CURRENT RESEARCH

Volume 1 1984

Editor
Jim I. Mead

A Peopling of the Americas Publication

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From the Editor

This is the first issue of *Current Research,* a journal to be published annually as part of the Center for the Study of Early Man's PEOPLING OF THE AMERICAS publication program. The journal focuses on the broad topic of the Pleistocene peopling of the Western Hemisphere. Specialists from all over the world are invited to submit short current research statements for publication. We also invite opinions on interdisciplinary subjects and the development of topics for future grant proposals, a testing ground for new and innovative ideas. Collectively, these concise, state-of-the-art reports provide an overview of trends and developments in New World early human studies and allied disciplines, all in a single source.

Current Research is different than other journals. Its purpose is to bridge the gap between abstracts, which might be published in academy and society meeting proceedings, and those notes and short articles printed in regular peer reviewed journals. Authors of *Current Research* articles should be permitted to expound freely about their ideas and research goals. Views of the authors are not necessarily those of the Center.

Manuscripts received are first read by the editorial staff to ensure that the minimum requirement is met (i.e., studies pertaining to subjects of the peopling of the New World, dating greater than 10,000 years old). All manuscripts are edited for style and general grammar. The journal follows a style (see 'Information for Contributors') that permits continuity of format and allows for concise reporting. Each author is requested to submit in essence a "camera-ready" manuscript. Because one of the principal goals of the journal is to provide quick turnaround time for the printing of manuscripts, authors do not review galley or page proofs. If a submitted manuscript is found to require extensive editing or if editorial changes alter an inherent meaning, the author will be contacted prior to final printing. Because of this editorial policy, it is imperative that authors submit manuscripts that have been carefully proofed for content and grammar. It is suggested that all manuscripts be reviewed by a colleague of the author prior to submission. The editorial staff reserve the right to request an outside peer review of any manuscript prior to determining its acceptance for publication.

The success of this journal rests on the specialists who submit their reports of current research. If this is done, everyone interested in the study of the peopling of the New World and the paleoenvironmental reconstructions of the Western Hemisphere should be able to keep abreast of this fast-changing, interdisciplinary topic.

J.I.M.

Contents

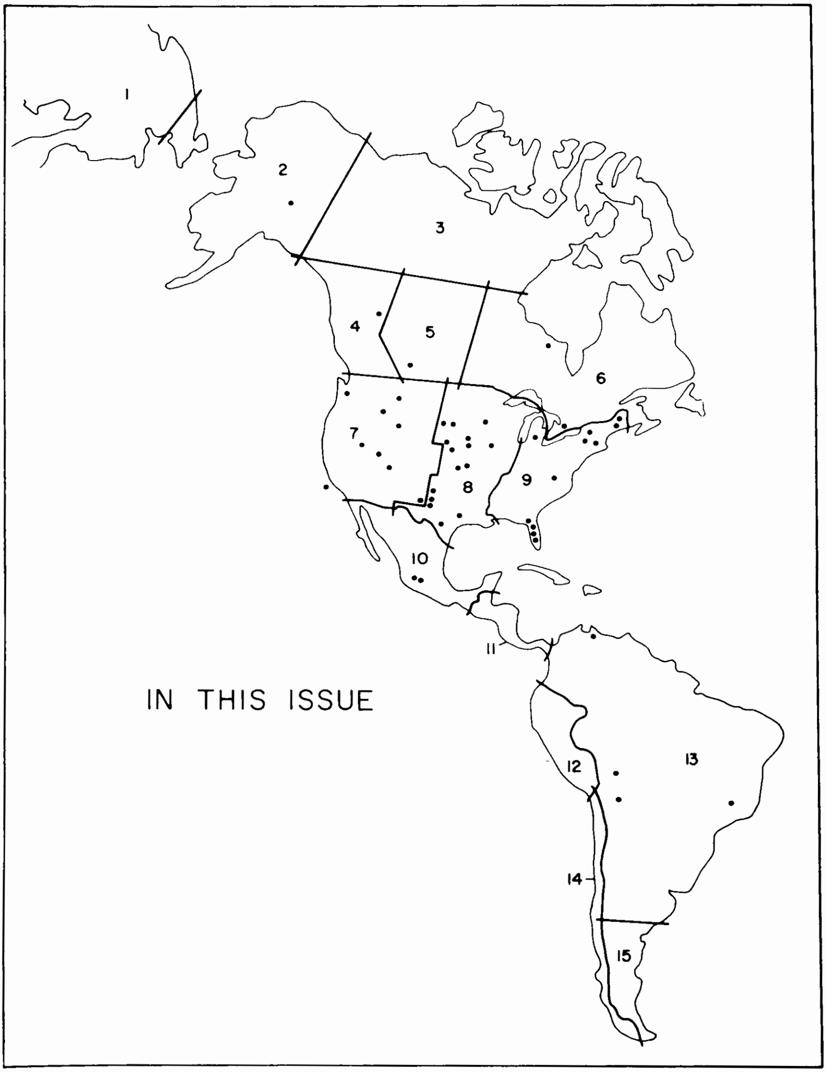

Fig. 1. Map of the Western Hemisphere and northeastern Asia. Dots represent localities reported in this issue. For the location of reports from any given area, refer to Fig. 2 on page 102 and the regional index.

Archaeology

Paleoindian Sites in the Munsungun Lake Region, Northern Maine

ROBSON BONNICHSEN

The Munsungun Lake region of north-central Maine, located approximately 35 km north of Baxter State Park is yielding new evidence important for understanding the initial colonization of northern New England. Three seasons of archaeological survey and testing (1977-1979) and four years of excavation (1980-1983) by University of Maine at Orono research teams have resulted in the definition of significant lithic source region where prehistoric hunters and gatherers came to acquire stone for manufacturing tools. In northern New England and the adjacent Canadian provinces, fine-grained raw materials suitable for flaking are a limited resource with a finite distribution. Apparently, the northeast to southwest trending Munsungun Lake Formation was an important factor that attracted human populations to this area since the end of the last ice age. Fine-grained cherts, wackes, and volcanics have a wide range of colors (red, green, gray, black, or combinations of the above) motteling, banding, and textures.

Archaeological surveys netted over 100 sites and three centers of activity in this densely-wooded remote mountainous area. Clusters of quarry and workshop-habitation sites occur at Round Mountain Pond, at Mooseleuk Lake and Munsungun and Chase lakes. Quarries, where raw materials were extracted from bedrock, occur either at outcrops or as pit mines excavated into bedrock. Early stages of core and biface reduction are commonly found at these sites. By contrast, workshop-habitation sites occur along modern and ancient terraces, on lake and kame terraces, and on benches associated with glacial spillways between basins.

Particularly important for understanding the Munsungun Lake area is a bedrock divide separating Munsungun and Chase lakes. This section of land known as the Thoroughfare is covered with surficial deposits of till and terrace gravels. Excavations have demonstrated the occurrence of workshop-habitation sites on seven separate but adjacent landforms, representing the Ceramic to Paleoindian periods. Interestingly, Paleoindian sites occur only on kame terraces and benches 14 m or more above current pool level of Munsungun Lake, and only two of the kame terrace sites have been thoroughly investigated. The Fluted Point site (154-14) occurs on the Munsungun side of the Thoroughfare and the Windy City site (154-16) occurs on the Chase Lake side of the 14 m terrace. The Fluted Point site covers an extensive area involving approximately 3,000 m^2, but the Windy City site covers no more than 300 m^2 and is clearly a single occupation site. Twenty-four two m^2 units were excavated at 154-14 while only 11 two m^2 units were excavated at 154-16. The artifact inventory from these sites is similar but not identical. Tools are predominately made from

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black, black-and-gray banded, and red-and-green mottled cherts. Judging from tools recovered (fluted points, end scrapers, spurred end scrapers, gouges, pieces esquilles, backed flake knifes, and numerous utilized flake tools) tool kits were stocked at these locations. In addition, the high frequency of utilized flakes and worn end scrapers suggest other manufacturing or subsistence activites occurred. Only one cultural feature was found, a hearth at 154-16. Charcoal has been submitted for radiocarbon dating. We presently suspect human occupation occurred at these kame terrace sites when glacial ice was still in the Chase and Munsungun basins. However, this will not be known until the radiocarbon results are available and can be related to the dated pollen diagram from Chase Lake. If this scenario is also supported by geomorphological research now in progress, the proposition can be advanced that initial colonization of this region occurred under periglacial environmental conditions.

Excavations at the Harney Flats Site in Hillsborough County, Florida

RANDY DANIEL AND MICHAEL WISENBAKER

Harney Flats is a large (ca. 1.35 ha) early man site in Hillsborough County, Florida. It is located on the northern edge of Harney Flats, a large inland basin covering several square km, at the boundary of the Polk Upland and the Gulf Coastal Lowlands (6-9 m above sea level). The site was discovered in 1978 during an archaeological survey as part of the Florida Department of State Highway Salvage Program (Jones and Tesar 1982). In 1981 test excavations were conducted by the Bureau of Historic Sites and Properties (now Bureau of Archaeological Research), of the Department of Archives, History and Records Management. As a result of this testing, large scale salvage excavations were carried out under the direction of the senior author between November, 1981 and March, 1982. A preliminary report of this project has been presented elsewhere (Daniel and Wisenbaker 1983). Final report preparation is now being concluded. Funding for the project has been provided by the Florida Department of Transportation and the Federal Highway Administration.

The excavations at Harney Flats were quite extensive, covering 967 m^2 in the early component. The excavations were conducted in three stages. The first two stages bounded the Suwannee-Simpson (see Bullen 1975) Paleoindian component and provided preliminary data on artifact types and potential site structure. The final stage consisted of large block excavations within the Paleoindian component. Three areas were excavated in this manner (Area 1: 283 m^2, Area 2: 380 m^2, and Area 3: 196 m^2). This stage was intended to provide data on the spatial structure of the three areas. Data utilized from the block excations consisted of 1 x 1 m grid square and level provenience for over 79,000 pieces of lithic debitage and exact horizontal and vertical provenience for over 1,000 lithic tool specimens.

Deep sand lithic sites are common in central Florida and are often composed of lithic material distributed in a 2-3 m deposit of homogeneous sand. Organic materials, including bone, charcoal, and soil feature are not preserved in the sandy, acidic soils as was the case at Harney Flats. Although the site remains undated the Suwannee component is estimated to date from 10,000-11,000 yr B.P.

Although the focus of the excavations was on the early component, a middle Archaic and an ephemeral ceramic occupation were identified during the testing, demonstrating the stratified nature of the site. The middle Archaic component appeared to be isolated between 70-100 cm below surface while the Suwannee component was present from 100-160 cm below surface. Subsequent analysis however, has indicated a concentration between 100 and 130 cm below

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surface. Therefore, a few Bolen points were also recovered in the Suwannee levels. These points are typical of the side and corner-notched points identified as early Archaic elsewhere in the Southeastern United States.

The major goals of the project have been to construct a tool typology for the Suwannee component and to describe the spatial organization of the site. The Harney Flats assemblage can largely be divided into bifaces and unifaces. Within the uniface category both curated and expedient forms have been identified. The curated unifaces include end scrapers, discoidal scrapers, and an oblong scraper form. As used here the term curated refers to tools probably transported from site to site and maintained by resharpening and recycling. The majority of the unifaces however, appear expedient and are basically made on flakes of varying shapes and sizes with almost all the retouch restricted to the flake margins. Other tool classes include adzes, hafted spokeshaves, flakes with spurs or projections, and the presence of four large specimens of non-cryptocrystalline stone that appear not to be indigenous to the state. Finally, a series of core types are present as well as hammerstones and a few sandstone abraders.

The large number of recovered tools is believed to be a result of the postulated site function - a quarry related base camp. Limestone and coral is abundant in the area and refurbishing tool kits is believed to have been a major activity at the site. Moreover, it is believed that many of the recovered curated unifaces were brought to the site in anticipation of retooling and may never have been used there (Keeley 1982). The presence of expedient unifaces, on the other hand, are felt to be a function of the easy availability of raw material and probably better reflect actual tool use at the site. Aiding the analysis is a tool replication and use-wear study by George Ballo of the University of South Florida which represents the most comprehensive study to date on Florida cherts. This study has helped reveal the generalized nature of the assemblage and indicates that tool form and function are not independent variables among tool types. Another auxillary study is attempting to document Paleoindian lithic raw material selection in central Florida and trace mobility patterns as revealed by the use of chert from particular quarry areas (Upchurch *et al.* 1981).

Spatial analysis indicates that broad scale patterning is observed within the sites by the identification of a living area (Area 1) occupying the highest and flattest portion of the site separated by activity area (Areas 2 and 3) further down slope. Activity areas are believed to be dominated by tool manufacture as indicated by relatively higher concentrations of hammerstones, cores, core fragments, and lithic debitage. Fine scale patterning within each area is still unclear; this awaits further methodological consideration.

