenán River (two are associated with small, permanent lakes); these sites were sampled to a maximum depth of 2.5 m, where the

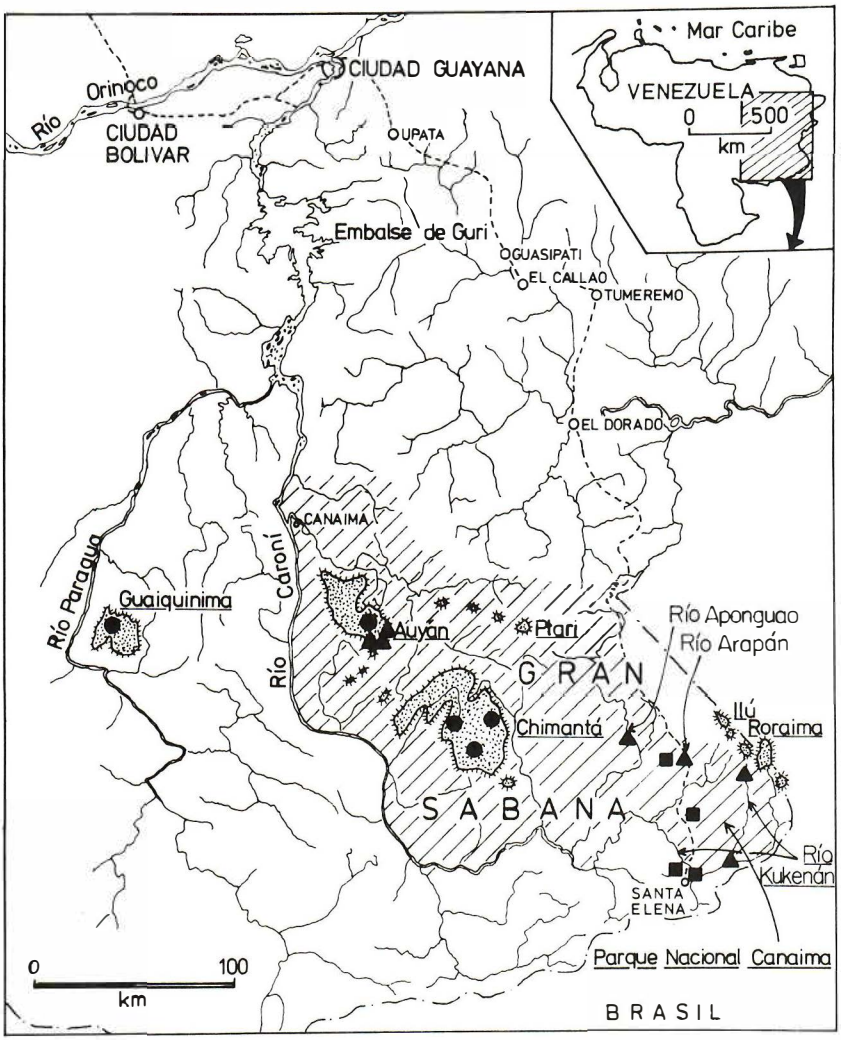

Figure 1. Location of study areas. Stippled areas are table mountains (1,600–2,400 m elevation); these are surrounded by areas of tropical forest and savanna (900–1,000 m; hatched area). Circles: sites of highland peat collection; squares; sites of lowland peat collection; triangles: sites of alluvial deposits.

peat overlies an ochre, ferruginous sand, interpreted as part of a pre-Holocene duricrust. Radiocarbon analyses of six samples are currently being processed. Palynological analyses of highland and lowland peat, and a comparison with the modern flora of the table mountains (Grupo Científico Chimantá 1986, Huber 1986) and surrounding savannas, will aid in the paleoecological reconstruction of the Holocene climatic history of this region. It is expected that the lowland cores will reach Pleistocene ages to enable the testing of the biological "refugia" hypothesis.

This study is part of a long-term project in collaboration with C.V.G.-EDELCA, the Department of Earth Sciences (University of Waterloo, Canada), and support of CONICIT Grants S1-1343 (O. Huber) and S1-1834 (C. Schubert).

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Dissertations

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

Blumenschine, Robert J. 1985
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Order No.: DA8609943.

Hoganson, John J.W. 1985
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Radiocarbon dates should be expressed in ^{14}C years before present (yr B.P.) and should include the standard error and the laboratory number (e.g., 11,000 ± 140 yr B.P., A-1026). International notation should be employed in all cases of chemical notations.

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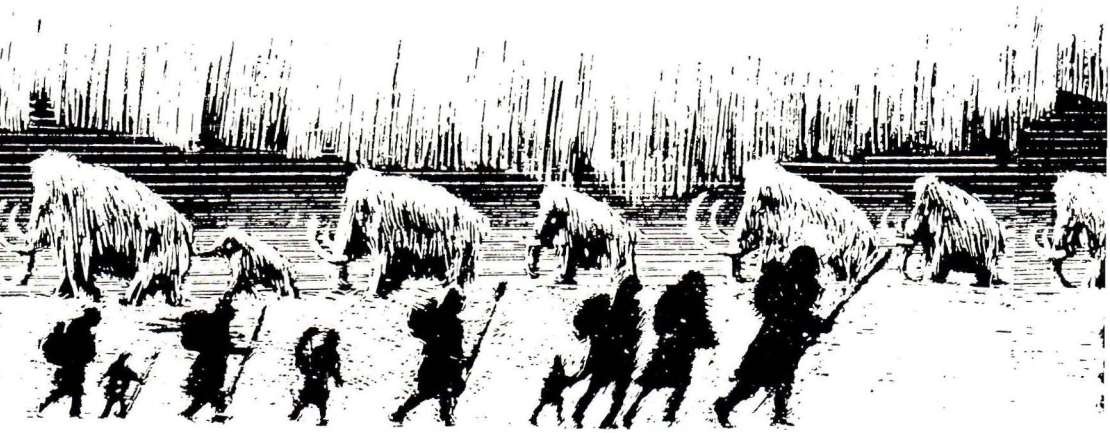

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