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Late Pleistocene to Mid-Holocene Adaptations at Indian Creek, West-Central Montana Rockies

LESLIE B. DAVIS

Discovered and tested in 1979 (Davis *et al.* 1980) and intensively excavated in 1982 and 1983, the Indian Creek site (24BW626), at an elevation of 1,350 m, inside the dissected east flank of the Elkhorn Mountains in the Upper Missouri drainage west of Townsend, Montana, is yielding a detailed record of interrelated natural and cultural events. Encroached upon and partly destroyed by gold placer mining, the exposed culture-bearing alluvial section consists of ± 8.5 m of *in situ* deposits overlain by ± 3 m of dredge tailings; this section spans late Glacial through Holocene time, from ca. 13,000 yr B.P. to the present. More than a dozen occupations are preserved in the lower part of the section, bracketed by Glacier Peak, Layer G, tephra (11,125 $\pm$ 130 yr B.P., Beta-4951) and Mt. Mazama tephra (6,700 yr B.P., several dates; see Fig. 1). The post-Mazama part of the section has not yet been sampled.

The deepest and earliest occupation (OL 18) is Folsom in affiliation, while the Mazama substrate is a Bitterroot complex manifestation. OLs 17b and 17a are likely also Folsom, based upon utilized lithics shared with one another and OL 18; diagnostics occur only in OL 18, and a reused Clovis point was also recovered from this surface. OLs 16c and 12b are likely attributable to the Hell Gap and/or Agate Basin complexes, based upon stratigraphic and radiometric correspondences upstream where diagnostic projectile points were recovered *in situ* in 1983.

Only the 1982 flaked stone assemblage from OL 18 has been fully analyzed and compared externally. Twenty-six marginally retouched scrapers, gravers, and knives, one fragmentary fluted point, one core, and 238 waste flakes comprise this lithic subassemblage. This toolkit is indistinguishable in many ways from a Folsom component at the Agate Basin site (Frison and Stanford 1982) and is very similar to elements in the Hanson site Folsom component (Frison 1978; Frison and Bradley 1980), both in Wyoming. Localized calcined rodent bone and utilized bison bones attest to a big game hunting and small mammal gathering economy, with food procurement, food processing and cooking, hideworking, wood and/or boneworking, and stone tool production and maintenance activities represented.

The hunting of bison, bighorn sheep, and deer/sheep was supplemented by the gathering of marmot, cottontail rabbit, jackrabbit, and rodents at Indian Creek. Bison is most often represented, with bighorn sheep second, and deer/sheep the least common. The Indian Creek archaeological fauna divides into two distinct faunules: the bison-marmot faunule that begins in OL 18 and extends to OL 7 (10,980 to 7,700 yr B.P.) and a succeeding bighorn sheep faunule that begins in OL 6 and continues to the base of the Mazama.

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Seasonality is tentatively well established for five occupational events: OL 18, 10,980 yr B.P., spring; OL 17, 10,160 yr B.P., late winter; OL 3, 7,210 yr B.P., late winter-early spring; OL 1, ca. 6,900 yr B.P., late winter-early spring; and, at the base of the Mazama, 6,700 yr B.P., spring.

Hunter-gatherers successfully occupied the Indian Creek site and utilized proximal resources during late winter-early spring, spring, and summer, attracted by high-quality local cherts and quartzites, where they subsisted principally on big game supplemented by small mammals and possibly by various edible plants. Thus, Indian Creek was probably visited and exploited seasonally by small semi-nomadic groups of hunter-gatherers replenishing winter-depleted lithic raw material supplies in preparation for proceeding on the seasonal round.

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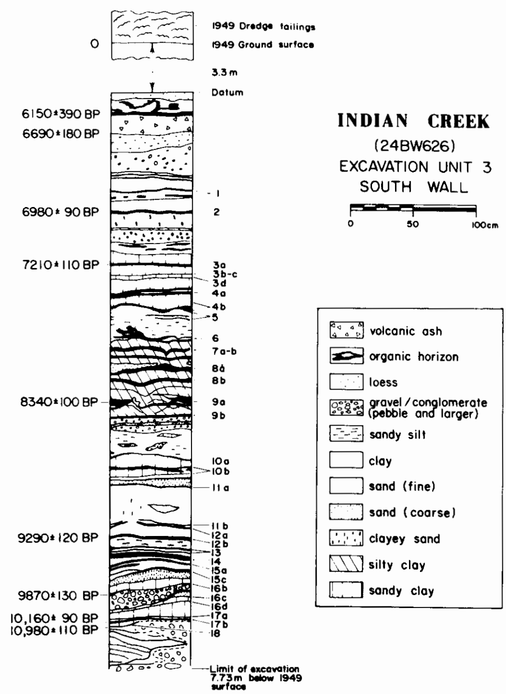

Fig. 1. Excavation profile at Indian Creek, with stratigraphic units and radiocarbon dates associated.

The Lubbock Lake 1983 Field Season

VANCE T. HOLLIDAY AND EILEEN JOHNSON

Lubbock Lake (41LU1) is a well-stratified, well-dated archaeological site on the Southern High Plains of Texas containing a record of human occupation spanning at least the past 11,100 radiocarbon years (Holliday *et al.* 1983). During the 1983 excavations into the Paleoindian deposits, two features of unknown cultural affiliations were discovered that may be of considerable significance to the Paleoindian record of the Great Plains.

Lubbock Lake is situated in an entrenched meander of Yellowhouse Draw, a tributary of the Brazos River. The drainage had been incised during the late Pleistocene and since then has been filling episodically. Paleoindian material is found within two geological units (Johnson 1983). Stratum 1 (12,000 to 11,000 yr B.P.) is a deposit up to 1 m thick of interbedded sand and gravel from a meandering stream. The unit contains a late Pleistocene megafaunal processing station (FA2-1) of late Clovis age (11,100 yr B.P.). Stratum 2 (11,000 to 6,500 yr B.P.) consists of diatomaceous and organic-rich lake and marsh sediments about 1 m thick. The 1983 excavations focused on the post-Folsom Paleoindian record. Geologic research dealt with the microstratigraphy of the entire Paleoindian sequence.

One of the new features is a bone bed containing the remains of mammoth, camel, horse, and butchered bison found on and in a stream gravel deposit. This deposit is part of an extensive buried terrace originally identified as stratum 03 (Stafford 1981). The deposit now is considered to be part of stratum 1, but because of its position along the valley wall, it must be older than stratum 1, typically found in the valley. Several working hypotheses were generated concerning the bone from the terrace. (1) The material immediately predates the stratum 2 sediments that bury it. Statigraphic correlations and radiocarbon ages from nearby excavation areas indicate that the sediments burying the bone are about 9,500 years old. If this hypothesis were the case, then mammoth, camel, and horse existed in the area until 9,500 yr B.P. (2) The bone is of late Clovis age and was exposed at the surface until burial ca. 1,500 years later. This situation is highly unlikely because the bone would have weathered and decomposed long before burial. (3) The bone was eroded from the gravel terrace shortly before burial. If the bone is from the terrace, then it must be older than the late Clovis feature (FA2-1) at the site. This situation, in turn, would suggest that the bone bed in question is either from an earlier Clovis occupation (between ca. 11,500 and 11,100 yr B.P.) or a pre-Clovis occupation (older than 11,500 yr B.P.).

The other significant find of 1983 is from stratum 2. The edge of a bison kill/butchering locale (FA5-17) was tested. The unusual aspect is that five projectile points of an unknown type were recovered, all within a 10 m^2 area. Mor-

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phologically, the points are lanceolate with slightly constricting stems and straight bases. Technologically, the points appear to fit into the Subplano technological tradition as defined by Knudson (1983, pers. comm.). This tradition is characteristic of and unites Southern High Plains early Holocene Paleoindian projectile points. The age of the feature fits into the Subplano tradition. A nonfinalized radiocarbon age, determined on the NaOH-soluble fraction of organic sediments from the feature, is 10,090 ± 130 yr B.P. (SMU-1261). An overlying lacustrine deposit yielded a finalized radiocarbon age, also on the NaOH-soluble fraction, of 9,780 ± 100 yr B.P. (SMU-699). The relationship between this new unnamed point and the Plainview point and culture which occurs on the Southern High Plains at 10,000 yr B.P. (Johnson and Holliday 1980; Johnson *et al.* 1982) currently is unexplored.

The quantity of projectile points found and their concentration in such a small area is unusual for Lubbock Lake. Typically, the bison kill/butchering locales produce very few projectile points and those that are recovered are heavily reworked (Johnson and Holliday 1980, 1981). In addition, the bone beds usually produce a large number of resharpening flakes. This conservation of resources is considered to be related to the relative paucity of suitable lithic resources in the area (Holliday and Welty 1981). One of the unnamed points virtually is complete and very few resharpening flakes were recovered.

The source area for the lithic material used to make the points is unknown for four of the five artifacts. One point is made of Alibates agate. Another point is made of obsidian, one of the very few known obsidian Paleoindian artifacts in the region. The nearest known source of obsidian is the Jemez Mountains in New Mexico, some 600 km distant. The other three artifacts are made of chert of unknown origins. Two of the artifacts may be of Pedernal chert whose source area also is the Jemez Mountains region (John Hawley pers. comm.).

Several working hypotheses also were generated for the new projectile points and associated bone bed. (1) The points are not indigenous to the Southern High Plains and represent an intrusive culture. (2) The points are indigenous and represent a hitherto undocumented Paleoindian culture. (3) The points are indigenous and represent a design alternative to a named point type from an already established culture.

Excavations are planned in both new features at Lubbock Lake in 1984. In addition, a careful technological analysis of the new points is underway by Knudson, Johnson, and Holliday and attempts are being made to determine the source area for the obsidian using non-destructive X-ray fluorescence.

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Ice Free Corridor Paleoindian Survey

ARTHUR ROBERTS

The "ice free corridor" that extended from southwestern Alberta, northwest through British Columbia into the Yukon Territory has been considered for decades as the primary entry route for early man into the Americas (Antevs 1935; Haynes 1969, 1980; Morlan 1977; Müller-Beck 1967). Although occasional Paleoindian finds have been reported from northeastern British Columbia and the Yukon Territory (Fladmark 1980; Vandyke 1982), and fluted points are common in Alberta (Wormington and Forbis 1965), there has been only a few desultory surveys of this important area (Fladmark 1980; Vandyke 1982).

As Fladmark (1979) argued, a Pacific coastal route would also be a logical entry corridor. The results of several decades of coastal archaeology indicate that the earliest dated site on the British Columbia coast is no older than ca. 9,700 yr B.P. (Carlson 1979). Although no fluted points have been found along the same coast, a number of undated lanceolate projectile points, resembling late Paleoindian points east of the Rocky Mountains have been found in the Fraser Lowlands near Vancouver. Clague (1980, 1981, pers. comm.) and Armstrong (1980) indicate that ca. 11,000-10,000 yr B.P. sea levels in the Vancouver area were above or at modern sea level. If, therefore, there had been a fluted point Paleoindian occupation near Vancouver the sites would still be above sea level and diagnostic artifacts should have been found.

In the Dawson Creek, Fort St. John vicinity of the relict "ice free corridor" a brief exploratory Paleoindian survey concentrating upon private artifact collections has produced evidence of 23 localities producing evidence of at least 39 separate Paleoindian occupations, on the basis of projectile point identifications. (1) Two produced fluted point blades; both artifacts are unifacially fluted with their bases missing. They are made from black chert, the most common local toolstone. Both localities also produced other diagnostic Paleoindian artifacts including unifacial end scrapers and gravers. (2) Three localities produced Plainview-like points made from dark grey or black chert. Although these specimens exhibited basal thinning they are not fluted. (3) Two of these localities also produced Midland-like points and one of these exhibited extensive basal thinning on one side such that it could be considered fluted. (4) At another locality a Milnesand-like specimen also exhibited extensive basal thinning on one face and could also be considered fluted. This specimen was also made of black chert. (5) Seven localities produced good Agate Basin or Haskett-like points. Similar artifacts have been dated by Frison and Stanford (1982), Butler (1978), and others between 10,500 and 10,000 yr B.P. (6) Five localities produced a number of Hell Gap-like specimens. There was also a large number of point fragments that probably were Hell Gap from these and other localities. In general, Hell Gap points were the most numerous Paleoindian projectile point. (7) Five localities produced Alberta points (Fig. 1) from the Cox collec-

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tion in Lone Prairie, British Columbia; it is the western-most find of an Alberta point known to the author. (8) Three localities produced Pryor Stemmed points. Frison (1978) dates these ca. 8,500 yr B.P. Their characteristic lanceolate shape and lateral re-shaping is reminiscent of eastern Dalton and Hi-Lo projectile points. (9) Seven localities produced a number of Scottsbluff points. Three specimens were made from a black obsidian and one from a tan chalcedony; the other artifacts were mottled blue-grey, grey, or black chert. (10) Four localities produced collateral flaked lanceolate projectile points; some were similar to Cody Complex Eden material, while others remain un-typed.

Approximately 20% of the collection localities produced Paleoindian projectile points. In addition, unifacial end scrapers and large thin chert bifaces were abundant. Several of the unifacial end scrapers had graver spurs and several chert flakes with graver spurs were located. Fladmark (1983) recently dated a buried fluted point component in the same vicinity ca. 10,500 yr B.P. and the accumulating evidence suggests a substantial and continuous Paleoindian occupation throughout the southern "ice free corridor" since the initial fluted point - Plainview - occupations.

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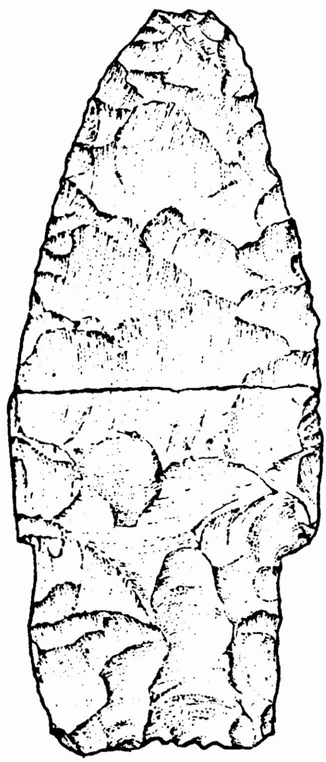

Fig. 1. Alberta Point from Lone Prairie, British Columbia.

The Donahue Locality: Evidence Suggesting a Pre-Wisconsin Human Presence in North America

RICHARD A. ROGERS

A stream terrace analysis has been done for the Arkansas River drainage in Kansas. The terraces were dated by associated diagnostic artifacts, fauna, and absolute dates. The Floodplain (Terrace Zero) and Terrace One were found to date to the Holocene. Terrace Two and Terrace Three were found to date respectively to the later and earlier Wisconsin. Terrace Four dates to the middle Pleistocene.

The North Cottonwood River has cut a vertical exposure into Terrace Four approximately 10.9 km north and 5.5 km west of Lehigh, Kansas in Marion County. The locality is the property of Mr. James Donahue of Durham, Kansas.

I discovered a fragment of a bifacial artifact (Fig. 1A) protruding from the vertical face of Terrace Four at this locality. No other artifacts or evidence of human activity were discovered in the exposure. The artifact was buried in alluvial sandy silt 90 cm below the surface of the sloping edge of the terrace and 7.3 m lower than the top of Terrace Four. There was no evidence of a rodent burrow, the existence of which would have been obvious if it had been present. Therefore, intrusion by this route is unlikely. Columnar structure, presumably the result of soil forming processes, were clearly visible in the vertical exposure. The artifact was clearly within a columnar structure, not between structures. This makes it unlikely that it could have fallen down a desiccation crack. The horizontal orientation of the long axis of the artifact was consistent with the artifact being buried in alluvium, and somewhat less consistent with the artifact dropping down a hole or crack (in which case there would be an increased probability of a more vertical orientation). The sandy silt unit showed no evidence of sloping, which would argue against colluvium having buried the artifact. The author is convinced that the artifact was *in situ* in the alluvial fill of Terrace Four.

Terrace Four at another location on the Arkansas River drainage yielded a lower third molar of a mammoth. The tooth's enamel plate thickness indicate a middle Pleistocene age (for details of the dating technique see Schultz, Tanner, and Martin 1972). At various localities in the Arkansas River drainage, Terrace Three (younger than Terrace Four) has yielded mammoth teeth suggesting an early Wisconsin age. A radiocarbon date greater than 39,900 yr B.P. (I-10,063) was obtained from shell from the basal gravels of Terrace Three at another location. These data are consistent with a pre-Wisconsin date for the terrace fill containing the artifact at the Donahue Locality.

The artifact appeared to the author to have been heated. A ther-

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moluminescence date yielded an apparent age for the artifact of 311,944 ± 24,994 yr B.P. The date was obtained from the laboratory of Dr. Ralph M. Rowlett of the Department of Anthropology, University of Missouri-Columbia. There are many problems with thermoluminescence dating of flint, including whether the flint had been heated, or heated sufficiently to clear the thermoluminescence potential acquired during its geological history prior to human association. The author considers this date to be only suggestive of considerable age. The thermoluminescence date is in general agreement with the expected geological date of Terrace Four.

Evidence for human occupation of a roughly similar antiquity was reported from Hueyatlaco in Mexico (Steen-McIntyre, Fryxell, and Malde 1981). Irwin-Williams (1981) has challenged the proposed antiquity of the Hueyatlaco site (for a reply see Malde and Steen-McIntyre 1981). The fragmentary biface from the Donahue Locality is similar to a biface recovered from Hueyatlaco (Fig. 1B).

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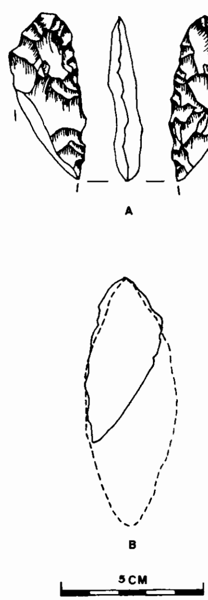

Fig. 1. The fragmentary biface from the Donahue Locality is illustrated (A), and an overlay of the Donahue Locality biface (solid line) on a biface (dashed line) from Hueyatlaco (B) is shown.

Paleoindian Research in Michigan: The Gainey and Leavitt Sites

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

In recent years, numerous Paleoindian sites have been discovered in Michigan. Detailed study of these sites will eventually improve our understanding of the cultural responses of foragers to colonizing opportunities and post-glacial habitats. Our research focuses on two sites: Gainey and Leavitt.

The Gainey site, typified by fluted points similar to those from the Bull Brook site (Byers 1954), was discovered in 1978. It is located on a nearly level area on the lee side of a major glacial moraine, overlooking a string of lakes and bogs to the south and rolling till plain to the north. The site is located in a cultivated field. Mapping of surface finds showed that Gainey is exceptionally large, covering nearly 2 ha, and consisting of at least six artifact clusters. Our strategy has been to excavate each of the oval clusters; by the end of the 1983 season, three of the clusters had been removed, and over 1,150 m^2 excavated in the process. Seven Paleoindian features have been found to date.

At least five cherts sources were utilized at Gainey, including, in order of frequency, Upper Mercer, Ten Mile Creek, Bayport, Onondaga, and Flint Ridge. None is known to occur locally and the major source, Upper Mercer, outcrops over 400 km to the southeast. The majority of the artifacts recovered are minute tool retouch flakes. However, over 500 tools or tool fragments have been found. This figure includes over 100 bifaces (including fluted points), and roughly 200 unifaces. However, only approximately 25 bifaces and 50 unifaces are large enough for detailed measurement. Nevertheless, analysis of the tools and tool fragments has enabled us to reconstruct the industrial sequence and to identify the major classes of tools employed. The entire sequence is simple and efficient, with most tools being used in some fashion at each step in their use-life until they reached exhaustion. Tool types include side scrapers, convergent end scrapers, parallel end scrapers, fluted points, and ovate bifaces; beaked tool, borers, and gravers were usually made on broken tools rather than directly from blanks.

Excavation will continue at Gainey in 1984. Meanwhile, the Leavitt site, typified by fluted points resembling those from the Barnes (Wright and Roosa 1966), Parkhill (Roosa and Deller 1982), and Fisher (Storck 1983) sites, will be excavated. It too is located in a cultivated field. Controlled surface collection has revealed at least two clusters at the site. One is badly eroded but the other, measuring approximately 900 m^2, is intact.

Based on geological events of known age, we currently believe that Gainey dates to approximately between 11,000-10,500 yr B.P., with Leavitt dating somewhat later. These inferences are consistent with the stylistic affinities the tool assemblages exhibit to other eastern Paleoindian sites. However, neither

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site has been chronologically assayed in a satisfactory manner. One Gainey charcoal sample was submitted for radiocarbon dating in 1979, but yielded an age of 2,830 ± 175 yr B.P. (DIC-1564). A number of other samples currently are undergoing study for botanical identification. Arrangements have been made with the University of Arizona's Laboratory of Isotope Geochemistry for the dating of some of these samples, and we intend to obtain dates for other samples from both sites as they become available. In addition, we are exploring the possibility of dating Gainey chert samples by thermoluminescence. Most artifacts there exhibit characteristics suggesting exposure to heat, and thus should be suitable for this method.

The relationship between Paleoindian settlement mobility and technological organization is one of our major research concerns. Analyses of fluted points from various Great Lakes sites have established a tentative Paleoindian chronological sequence for the region. Correlation of that sequence with paleoenvironmental trends enables us to postulate the character of successive Paleoindian habitats and the mobility patterns associated with them. Models relating settlement mobility to technological organization have been developed, and will be employed in comparing the assemblages from Gainey and Leavitt, as well as other sites.

These ongoing studies eventually will improve our understanding of the earliest human occupation of the Great Lakes region, and will shed light on forager adaptive practices and archaeological assemblage formation processes as well.

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Physical Anthropology

Human Skeleton Dating Project

MARCELLA H. SORG AND ROBSON BONNICHSEN

The Human Skeleton Dating Project was developed in 1982 to systematically date known New World human (*Homo sapiens*) skeletal remains of potential Pleistocene age using the new tandem particle accelerator radiocarbon dating method. Controversy surrounding the timing of human colonization of North and South America has revolved around problems of dating, especially of those sites yielding human skeletal remains. Dating these remains is perhaps the most direct way of documenting human presence in this hemisphere during the Pleistocene. However, many of the sites at which they were found were excavated before the advent of modern radiometric dating techniques. Availability of this new method of ^{14}C dating makes it possible to date very small pieces of bone, thus minimizing destruction of these important specimens.

Samples to be tested include four categories: (1) remains recovered recently and not yet dated, (2) remains recovered in the course of paleontological collecting and not reported in the anthropological literature, (3) remains discovered before the advent of radiocarbon dating, or (4) remains which were formerly discredited on purely morphological or other questionable grounds. In addition, contemporaneity testing using X-ray fluorescence and aspartic acid racemization is to be performed on bone specimens of extinct fauna associated with the human remains, when available.

Particle accelerator dating is to be done through the cooperation of Austin Long and Tom Stafford of the University of Arizona Laboratory of Isotope Geochemistry, with control samples tested at another reactor facility. X-ray fluorescence contemporaneity testing will be done through the cooperation of Tom Hess of the University of Maine-Orono Environmental Radiation Laboratory. Amino acid racemization will be done at the Biogeochemical Laboratory of the Carnegie Institution of Washington through the cooperation of Ed Hare. In addition, Larry Tyson (Augustana College, Sioux Falls) has offered to do C3/C4 testing if sufficient material is available after radiocarbon dating. Prior to any testing an independent evaluation of the species identification of the samples will be performed.

Remains currently in hand include samples from: Jaihuaico and Sacaba (Bolivia), Lake Chapala and Zacoalco (Mexico), Sumidouro (Brazil), Norfolk Gravel Pit and Columbus Gravel Pit (Nebraska), Lecanto Island, St. Mark's River, and Melbourne (Florida), Santa Rosa Island (California), and Clear Fork (Texas). A number of additional specimens are expected, and dating will commence in September of 1984.

The Human Skeleton Dating Project is part of a larger interdisciplinary effort by the Center for the Study of Early Man to review the human skeletal material from the New World in terms of its dating, morphology, and Quater-

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nary context. Dating of these remains involves the cooperation of many scientists and museum personnel who have agreed to participate. We especially wish to acknowledge the following who have already provided samples: Alan Bryan (University of Alberta), George Jefferson (Page Museum), Elizabeth S. Wing (Florida State Museum), S. David Webb (Florida State Museum), Douglas Ubelaker (Smithsonian Institution), Steve Holen (Nebraska State Historical Society), and George Corner (University of Nebraska State Museum). We also extend our thanks to many others who are helping to provide further material, and to Theodore Bradstreet and Earlene Hinton for assistance with project organization and implementation.

Stalker Site (Taber Child Site) Investigations, Alberta

MICHAEL CLAYTON WILSON

The "Taber Child" find has been a source of controversy since its discovery in 1961 in apparent Pleistocene deposits high on a bluff overlooking the Oldman River, in southern Alberta. The partial skeleton of a human infant was found in cemented sands by a Geological Survey of Canada team under the direction of Dr. A. Mac S. Stalker (Langston and Oschinsky 1963; Wormington and Forbis 1965; Stalker 1963, 1969, 1972, 1977). Assuming that the remains were *in situ* in the Pleistocene sands, there could be no doubt as to their considerable antiquity, because the sands are overlain by four tills apparently representing two major glacial events (Forbis *et al.* 1978).

This author was, for more than a decade, a strong proponent of "Taber Child" as a legitimate Pleistocene fossil; however, discussions with colleagues, in public and in private, indicated the extent of disagreement that existed on the basis of the few data readily available. Thus, it was concluded that a return to the site was in order. A proposal prepared by Dr. R.G. Forbis and the author was submitted to the Social Sciences and Humanities Research Council of Canada, and funding was received to support a summer's fieldwork. Supplementary funds received from the Archaeological Survey of Alberta allowed stripping of overburden from the site in late summer of 1978 (Forbis *et al.* 1978) and detailed, gridded excavations proceeded in 1979 (Wilson *et al.* in press).

The purpose of these excavations was to search for additional human or other vertebrate fossils, and to clarify the complicated stratigraphic sequence at the site. Excavations by trowel and shovel failed to reveal any additional bones in the Pleistocene sands, but did expose inset Holocene deposits on the slope face, including variably bedded, sorted to diamictic inset channel fills. These appear to be of mudflow origin, and they are of particular interest because they incorporate sediments from (and therefore locally resemble) the Pleistocene deposits into which they are channeled. Bones of bison (*Bison bison*) and jackrabbit (*Lepus townsendii*) were found in these deposits, and additional bones were found in the more widespread colluvial/aeolian deposits that blanketed much of the slope face.

Most significantly, these inset deposits were locally cemented by calcium carbonate, a characteristic formerly thought to apply only to the Pleistocene deposits. Thus, the cementation of matrix around the "Taber Child" specimen can no longer be cited as evidence for its great antiquity.

An attempt was also made to link the "Taber Child" specimen to the Pleistocene deposits through direct comparison of powdered bulk sediment samples by means of semi-quantitative X-ray diffractometry. The results of

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this analysis showed that the "Taber Child" matrix fell outside the cluster of samples from the Pleistocene sands, but close to various slope deposits.

On this basis it was reluctantly concluded that the "Taber Child" specimen was not of Pleistocene age, but that it instead came from Holocene channeled (?mudflow) deposits inset into the earlier sands (Wilson *et al.* in press). That this conclusion was reached in complete independence from the radiocarbon dating effort carried out by another research team must be emphasized here. Bone from the "Taber Child" specimen was decontaminated of preservatives and was radiocarbon dated by the accelerator technique at the Chalk River reactor, Ontario. A date of $3,550 \pm 500$ yr B.P. was calculated on the basis of the Libby half-life, for an estimate of $4,100 \pm 750$ calendar yr B.P. (Brown *et al.* in press). Protein content of the bone, studied by a team from the Canadian Conservation Institute, was also found to be consistent with a Holocene age (Moffatt and Wainwright in press). Because if was assumed (incorrectly) that the present author was receiving this information second-hand via a colleague, these teams did not contact the author directly, and thus he was unaware of their results until well after the same conclusion was reached on the basis of geological evidence. Indeed, the author was unaware that the other studies were even being contemplated. Thus the geological and geochronological studies stand as fully independent efforts, and their agreement strengthens the case for a Holocene age for "Taber Child".

The findings therefore force the author to abandon his crusade for acceptance of a Pleistocene age for the fossil. To attempt to "explain away" all of these findings would belie his commitment to the scientific method, however tempting it is to continue promoting the find as part of an unwavering hope that acceptable Pleistocene occurrences will be found. Rejection of a Pleistocene age for "Tabor Child" is in no way presented as a basis for rejection of the case for pre-Clovis occupation of mid-continental North America. Detailed arguments relating to all of the cited lines of evidence will be appearing in Volume 7, No. 2 of the *Canadian Journal of Archaeology* (for 1983).

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Lithic Studies

Distinctive Bifacial Artifacts from Wisconsin Terraces in Kansas

Richard A. Rogers

Artifacts were collected (mostly from the surface) of 101 prehistoric archaeological sites distributed on the lowest four alluvial terraces in the Arkansas River drainage in Kansas. The terraces were dated by associated diagnostic artifacts, fauna, and absolute dates. The Floodplain (Terrace Zero) and Terrace One date to the Holocene. Terrace Two dates to the late Wisconsin. Terrace Three dates to the early Wisconsin. Higher stream terraces are older land surfaces than lower stream terraces in the same valley. Artifacts that were used during the Wisconsin but not during the Holocene should be lacking from the Holocene terraces. This is the case for fluted projectile points that are not found lower than Terrace Two. Two types of distinctive large bifaces were found only on Terrace Two or higher. One type of a thick sub-triangular biface (Fig. 1A); the other was a thick asymmetrical biface (Fig. 1B).

The percentages of sites with thick sub-triangular bifaces were: Floodplain 0% (0 out of 21 sites), Terrace One 0% (0 out of 51 sites), Terrace Two 18% (2 out of 11 sites), and Terrace Three 28% (5 out of 18 sites). The percentages of sites with thick asymmetrical bifaces were: Floodplain 0% (0 out of 21 sites), Terrace One 0% (0 out of 51 sites), Terrace Two 18% (2 out of 11 sites), and Terrace Three 6% (1 out of 18 sites).

Assuming the sites with the artifact type in question were randomly distributed on the terraces, their frequency on each terrace should be comparable to the proportion of all sites on each terrace. The proportions derived from dividing the number of sites with either biface type on each terrace by the total number of sites with the corresponding biface type varied from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

The only artifact type found on the Holocene terraces that resembled thick sub-triangular bifaces was a celt which was relatively narrow and probably functioned as a gouge. No artifacts found on the Holocene terraces resembled the thick asymmetrical bifaces.

The presence of these distinctive bifacial forms on Wisconsin terraces and their absence on Holocene terraces suggest these are Paleoindian artifacts. Artifacts similar to the thick sub-triangular bifaces from this study have been recovered from the Timlin site in New York state. Raemsch and Vernon (1977) described these artifacts as "handaxes" and reported they were found *in situ* above and below glacial till. Renaud (1940) reported similar artifacts (described as "coup de poing-like") on high terraces in Wyoming. Renaud (1940) compared his finds to typologically similar artifacts from the lower Paleolithic of the Old World.

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The presence of thick sub-triangular bifaces and thick asymmetrical bifaces on Terrace Two, a late Wisconsin surface, indicates they were in use as recently as the late Wisconsin in this drainage. A thick sub-triangular biface was discovered deeply buried in a Terrace Three alluvial fill in a gravel pit by a local artifact collector, Mr. Rick Shroeder (pers. comm.). This suggests that sub-triangular bifaces may have been in use during the early Wisconsin.

None of the archaeological sites examined were quarry localities. This and the absence of thick sub-triangular bifaces on Holocene terraces is not consistent with an opinion held by Holmes (1897) that all New World artifacts similar to Old World Acheulean bifaces were blanks of recent antiquity, usually found at quarry localities.

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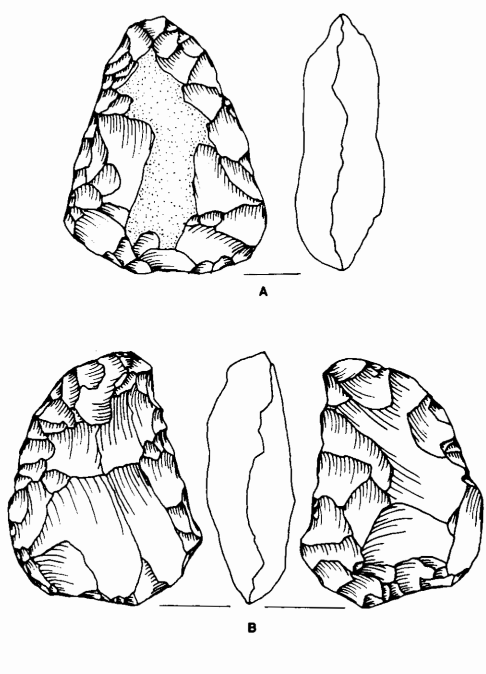

Fig. 1. An example is illustrated (A) of a thick sub-triangular biface, and (B) of a thick asymmetrical biface.

Paleoindian Movement on the Southern High Plains: A Re-evaluation of Inferences Based on the Lithic Evidence from Blackwater Draw

PHILLIP H. SHELLEY

Approximations of Paleoindian mobility on the Llano Estacado have been based on macroscopic identification of lithic materials found in archaeological contexts and assignment of nonlocal raw material types to assumed source areas (Wilmsen 1970; Jelinek 1971; Hester 1972, 1975). Recent examinations of lithic resource areas on and adjacent to the Southern High Plains have generated doubt concerning the accuracy of past assumptions of source area locations and areas traversed in paleo-migrations.

At Blackwater Draw two nonlocal raw material types accounted for over 60% of the Paleoindian sample. These raw materials were identified as Alibates chert (45.7%) and Edwards Plateau chert (18.5%) (Hester 1972). Hester and others have assumed that these material types were acquired from major bedrock deposits of physically similar (i.e., coloration, color pattern, and silica content) silicates, presumably east and northeast of the Blackwater Draw site (Hester 1972; Holliday and Welty 1981). Acceptance of these source localities has led to the conclusion that the major movement patterns during the Paleoindian occupation of the site was to and from the northeast (Alibates area) during Clovis times and in Folsom times "there was a shift in preference in stone types to Edwards chert. Persumably, this also records an associated shift in the territory hunted" (Hester 1972:178).

Silicates which are macroscopically identical to Alibates and Edwards Plateau cherts exist adjacent to the Llano much closer to the site then previously assumed (Fig. 1). If these alternative locations are considered as possible sources then they suggest movement or interaction 125 km to the northwest from the site for Alibates-like material and 144 km to the southwest for Edwards Plateau-like materials.

Alibates chert, "one of the widest known lithic resources in the central United States" (Tunnell 1978:7), has been described as "commonly containing large vugs with well formed quartz crystals. The distinctive coloration includes many shades of red, blue, purple, gray, maroon, and white, with spectacular examples of banding and speckling of various colors" (Tunnell 1978:7). Another locality for this material, near Yeso, New Mexico, has been previously reported by Green and Kelley (1960), although few archaeologists working in the area have considered this source area in reconstructing Paleoindian seasonal movement patterns. A re-investigation of this locality resulted in the location of substantial amounts of Alibates-like material in Salado Canyon, north of Yeso, New Mexico. This area shows heavy aboriginal exploitation as evidenced by extensive distribution of debitage.

Edwards Plateau chert has been described by Tunnell as "fine grained with excellent conchoidal flaking qualities, and ranges in color from pale gray and

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brown to medium gray and brown with various mottled shadings of these hues. Marine microfossils are relatively common and occasionally abundant" (Tunnell 1978:7). Macroscopically identical materials have been recovered by the author from primary deposits on the eastern flanks of the Sacramento Mountains, north of Roswell, New Mexico. At this locality the chert occurs as nodules in San Andres limestone. These nodules range from 5-35 cm in diameter and there is evidence of prehistoric chert exploitation of the area. No temporally diagnostic form tools were observed on the surface.

If one compares the distances from Blackwater Draw to these alternate locations for Edwards and Alibates materials it is obvious that they are upslope from, and substantially closer to the site than traditionally accepted source areas. If we entertain the possibility that these alternative locations were the source areas for the materials recovered from Blackwater Draw, it is possible to postulate that the movement or interaction pattern for Paleoindian occupation of the site was more transhumant than the extensive wanderings suggested by previous interpretations.

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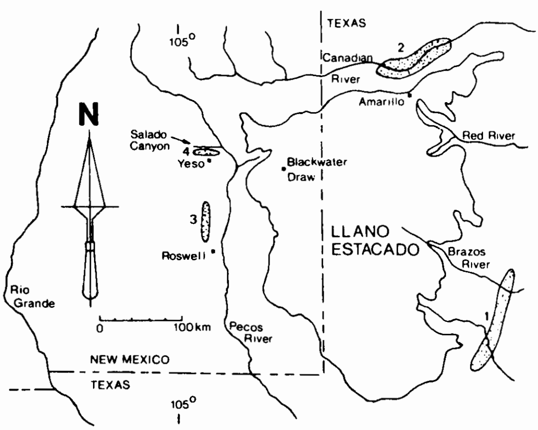

Fig. 1. Map locating the traditional and alternative lithic source areas on the Llano Estacado discussed in this report. Areas 1 and 2 are the traditionally recognized sources for Edwards Plateau chert (1) and for Alibates chert (2) (Hester 1972); areas 3 and 4 are alternative sources for Edwards Plateau-like materials (3) and Alibates-like chert (4).

Preliminary Results of Microwear Analysis on Experimental Quartz Tools

CAROLE SUSSMAN

Stone has been used by man for the past two million years as a means of efficiently exploiting surrounding resources for food, shelter, tools to make tools, etc. Remains of these stone tools and the waste products of their manufacture are often preserved in the archaeological record. Various interpretations have been offered based on associations, tool form, etc. but these have been largely speculative.

Studies of damage caused by use has long been considered a promising line of investigation. Semenov (1964) looked at striations left on the tool surface after use, and Tringham *et al.* (1974) analyzed the types of chips and breakages left along the edges. Using low (<100X) magnification, both lines of investigation provide information on relative hardness of the material worked but cannot tell us specifically on what material the stone tool was used.

Larry Keeley (1974) first recognized and described microwear on artifacts made of flint. Keeley (1974) found, when he examined flint at high (200X) magnification, that polishes could be detected along the tool edges after use and are distinctive and identifiable as to material worked and activity performed. This method is now being extensively applied to flints and cherts.

In many areas and many time ranges, artifacts are made on materials other than flints and cherts. Quartz is one very important material that comprises a major component of many Old and New World stone tool assemblages in many time periods. I chose to investigate the residues and abrasion left on quartz tools after purposeful use on various materials in the hopes that Keeley's (1974) method could be expanded to include other raw materials. This report is a brief summary of the initial results of experiments in progress for my dissertation.

All material is cleaned before examination (Keeley 1980) and is examined using a metallurgical microscope. Use of a scanning electron microscope (SEM) is in the initial stages. The magnifications used on the SEM are comparable (200X-400X) to those on the metallurgical microscope, although I also use a somewhat higher range (500X-800X) for comparisons and identification of surface textures. Only the results from the metallurgical microscope will be discussed here.

Over 200 experiments simulating those activities known or thought to have been performed in prehistory have definitely established that use wear is distinctly visible, microscopically, on the surface of quartz tools. Experimental activities were carried out, whenever possible, in natural settings and were goal oriented, e.g., efficiently carrying out a task rather than counting the number of strokes. Variables in the experiments include: duration of use (1, 5, 10, 20, and 60

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minute intervals); material worked; and actions performed (sawing, scraping, etc.). The term "polish" is used here to describe an alteration in the texture of the surface of the quartz; usually, but not necessarily, it appears as a smoothing and "bright" quality which is somehow different from the surrounding quartz surface. Whether a substance is being deposited onto the surface of the quartz itself or the smoothing comes about through friction, fusion, or abrasive removals has not yet been ascertained.

Preliminary Results

Cutting soft plants produced scalar and half moon scars along the worked edge. Pitting, striae, and rounding of the edge are all features associated with this activity. It was observed that the intensity of all these features seems to vary with the amount of silica present in the plant itself and its brittleness. It was interesting to note that the striations did not necessarily run parallel to the direction of use.

Sun-dried hide stretched over a log quickly produced polish when scraped. Distinguishing features are: severe edge damage on the side not in direct contact with the hide, slight rounding of the worked edge, and a roughened "corroded" aspect restricted to the edge in contact with the hide. Pitting tends to follow the direction of use, running perpendicular to the edge. No striae were noted.

Sawing several types of wood produced edge damage in the form of half moon and scalar scars, roughened areas near the edge, pitting, and striae. The hardness of the wood determined the amount of edge damage present, with harder wood such as oak producing more scarring. Pitting developed more quickly on the hardwood with a bright polish developing more slowly. Softer wood such as pine causes rapid polish development, with striae running parallel to the cutting edge.

Sawing dry antler produced abrasion with rough areas, pitting and narrow striae. Step and scalar scarring were present on the edge. Graving soaked antler caused broad, shallow striae running parallel to the direction of use with pitting and rough areas present intermittently down the edge. Fresh bone graving produced long, narrow striae accompanied by rounding of the worked edge and what appears to be comet-tailed pits, visible in the rough, low lying areas. This polish appears as if it were deposited on the edge, however further work is needed to confirm this. Sawing fresh bone left scalar scars and striae running parallel to the edge. Polish develops slowly but becomes concentrated after long periods of use.

Conclusions

To summarize briefly, it has been demonstrated that use wear polishes are detectable on the surfaces of experimental quartz tools after purposeful use. Polish is best detected after use on such materials as dry hide, antler, bone, soft wood, and various soft plants. For some of these materials (soaked antler, for example) evidence of use was visible after one minute. What now remains is to determine if textural differences can be distinguished among the materials which produce clear evidence of use wear on quartz.

The "fine-tuning" of this technique will provide the higher degree of resolution and distinction between mode of use and material worked that is necessary to identify specific activities in the archaeological record.

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Methods

Database Management of Archaeological Radiocarbon Measurements

R. Esmée Webb

A database of radiocarbon age determinations directly relating to archaeological sites with Old World cultural material of Palaeolithic and Mesolithic age (>50,000-6,000 yr B.P.) set up at the Institute of Archaeology, University of London, is now being applied to New World data. This is hosted on a Z80A 4MHz microcomputer with a 20Mbyte hard disk and a single 8 inch double-density double-sided floppy disk drive. The Z80A uses a CP/m 2.2 operating system but is also capable of reading and writing to non CP/m formatted disks, such as DEC. Thus both the data and the programs could be transferred to other systems. A copy of the datafile is also maintained at the University of Cambridge, on a different microcomputer system running dBASE II.

The datafile is managed using a commercial database package designed to run on microcomputers. This incorporates: a data definition language, a data manipulation language hosted on the above system in Pascal/Z, a query/report system, and database recovery and restructuring programs. The Z80A is also capable of driving both a printer and a graph plotter. Programs are available to produce automatic illustrations of specified radiocarbon dates drawn as one standard deviation bars against a linear timescale. Full details of the database system are given in Moffett and Webb (1983). Various illustrations of its uses and applications to research problems in Old World cultural chronology are given in Moffett, Orton, and Webb (in press).

The datafile is as comprehensive as possible but I would be pleased to be informed of corrections and additions wherever possible. The sources which have been searched comprise *Science* and *Nature* in which the earliest age determinations were published prior to the creation of *Radiocarbon* which is now the main source of information. The general archaeological and scientific literature has not been searched, but where possible other published lists have been consulted. For example: Beaumont and Vogel (1972); Camps, Delibrias, and Thommeret (1973); Delibrias, Guillier, Evin, and Thommeret (1976); Delibrias and Evin (1974, 1980); Gabori-Csank (1970); Schvoerer, Bordier, Evin, and Delibrias (1979). Where it has proved possible to check this information it has sometimes proved inaccurate or insufficient.

The database functions as a keyword index giving access to the original full publication details. Radiocarbon age determinations are particularly suited to this type of analysis since the necessary information can be broken down easily into keyword fields and selectively retrieved to answer specific research problems. Retrieval is permitted of all or part of the datafile by one or any combination of the keyword fields. These are: the site name (abbreviated if necessary), the excavator's designation of the site layer, the excavator's designa-

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tion of the assumed cultural attribution, an assessment from the information given of the quality of association between the sample dated and the cultural material being dated, the laboratory's description of the actual nature of the sample material, an assessment (adapted from Waterbolk [1971]) of how far the time of death of the sample was contemporaneous with the event being dated, the age and standard deviation in years before present, the stable isotope ratio if given, the laboratory identifier and sample number, and the publication reference.

As originally set up, the database was intended to answer Old World Palaeolithic problems. However, as my research interests have developed, the database has been expanded. It now includes, as a matter of course on each annual up-date, information on sites within the 50,000-6,000 yr B.P. time bracket from both Australasia and the Americas, but these subsections are far from complete. I am, therefore, interested in contacting anyone currently compiling similar datafiles on radiocarbon or other radiometric measurements (TL, U/Th, etc.) for prehistoric sites in the New World, with a view to exchanging all data not limited by copyright restrictions. Such databases are very useful research tools and should be as widely available as possible. In Europe we are beginning to organize an informal data exchange system which it is hoped to set on a more formal footing at the next U.I.S.P.P. congress. I would hope to extend such an exchange across the Atlantic.

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Taphonomy-Bone Modification

An Introduction to the Identification of Trample Marks

ANTHONY R. FIORILLO

A survey of bone conditions is a vital part of any taphonomic analysis. In the past, it has been suggested that some of the marks found on bones are indications of human activity. One such type of mark, shallow scratch marks, has often been referred to as cutmarks (e.g., Bunn 1981; Potts and Shipman 1981). The result of a recent taphonomic investigation (Fiorillo n.d.) of a Barstovian (Miocene) mammal locality questions this as a general means of interpretation.

The study of Hazard Homestead Quarry in Hitchcock County (southwestern) Nebraska (Fiorillo n.d.) uncovered hundreds of bone specimens from a poorly sorted, sandy matrix. After completion of the excavation, a randomly chosen sample of 210 bones and bone fragments were closely examined, noting any features which showed modification of the bone (e.g., tooth marks, weathering cracks). This examination revealed that 38% of the bone sample had shallow, sub-parallel sets of scratch marks on their surfaces (Fig. 1). The morphology of these fine marks was such that they cannot be readily confused with rodent gnaw marks which occur as paired, flat-bottomed grooves, or with carnivore tooth marks which are much broader and U-shaped in cross section. This new mark resembled marks commonly referred to as cutmarks in younger sites, which are equated with human activity. The fact that this site formed long before any humans are hypothesized to have been in existence in North America clearly indicates that this new scratch mark could not be the result of human activity. Another possible origin considered then, for these marks is trampling by the Barstovian age mammals.

To test this idea, a sample of 90 recent bones of cattle (*Bos taurus*) and a domestic pig (*Sus scrofa*) were laid out around a cattle salt lick, an area previously observed to be the site of much activity by a small herd of cattle. The substrate on which the bones were laid was hard, sandy, and dry. Before the experiment began, all of the bones were examined for any diagnostic taphonomic features. The only features present were weathering cracks and carnivore tooth marks. The experiment ran for approximately five weeks and at its conclusion, all the bones were collected and examined again. These results showed that 49% of the bones had shallow, sub-parallel scratch marks nearly identical to those found on the fossil bones.

This study then, has shown that the sets of scratches which appeared on many of the fossil bones at Hazard Homestead Quarry, were reproducable with modern bones subjected to trampling by large, hooved mammals on a sandy substrate. Hence, these marks, when found on bones at other sites, cannot be used by themselves to argue for the occurrence of human activity without first recognizing the potential of dealing with a trampled bone assemblage.

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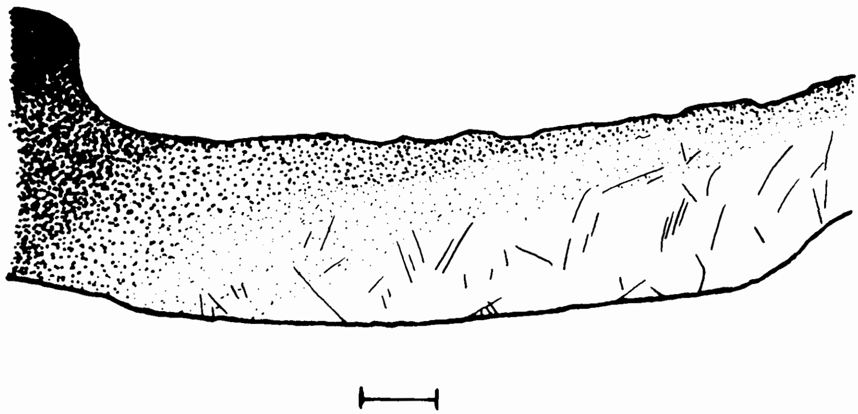

Fig. 1. Diagrammatic reproduction of "camelid" rib (University of Nebraska State Museum 91091) from Hazard Homestead Quarry, showing fine, sub-parallel scratch marks. Scale bar represents 1 cm.

Taphonomic Perspectives on Late Pleistocene Extinctions: Fieldwork Projects

GARY HAYNES

There is no unequivocal causal link between the abrupt appearance and Clovis culture in the New World and the (seemingly) abrupt disappearance of megafaunal taxa at the end of the Pleistocene. My recent fieldwork (1978-1984) is part of the Paleo-Indian Program at the Smithsonian Institution, Department of Anthropology, and seeks to gain more information about these extinctions. The primary questions addressed by the studies are as follows. (1) How fine a time resolution can be deciphered from direct examination of bone assemblages? Radiocarbon determinations are too coarse-grained to resolve time differences of less than, say, 100 years. Much more sensitive indicators are being analyzed. These indicators will also provide evidence on whether terminal Pleistocene bone accumulations were formed episodically or incrementally. (2) How severe need climatic changes be for bones to record or reflect them in some way? Even yearly trends in environmental stress on herbivores are visible in modern bone assemblages, mainly seen in the ways that carcasses are utilized by carnivores. Thus, there ought to be clearly visible 5-yearly, decade-long, and century trends in fossil accumulations.

Secondary questions involve methods for determining whether or not some late Pleistocene fossils were modified by humans. Especially of interest are specimens in pre-Clovis collections. This question is addressed by seeking non-cultural agencies that can or do create bone modifications identical to human-created modifications.

Methods of study include recording and documenting modern processes such as climatic changes, then explaining how these processes affect bones, by: (1) observing the end-effects of predation and feeding behavior (done by monitoring large predators by means of controlled radio-telemetric studies); (2) observing trampling, wallowing, and other animal behaviors in the wild, where bones are present; (3) recording bone assemblages that were affected by unobserved but inferable agencies in the wild; (4) returning to bone deposits over extended periods of time (decades) to monitor their "life" histories and weathering rates in subarctic, temperate, subtropical, and subarid microenvironments; and (5) replicating butchering of large herbivores (elephants and bison) with and without stone tools.

Study areas are wilderness preserves in northern North America and southern Africa. Research on feeding behaviors has also been carried out in three zoological parks, involving hours of observations of rodents, primates, ungulates, and carnivores that were fed fresh bones or body parts of large herbivores. In North America, 180 carcasses or skeletons of large mammals have been examined in the wild over at least two different years between 1972-1984

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(exclusive of domestic livestock or animals dying at the hand of man), while 75 carcasses or skeletons of culled animals have been examined. In Africa, the remains of 891 large mammals have been examined, including 556 elephants.

Another important variable under study is the age distribution of large herbivores in cultural and non-cultural assemblages, and in catastrophic and non-catastrophic assemblages (both cultural and non-cultural).

An ambitious comparative study of modern and fossil collections is underway, and involves fossils from three levels of the Selby and Dutton sites, the Jones-Miller site collections, Lamb Spring collections, Pleistocene collections from Alaska (at the University of Alaska, the American Museum of Natural History, and the Smithsonian Institution), and Plio-Pleistocene collections from numerous locales in the central and western United States.

The scope of results to date involves: (1) comparative study of the demography of proboscidean bone accumulations; (2) documentation of bone modifications in the wild, including limb bone fracturing (expectable types and percentages), presence of "impact notches" on naturally fractured bones, flaking of ivory, scratching and cutting of bone surfaces, rounding of fracture edges, and similar variables; and (3) detailed records of variables in modern bone assemblages that will be applied as guidelines or analogues in the study of Pleistocene extinctions. For an example of the latter, (a) the live-to-dead ratios (skeletons to live animals) that exist under different environmental conditions in the wild; (b) diagnostic biasing of the bone record due to specifiable death processes such as predation, die-offs, and catastrophes; and (c) diagnostic modifications in bone assemblages that indicate causes of individual animals' death, and the degree of carcass utilization - these indicators are sensitive, fine-grained reflectors of climatic stress.

It is my opinion, after well over a decade of research on the topics described here, that: (1) the more non-cultural bone assemblages you see, the more natural modifications you will see that look like the so-called cultural modifications; (2) the larger the accumulations you find in the wild, single locales, the more kinds of natural modifications that look cultural will be found together; and (3) the longer you do this kind of in-depth field surveying, the more probable it seems that most so-called cultural modifications to fossil bones are in fact nothing more than the end-effects of very non-cultural processes that may be either rare or commonplace.

Taphonomic Research on Rye Patch Reservoir Faunal Remains

MARCELLA H. SORG AND ROBSON BONNICHSEN

The Rye Patch Reservoir site PPe23, located in Pershing County, western Nevada, is being re-analyzed in terms of its taphonomy and possible relation to human activity. Green and Rusco (1978), Rusco, Davis, and Firby (1979), and Rusco and Davis (1981) have previously reported on the geological and paleontological dimensions of this ancient spring mound complex. The site has produced a Rancholabrean age fauna dominated by camel (*Camelops* sp.), and including mammoth (*Mammuthus* sp.), horse (*Equus* sp.), and bison (*Bison* cf. *antiquus*). Paleontological analysis is still being conducted by James Firby and John Mawby.

The fossiliferous spring throat deposits are sandwiched between the Wyemeha Formation and the Sehoo Formation. Lacustrine deposits of ancient Lake Lahontan form the Sehoo Formation which commenced about 20,000 years ago. Radiometric dating of the bone apatite portion of teeth and bones yielded dates ranging from 23,920 ± 730 yr B.P. (Tx-3006) to 28,071 ± 100 yr B.P. (Tx-2928). Although bone apatite is considered unstable and poorly suited for dating, these dates do suggest some antiquity for the site.

Two factors suggest human association with the extinct fauna. A chert scraper, unifacially flaked, was found out of context. Secondly, evaluation of the large mammal long bone fragments suggests many were broken while green; several possess impact scars or long flake scars in association with spiral fractures. Although neither factor can be definitively associated with Pleistocene human activity, both suggest that humans cannot be ruled out as an agent of bone modification (Bonnichsen *et al.* 1983), possibly having struck the bones during the process of marrow extraction.

The bones from PPe23 are being subjected to extensive morphological and taphonomic analysis, in cooperation with James Firby (McKay School of Mines, University of Nevada), Jonnathan Davis (Desert Research Institute), and Mary Rusco and Donald Tuohy (both, Nevada State Museum). Morphological features resulting from specific taphonomic processes have been examined macroscopically and described; a subset of these will be subjected to analysis by scanning electron microscope.

A taphonomic approach has been developed to consider two fundamental questions: (1) how did the faunal assemblage accumulate, and (2) how were the bones modified during their taphonomic history? Taphonomic analysis in progress consists of documenting the co-occurrence of specific processes on individual specimens, including: permineralization, organic degradation, root etching, green bone fracture with and without impact scars, pitting by spring water and turbulent sand action, rounding by lake wave erosion, and split-

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line cracking. Sequencing of the processes has been inferred by overlapping morphological patterns. Keys for discriminating particular agencies (such as humans) have been developed based on the site's specific taphonomic history.

Analysis of the Rye Patch Pleistocene megafauna to data has revealed a complex taphonomic history. The occurrence of carnivore modification, root etching, and green bone breaks with impact marks and flake scars suggests the bones did not accumulate in a quicksand bog entrapment as originally hypothesized. Rather, at least part of the assemblage was subjected to taphonomic alteration prior to inclusion in the spring throats. Because excavations focused on the recovery of paleontological specimens from the spring throats, land surfaces adjacent to them on which humans may have resided have yet to be investigated. Because the taphonomic evidence presented to document human presence here is still quite suggestive, additional excavation outside of the spring complex area is being proposed in order to explore the possible occurrence of a late Pleistocene archaeological site.

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The Crappie Hole Site: A Concentration of Spirally-Fractured Rancholabrean Mammal Bones in Western Nebraska

M.R. Voorhies and R.G. Corner

Disarticulated skeletal elements of late Pleistocene vertebrates, mostly large ungulates, occur in a lens of laminated sandy silt exposed along the southern shoreline of Lake McConaughy, a reservoir on the North Platte River in Keith County, western Nebraska. The site, designated Kh-104 in the University of Nebraska State Museum (UNSM) locality catalog, is at the center of sec. 22, T15N, R40W, 16.5 m above the former river level and 135 m below the level of the loess-mantled tableland forming the divide between the North and South Platte rivers. The elevation is between 975 and 978 m above sea level, about 2 m below normal reservoir level. The fossiliferous unit is bounded laterally by Ogallala (Miocene) bedrock; its thickness has not yet been determined.

The mammalian assemblage from the site, obtained by excavation and surface collection, is herein named the Crappie Hole Local Fauna; it consists of the following taxa: black bear (*Ursus americanus*), mammoth (*Mammuthus* cf. *M. jeffersoni*), ground squirrel (*Spermophilus richardsoni*), horse (*Equus* sp.), camel (*Camelops hesternus*), deer (*Odocoileus* sp.), large cervid (*Sangamona*), and large extinct bison (*Bison* cf. *B. antiquus*). All but the small deer are extinct or locally extirpated and clearly indicate a late Pleistocene (Rancholabrean) age for the site. No radiocarbon date is yet available. No stone artifacts have been excavated from the site although local amateur collectors have found fluted points nearby.

Taxonomically, the fossils are of no more than routine interest; from a taphonomic standpoint, however, they are noteworthy in exhibiting a high frequency of green-bone (spiral) fractures and other modifications often observed on bones from known or putative archaeological sites (e.g., Casper [Frison 1974]; Selby-Dutton [Stanford 1979]; Old Crow [Bonnichsen 1979; Morlan and Cinq-Mars 1982]). Eighteen of 22 identifiable long bones of large ungulates show spiral fractures as defined by Haynes (1983). Other damage clearly inflicted when the bones were still fresh includes examples of depressed fractures (Fig. 1A) and conchoidal flake scars (Fig. 1B). Remains of the largest mammals present (mammoths) exhibit well-developed curvilinear fractures, strong evidence that destructive forces of considerable energy were applied to them soon after death. Clearcut examples of carnivore tooth marks are rare but scalloped edges similar to those of wolf-gnawed bones (Haynes 1983; Binford 1981) are present on some bones.

It is not clear whether the observed breakage is cultural or natural or both. Post-fracturing weathering of many specimens has obscured potentially infor-

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mative surface detail and the available sample is still small. Compared with geologically older bone assemblages in the UNSM paleontological collections reported earlier (Myers *et al.* 1980), however, the Kh-104 elements appear to have a very high frequency of fresh-bone modification. Were humans involved? Experimental work by such workers as Bonnichsen, Morlan, and Stanford has elucidated patterns of artificial bone breakage while the bone-altering repertoire of carnivores, especially timber wolves, has been likewise intensively investigated by Haynes and Binford. The capabilities of such massive-jawed extinct predators as the giant short-faced bear (*Arctodus*) and the dire wolf (*Canis dirus*) are still virtually unknown, however, so it seems premature to eliminate them as possible breakers and flakers of megafaunal remains.

Continued excavations of the site is planned; unfortunately this is possible only when reservoir levels are low and high water for the last three years has precluded further work.

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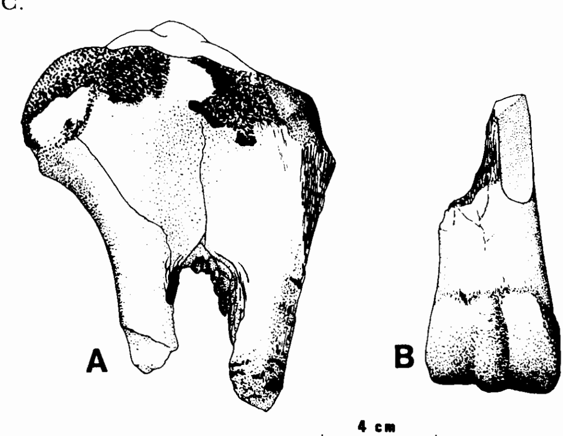

Fig. 1. Pleistocene mammal bones from Crappie Hole site showing fresh-bone breakage. A. Bison (cf. *B. antiquus*) proximal tibia (UNSM 91500) with circular depressed fracture. B. Camel (*Camelops hesternus*) distal metapodial (UNSM 91502) with long curved flake of cortical bone removed.

Paleoenvironments: Plants

Late Wisconsin Biotic Zones in the Interior of Western United States and Adjacent Regions

ARTHUR H. HARRIS

In the interior western United States, there now exists north-south and low elevation-high elevation biotic zonation. Hypotheses regarding how late Wisconsin zonation differed compared to that of today include a simple shift downward and southward of present zones, with internal compositional and elevational relationships similar to the present; reduction of the vertical range of higher-elevational zones more than of lower-elevational zones, the latter being displaced minimally; formation of new, different zones by simple overlap of present-type zones; and formation of new zones by independent, non-correlated adjustments of individual members of present-day zones.

An attempt has been made to select from among these hypotheses on the basis of evidence from vertebrate and macrovegetational (mostly wood rat midden) fossil evidence. Data on some 65 sites from the literature and personal investigations formed the main data base, though data from more than 200 other sites played a subsidiary role.

The interplay between latitude and elevation makes direct comparison of sites difficult. Thus site elevations were reduced to hypothetical elevations above sea level at the equator by using a lapse rate of 107 m per degree of latitude: a site was assigned an elevation in "meters equator equivalent" (m ee) by multiplying the site latitude (nearest 30') by 107 and then adding its present elevation above sea level in meters. Wisconsin fluctuations of sea levels and the possibility of different Wisconsin lapse rates are uncorrected weaknesses in the method as used here.

Following such site standardization, the Wisconsin vegetation of each site was reconstructed by using plant macrofossil data and, particularly, the presence or absence of stenotopic mammals and birds. Subsidiary data from other sources also were considered.

The results suggest that the elevational and latitudinal ranges of taxa making up present-day biotic zones overlapped more broadly during late Wisconsin times, and that this overlap was due to the upper range limits having been only moderately less than today's while the lower limits were dramatically lower. The resulting pattern was an upper biotic zone (descending to about 6,050 m ee) consisting of an intermixture of taxa that today are most typical of tundra, boreal forest, sagebrush, and grassland habitats; below this, extending down to about 5,000 m ee, was a zone that differed by lacking tundra-like elements and, in the lower half, by presence of woodland elements; then a sagebrush-steppe woodland to about 4,550 m ee; a steppe-woodland zone (lower boundary about 4,375 or, likely lower); and, at lowest available elevations, possibly grassland without woodland elements. Although these stadial biotic

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zones may be pictured broadly as overlapped present-day zones, the data support the zonation as being the result of taxa reacting individualistically to environmental parameters.

The causes for the greater overlap of taxa in the late Wisconsin likely included a more equitable temperature regime (winters averaging colder, but without the extreme lows of the present; cool summers lacking the maxima of today), greater slope temperature contrasts (average air temperatures were lower than today at any given latitude, but insolation values on southerly slopes would have approximated those of today); and effective moisture levels at any given elevation exceeding minimal requirement of more taxa.

The increased vegetational complexity generated by the overlaps, along with direct climatic effects, allowed sympatry or near-sympatry of taxa now distantly allopatric as well as a distinctly different pattern of species abundance. Today, the number of species of vertebrates tend to drop significantly with increasing elevation (and with increasing latitude). The situation in Colorado today is typical: from Upper Sonoran to Alpine zones, the number of mammalian taxa is approximately 97, 63, 53, and 17; for the interior United States and adjacent portions of Canada and Mexico in the late Wisconsin (mammals plus four birds), the number of taxa recorded from lowest to highest zone was about 38, 40, 111, 101, and 96 (or assuming presence in all zones between lowest occurrence and highest occurrence 38, 55, 119, 112, and 96). Although site-related biases are present, the trend seems clearly different from that of the present.

The zonation delineated by this study is a first rough approximation - essentially a hypothesis to be tested and certainly requiring major refinement by future studies.

Paleoenvironments: Vertebrates

Mammoth, Wolf, and Bear from the Hot Springs Mammoth Site, South Dakota

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Excavation at the Hot Springs Mammoth site began as a salvage operation in 1974 after accidental discovery of the site by construction equipment. Field excavations were conducted during the summers of 1974-1979. At that time, a self-imposed moratorium on further excavation was initiated in hopes a permanent structure could house the locality, leaving excavated faunal remains *in situ* for public display. A step toward that goal was the establishment of the site as a registered National Natural Landmark in 1980. An additional field season was undertaken in 1983, followed by a new self-imposed moratium until a structure is constructed over the remains.

The Hot Springs site is a unique hydrological-geological trap that appeared to be nearly a mammoth selective thanatocoenosis. The 1983 field season provided the first fossil record of the giant short-faced bear (*Arctodus simus*) for the north-central Plains states. It also provided the first fossil record for the timber wolf (*Canis lupus*) in addition to raising the known number of individual mammoths (*Mammuthus*) to 34, based on tusk count.

Excavations to date have disturbed less than 15% of the total site - an elliptical sinkhole deposit of approximately 50 m in major diameter. Test drilling has shown the Pleistocene fill to extend 12.0 to more than 19.5 m below the machine surface.

Sedimentological data (Laury 1978) substantiates a model proposed in 1974, i.e., the sinkhole was occupied by a pond, fed by a thermal artesian spring. The deposit is characterized by laminated silty-clays and silty-sands, with a high energy environment near the spring conduit and a low energy environment on the opposite edge of the pond.

The unique trap mechanism and accompanying sedimentation/preservation provides the largest primary accumulation of mammoth remains in the New World. The faunal material deposited in the trap did not undergo mechanical transport giving us a unique taphonomic accumulation, acted on only by processes that operated within the sinkhole. As a result, faunal elements not usually recovered from paleontological sites are relatively abundant and often unbroken within the Hot Springs deposit - mammoth hyoids are but one example.

Chronologically, the site predates human activity in the region at 26,075 + 975, -790 yr B.P. (Gx-5895-A). It also provides examples of greenbone breakage (spiral fractures) of mammoth bone, in a prehuman context.

Pollen recovered from the 1983 excavations reflects aquatic plants of the spring and pond environment, but also reflects short and tall grass communities, as well as woody plants suggestive of a steppe-tundra or tundra environment at or near the present city of Hot Springs.

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The site provides the first Quaternary fossil vertebrate locality within the Black Hills physiographic province. It has produced and will continue to produce an outstanding sample of a local, late Pleistocene, mammoth population - allowing metric analysis of post cranial elements, age structure analysis, etc. of a large specimen population. It is producing first occurrences of late Pleistocene megafauna and microfauna for the region. The microfauna tied to the pollen analyses will provide insight into the local paleoenvironment at 26,000 yr B.P.

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Mammoth Excavations at the Duewall-Newberry Site on the Brazos River in Texas, 1983

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Excavations were conducted from July through September 1983 at the Duewall-Newberry site on the Brazos River in Brazos County, Texas. The site consists of the remains of a single mammoth (*Mammuthus columbi*). Preliminary analysis of the material and the geological deposits indicates that the animal is resting on a coarse silt point bar deposit. The point bar deposit is overlain by approximately 7.5 m of red clayey silt alluvium. Coarse gravel deposits, believed to represent terminal late Wisconsin glacial outwash, lie 1.5 to 2.0 m below the animal. Based on these observations, the age of the site would appear to be in the range of 12,000 to 10,000 yr B.P.

Excavation of 21 m^2 of the site resulted in the recovery of the dentition and tusks of a single individual, along with the scapulae, humeri, one radius, one femur fragment, one tibia, six ribs, 13 vertebrae, and one calcaneus. Additional material may extend to the east and south of the initial excavation area (Fig. 1). The silty sediments surrounding the bone were water-screened through quarter-inch hardware cloth, but no stone tools or lithic debitage were recovered. As the site plan indicates, the bones are not articulated. Some bones, such as the femur fragment, have been moved a meter or more from their correct anatomical position. Additionally, three bones, the shafts of the humeri and the one recovered femur, exhibit green bone spiral fractures.

Several aspects of the site make it an important find. Dating of the bone will not only provide a date for the site, but will also provide a basal date for some of the most recent alluvial deposits within the Brazos River valley. Secondly, the recovery of the teeth and long bones from a single individual will provide additional data on mammoth growth and maturation rates. The remnant fragments of the second molars are still in place along with the completely erupted third molars. The epiphyses of the proximal end of the femur and the humeri have not fused and several of the epiphyseal rings of the vertebrae are unfused. Both of these growth processes suggest that the animal was near skeletal maturity (about 30-40 years).

The most important aspect of the site is that the bones show evidence of human modification. Several of the ribs exhibit a series of short, parallel cutlines. The femur has been partially reconstructed by fitting three shaft fragments to the proximal epiphysis. The reconstructed bone shows evidence of two impact points, each surrounded by a series of concentric fracture rings. The nature of these impact points and the fact that the cortex of the femur is two cm thick at this point indicates that at least two massive blows were required to break the bone. In addition, the concentration of bone around and beneath the tusks suggests the possibility of stacking. The absence of gravel or boulders in the

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deposits and the low stream velocity indicated by the coarse silt point bar deposits indicates that dispersal or breakage by water transport is not a plausible explanation for the observed breakage. The very limited evidence of gnawing, which is located only on the articular ends of the bones, and the fact that only the thick cortical shafts rather than the thinner articular ends are broken, suggests that non-human predators are not the probable cause of the bone reduction.

The material is currently being cleaned, examined, and preserved at Texas A & M University under a grant from the Witte Museum in San Antonio, Texas who also provided funding for the excavations. Additional funding is being sought to expand the excavations to the east and south in 1984.

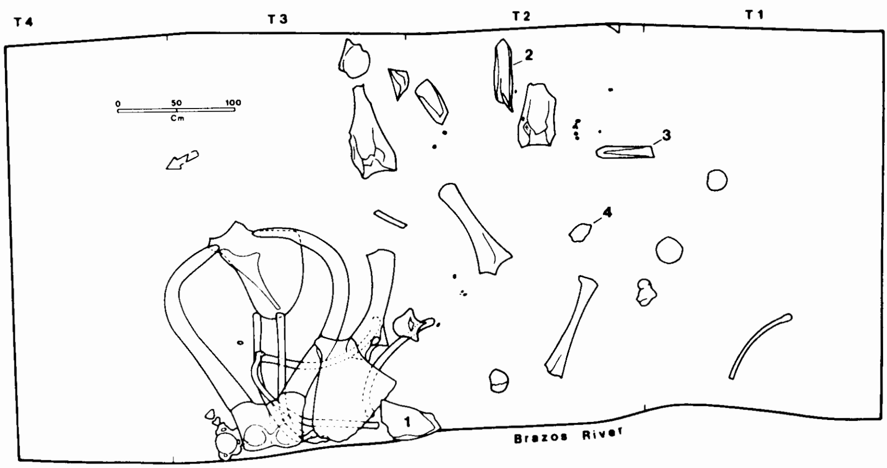

Fig. 1. Site plan showing the distribution of the mammoth at the Duewall-Newberry site. Bone number 1 is a proximal fragment of a femur. Bones numbered 2-4 are fragments which fit the femur and exhibit evidence of two impacts.

Preliminary Report on the Quaternary Vertebrate Fossils from Crystal Ball Cave, Millard County, Utah

TIMOTHY H. HEATON

Crystal Ball Cave is a 150 m long semi-commercialized cave located one km east of the Utah-Nevada border near the town of Gandy, Utah. A large assemblage of vertebrate fossils was found (preserved in fine dry dust) about 50 m inside the cave. About 50 specimens were collected as float by Herbert Gerisch, Robert Patterson, and Michael Stokes in 1956, shortly after the cave was discovered. These specimens were given to the Los Angeles County Museum and are included in this study. Dr. Wade E. Miller (Brigham Young University) collected thousands of specimens in 1977 by screening the cave sediments (Miller 1982).

My fieldwork, which included additional screening, is completed, and specimens are being identified to produce an updated faunal list. The completed study will include a comparison of the assemblage to other nearby fossil localities, especially that found in Smith Creek Canyon, 14 km south of Crystal Ball Cave (Miller 1979; Mead, Thompson, and Van Devender 1982). The mountain in which the cave is located was a small island in Lake Bonneville when the lake was at its highest level. How the lake's presence and recession affected life near the cave will be considered.

Description of the Assemblage

The Crystal Ball Cave assemblage consists predominately of mammals, but also includes birds, reptiles, fish, gastropods, and plants. Because the fossils were found in a layer of shallow unstratified dust, no relative dating could be done. The presence of extinct and extirpated species show the antiquity of the assemblage; however, specimens representing the present-day local community were also found.

There was little articulation of bones or evidence that much of any one individual was represented, especially for the larger species. There is a maximum length of about 10 cm for bones found in the assemblage. For these reasons, and because the original cave entrance was less than one m in diameter, it is my belief that the bones of larger species were brought in by cave-dwelling wood rats after the carcasses deteriorated. This would explain why isolated bones, small enough for a wood rat to carry, are the only representatives of the larger species. Smaller species could have lived in the cave and died there or could have been carried in by small carnivores to be eaten. There were no human artifacts found in the cave, and there was no evidence that the cave was known to humans prior to 1956.

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Methods

Fieldwork consisted of carefully excavating through the cave sediments for large fossils, then screening the sediments for smaller remains. Large amounts of cave sediment were taken to the lab where a one mm mesh sieve was used for wet screening to recover small bones and teeth.

Because of the great abundance of small mammal fossils recovered, only skulls and jaws of these smaller species are being examined in this study. For the larger mammals, all available material is being used in the study because they are not as well represented as the smaller taxa. Identification is being made by comparison to specimens housed at Brigham Young University and elsewhere, and by extensive use of the literature. Radiocarbon dates will be run on several extinct taxa to determine the minimum age of the assemblage.

Material Recovered

The Crystal Ball Cave assemblage is very large, which has allowed the recovery of species that are usually rarely found in other such assemblages because of their low frequency. Thirty-three soricid jaws were recovered, one of which is assignable to the shrew (*Sorex*), along with 32 chiropteran jaws (three assignable to the evening bat [*Myotis*], six to the pallid bat [*Antrozous*], and some of which are probably the big-eared bat [*Plecotus*]).

Lagomorphs are very abundant in the assemblage. Thirty-one pika (*Ochotona*) skulls and jaws have been identified, in addition to the hundreds of leporid specimens (103 of which have teeth that should allow them to be identified to the species level).

Rodents are the most abundant fossils, but they have not been extensively studied. There are 154 marmot (*Marmota*) jaws and over a thousand jaws of smaller sciurids. The geomyids and heteromyids are fairly well-represented, as are such cricetids as the deer mouse (*Peromyscus*) and meadow vole (*Microtus*). The wood rat (*Neotoma*) is the best represented genus with about 500 jaws and 2,000 isolated teeth.

A variety of carnivores have been recovered including wolf (*Canis lupus*), coyote (*C. latrans*), red fox (*Vulpes vulpes*), kit fox (*V. macrotus*), weasel (*Mustela* -at least two species), marten (*Martes*), striped skunk (*Mephitis*), spotted skunk (*Spilogale*), and bob cat (*Lynx*). A sabertooth cat (*Smilodon*) claw has been identified, as well as a possible American lion (*Felis atrox*) tarsal.

Nearly 100 horse (*Equus*) bones represent at least two species based on a size dichotomy of foot and toe bones. There are 27 foot and toe bones and one tooth of camelids (probably two species). Deer (*Odocoileus*) and pronghorn (*Antilocapra*) are both well-represented. A pair of lower jaws represents the bighorn sheep (*Ovis canadensis*).

In addition to mammals, 37 fish vertebrae, 265 lizard and snake jaws of varying sizes, and a wide variety of bird bones have been found. One very large bird vertebra can probably be assigned to the extinct teratorn (*Teratornis incredibilis*), originally described from nearby Smith Creek Cave (Howard 1952).

Discussion

The Crystal Ball Cave assemblage represents specimens living from at least several thousands of years ago to the present time. Many changes have taken place during that period as attested to by the assemblage. The presence of fish vertebrae indicates a close proximity of a lake (Lake Bonneville). Presence of *Marmota* and *Ochotona,* which now inhabit only much higher elevations in the region, attest to climatic shifts probably representing a replacement of woodland-alpine by desert communities. The presence of extinct species such as horses, camels, large cats, and large birds in the assemblage gives further evidence for the widespread extinction that occurred about 10,000 years ago.

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Fossil Vertebrates and the Paleoenvironment of the Lange/Ferguson Clovis Kill Site in the Badlands of South Dakota

James E. Martin

In 1980-82, excavations at the Lange/Ferguson site (39SH33-SDSM locality V831) revealed the existence of at least two mammoths (*Mammuthus*) associated with evidence of the Clovis cultural tradition. In addition, many other fossil vertebrates were recovered, ranging in size from bison (*Bison*) to shrews (Martin 1982a, 1982b). Assuming that the habits of these fossil taxa were the same as those of their living counterparts, the paleoenvironment of the site can be determined.

The site is on the Pine Ridge Indian Reservation in Shannon County in the Badlands of South Dakota. The area is currently sparsely vegetated with a semiarid environment. The fossiliferous sediments at the locality consist of light green siltstones overlain by a dark carbonaceous layer from which a radiocarbon date of 10,670 ± 300 yr B.P. has been obtained (Hannus 1982). The majority of the fossil vertebrates occurred below the ancient soil horizon, and the relatively fast sedimentation rate in the Badlands suggest that the fossil vertebrates are not much older. In addition to the vertebrates, numerous mollusks were surveyed by A.B. Leonard, who made preliminary conclusions (1982) that the environment of deposition was a shallow lake bordered by wooded, brushy, or grassy slopes.

Although analysis of the fossil vertebrates is not complete, at least 25 taxa have been identified (Fig. 1). Five of these do not presently occur in the region of the Lange/Ferguson site, and all but grasshopper mouse (*Onychomys*) are indicative of a mesic climate. With only a fourth of the sample surveyed frog, (*Rana*) is the most abundant taxon present and composes about one-half of the sample. Meadow vole (*Microtus*), pocket gopher (*Thomomys*), deer mouse (*Peromyscus*), shrew (*Sorex*), and short-tailed shrew (*Blarina*) are the next most abundant taxa.

Of the lower vertebrates, frogs were very abundant at the site, and snakes and salamanders were common. One group of snakes includes the water snakes (Natricinae) and the salamander is not representative of the tiger salamander (*Ambystoma tigrinum*) which now inhabits the Badlands. Fish are represented by rare specimens of minute cyprinids, and birds are also rare although a coracoid of an anatid was recovered. Most taxa of the lower vertebrates suggest an environment close to water.

Small mammals are abundant and indicative of the paleoenvironmental conditions. Specimens of three genera of shrews are common and include two genera, pygmy shrew (*Microsorex*) and *Blarina*, which do not now occur in the

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Badlands. All three shrew genera currently prefer moist, brushy habitats and are common along running or standing water margins. Rabbits are rare, but rodents are very abundant. For instance, meadow vole (*Microtus pennsylvanicus*) comprises about 40% of the mammalian population. This vole is often found in damp areas near water, although it has a wide environmental tolerance. Red-backed vole (*Clethrionomys gapperi*) is another taxon which is not now found in the Badlands, and it prefers very moist, forested areas. All other rodents listed on Fig. 1, with the exception of northern grasshopper mouse (*Onychomys leucogaster*), are now found in or have a preference for a humid environment. *Onychomys* is found in more arid conditions and may indicate that a drier area existed distal to the proximal community, that the specimen was introduced into the area, or that the environmental preference of this cricetid has changed.

Three large mammals: *Mammuthus, Bison,* and a cervid, were recovered from the site. The former two exhibit evidence of butchering; the occurrence of a large, adult elephant and a subadult may substantiate the contention of Saunders (1977) that Clovis man hunted family groups.

Overall, the vertebrate evidence indicates that the Lange/Ferguson site was mesic, certainly not the dry environment that prevails today in the Badlands. The proximal community was probably a marsh, not running water. This is evidenced by the presence of muskrat (*Ondatra zibethicus*), only very small minnows, the lack of beavors (*Castor canadensis*), environmental preference of the invertebrates, and the small sediment size at the locality. This environmental conclusion complements the results of environmental reconstructions indicating a mesic period from about 11,000-8,500 yr B.P. on the northern Great Plains (Semken 1980; Walker 1982).

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Fossil Vertebrates from the Lange/Ferguson Locality

OSTEICHTHYES

Cyprinidae, sp. indet.

AMPHIBIA

Rana sp. cf. *R. pipiens*
Urodela, sp. indet.

REPTILIA

Natricinae, sp. indet.
Serpentes, sp. indet.

AVES

Anatidae, sp. indet.
Fringillidae, sp. indet.

MAMMALIA

INSECTIVORA

Sorex sp. cf. *S. cinereus*
Microsorex hoyi
Blarina brevicauda

LAGOMORPHA

Leporidae, sp. indet.

RODENTIA

Eutamias minimus
cf. *Spermophilus*, sp. indet.
Thomomys talpoides
Reithrodontomys, sp. indet.
Peromyscus leucopus
Onychomys leucogaster
Zapus hudsonicus
Ondatra zibethica
Cleithrionomys gapperi
Microtus pennsylvanicus

PROBOSCIDEA

Mammuthus, sp. indet.

ARTIODACTYLA

Bison, sp. indet.
Cervidae, sp. indet.

Fig. 1

The Effect of Pleistocene and Recent Environments on Man in North America

LARRY D. MARTIN AND JEAN BRIGHT MARTIN

The traditional idea that glacial man lived in a harsh, cold environment does not seem to apply to North America. Abundant evidence now supports a glacial climate of cooler summers and warmer winters over most of non-glaciated North America (Lundelius 1967; Slaughter 1967a, 1967b). The low seasonality of this climate permitted plants and animals to have broader ranges than they have today, and these broader ranges resulted in overlaps of species ranges that do not now occur. This created very complex Pleistocene community structures in North America that do not have close modern analogs. This was true for plants (Van Devender and Mead 1976), as well as for animals. The relative warmth of the glacial winters is well-supported by the northern range of the tropical-subtropical giant tortoise (*Hesperotestudo*) during the Wisconsin glacial in Texas and Oklahoma (Slaughter 1967a, 1967b, 1975). Giant tortoises are presently very temperature sensitive and cannot survive the modern Oklahoma winters. We can also compare the Wisconsin fauna of Florida with the present Florida fauna. The striking result of this comparison is the loss of many South and Central American animals at the close of the Pleistocene including: jaguars (*Panthera onca*), capybaras (*Hydrochoerus*), giant armadillos (*Dasypus bellus*), glyptodonts (*Glyptotherium*), and tapirs (*Tapirus*). It is hard to interpret the Gulf Coast fauna as anything but *less* tropical today than it was in the Wisconsin.

Almost all of unglaciated North America was more forested during the Wisconsin, and there were no extensive steppes or deserts. Tundra seems to have been restricted to a very narrow band along the margins of the continental glaciers and to areas of high altitude. Beringia and a few places south of the continental ice seemed to have been occupied by steppe tundra.

We know little about the people who occupied these special Pleistocene environments, and indeed some (Martin 1973) think that people only arrived in North America after the beginning of the collapse of these environments. They would accept a duration of man in North America of only about 12,000 years. We believe that this viewpoint can no longer be supported against numerous reports of sites dated at ages greater than 12,000 years (MacNeish 1976). The archaeological data suggest at least 20,000 years for the duration of man in the New World.

Distinctive floral regions during the Wisconsin had distinctive faunas (Martin and Neuner 1978). The western region of North America, south of the ice, was occupied by a montane conifer parkland that contained the *Camelops* Faunal Province based on the distribution of camel (*Camelops*), pronghorn (*Capromeryx*), mountain deer (*Navahoceros*), Shasta ground sloth (*Nothrotheriops*), giant short-faced bear (*Arctodus simus*), and American lion (*Panthera atrox*). Most Paleoin-

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dian sites fall within this faunal province, and we also know that this was an area of active mammoth hunting. The *Ovibos* Faunal Province falls along the edge of the continental ice and in high altitude sites in the mountains. It is characterized by the distribution of muskox (*Ovibos*), lemming (*Dicrostonyx*), and caribou (*Rangifer*). Paleoindian sites within this faunal province have produced primarily *Rangifer*. The northeastern United States was occupied by a spruce forest taiga that contained the *Symbos-Cervalces* Faunal Province which is characterized by the distribution of giant beaver (*Castoroides ohioensis*), moose (*Cervalces*), muskox (*Symbos*), and fugitive deer (*Sangamona*). The American mastodon (*Mammut americanum*) was most common in this faunal province, and at least one kill site for the American mastodon (Graham *et al.* 1981) has been found within its borders. The southeastern region was occupied by a deciduous forest that contained the Chlamythere-Glyptodont Faunal Province. This faunal province is characterized by the distribution of chlamytheres (*Chlamytherium*), glytodonts, capybaras, and the speckled bear (*Tremarctos*).

We can see from this that neither vegetation nor animal distributions were uniform throughout North America and that Paleoindians utilized whatever the more abundant local resources happened to be. In most cases, these would be extinct animals, because the large mammals which make up the modern fauna in these areas are uniformly rare in the fossil record. The Pleistocene communities contained much greater diversity in all aspects of hunting and gathering, and the chance for success was more nearly the same throughout the year than it has been during the Holocene.

Beginning about 12,000 years ago the complex Pleistocene communities began to break up and by 8,000 years ago we have essentially the modern distribution of plants and animals. The collapse of the Ice Age floral communities was accompanied by the extinction of over one-half of the species of North American large mammals. This severely diminished the hunting options of the Paleoindians. Changes in the distribution of small vertebrates and mollusks show that the understory vegetation was also affected. Gathering patterns must have been changed profoundly. Prairies and deserts become important factors in the North American biota and hardwood forests expanded during the Holocene. The resources that were the most important and widely distributed in the Ice Age became rare or absent in the Holocene. People at this time in North America were faced with new seasonal extremes of heat, cold, wetness, and dryness. They would need to increase their abilities to plan for the duration and coming of the seasons, and the development of calendars would be favored. They would also have had to improve the quality of their shelter and their means of preserving and storing food and water through the newly harsh summers and winters. At various times of the year, this effort would be facilitated by seasonal increases in the abundance of certain plants and animals due to newly developed migrational or seasonal growth patterns. However, this temporary wealth could not be so easily utilized by very small family groups and a new order of social cooperation might have been needed to harvest enough resources to insure winter survival. The development of huge monotypic stands of plants and vast herds of single species of ungulates would force specialization and in some ways may have encouraged the development of agriculture. The most striking aspect of the early Holocene record in North

America is the prevalence of mass kills of bison (*Bison*). The first signs of agriculture appear shortly after the Pleistocene.

Lundelius (1983) reports reduced seasonality in the late Pleistocene of Australia. This may be a worldwide phenomena and adaptations for extreme seasonality may be characteristic of Holocene cultures.

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Paleoecological Investigations at Saltville, Virginia

Jerry N. McDonald

The small (2 x 1.1 km), triangular Saltville Valley lies at about 530 m above sea level in the Appalachian Ridge and Valley Province in Smyth and Washington counties, southwestern Virginia. The valley floor consists of several meters of late Quaternary alluvial, lacustrine, and colluvial sediments that lie nonconformably above the Lower Mississippian MacCrady Formation (shales containing pockets of halite, gypsum, selenite, and satin-spar).

The Saltville Valley is best known to Quaternary scientists as a fossil vertebrate locality that has yielded remains of the region's late Quaternary megafauna for more than 200 years. The earliest record of a fossil from Saltville is that of a mastodon (?) tooth sent to Thomas Jefferson in 1782. Since then, several private and public collections of fossils from Saltville have been assembled, the more scientifically significant being those collected by the Carnegie Museum in 1917 (Peterson 1917), VPI and SU in 1964-1967 (Ray, Cooper, and Benninghoff 1967), the Smithsonian Institution in 1966-1967, and Radford University in 1980-present (McDonald and Bartlett 1983). Less well known is the archaeological record of the valley. Although the valley contains (contained?) abundant archaeological remains, as local collectors have documented, the human prehistory of the valley has received very little attention from professional archaeologists. Artifacts recovered from in and near the valley extend from the Paleoindian to late Woodland periods (Pickle 1946, 1947, 1949; Holland 1970; McCary 1983). Concern with other facets of the Quaternary paleoecology of the Saltville locality has been, until recently, casual and sporadic (Peterson 1917; Ray, Cooper, and Benninghoff 1967).

In October, 1980, I was invited to assist Dr. Charles Bartlett, Jr., of Abingdon, VA, to excavate an associated partial skeleton of an extinct muskox. This work clearly indicated that abundant, diverse, well-preserved information bearing up on the late Quaternary history of the valley and its environs was available at the site. Plans were made to conduct systematic, interdisciplinary research on the Quaternary history of the valley.

The first phase of this research took place in the summer of 1982. All work was located in the middle of the valley at or near the productive "muskox site." The specific objectives of this work included: (1) defining the Quaternary stratigraphy of the middle valley floor and establishing its absolute chronology, (2) collecting a complete column for pollen and plant macrofossil analysis, and (3) expanding the faunal recovery techniques to allow recovery of microfaunal remains as well as those of large mammals. This work revealed a sequence of changing local environments ranging from an active lotic system (the Saltville River: McDonald and Bartlett 1983) that ceased to exist ca. 14,500 yr B.P., through a lake and marsh that succeeded to dry land ca. 10,000 yr B.P., then

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through a marsh-dry and land-marsh sequence in the early to middle/late Holocene. The uppermost sediments have been disturbed by two centuries of agricultural and industrial activities.

A column of sediment overlying the deepest part of the Saltville River channel was collected in December, 1982, by Drs. Hazel and Paul Delcourt (University of Tennessee) for pollen and plant macrofossil analysis. This column extends from ca. 17,000-13,000 yr B.P. into the early Holocene. The analyses are nearing completion.

Abundant faunal remains were collected, including those of gastropods, bivalves, ostracods, insects, fish, amphibians, reptiles, birds, and mammals. The most interesting faunal find is probably the associated muskox skeleton (additional elements of which were found in 1982) that provides evidence of having been partly consumed and dispersed by carnivores. Important, however, is the abundance of new data that will allow a much expanded description of the regional fauna, its environments, and its ecology. Analyses of the faunal remains are underway by various students and specialists.

Although no systematic excavation of known archaeological sites was undertaken in 1982, several artifacts were recovered representing the early Archaic to late Woodland periods.

The second five-week excavation is scheduled for June 4-July 6, 1984. This work will look for information on: (1) the changing small scale community mosaic of the valley, (2) the morphology and history of the lower Saltville River, (3) the archaeology of the valley, (4) taphonomic processes typical of different environments, and (5) the location and composition of older (pre-late Wisconsin) sediments. At least six sites will be worked, including the "muskox site" and five sites on the periphery of the valley.

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The Mammoth and Sloth Dung from Bechan Cave in Southern Utah

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Late in 1982 a National Park Service (NPS) team undertaking a survey of the cattle and horse grazing in Glen Canyon National Recreation Area, southern Utah, entered a large, dry sandstone cave. The west-facing cavern, unusually large for the Navajo Sandstone, is unlike most other shelters in the region in that it contained no surface deposit of cow dung or evidence of other feral animals. The survey team found the surface of the cave to be predominantly sand. Pothunters had dug a few small holes in the sand only to uncover what appeared to be matted grass. The NPS team realized that the grass from these holes had the appearance of dung, so they saved a few specimens. Aware of the interest in fossil coprolites, the samples were sent to the Laboratory of Paleoenvironmental Studies, University of Arizona.

Inspection of the samples revealed that they were dung, rich in graminoid culms. The shape and texture of the dung was unlike the coprolites of the extinct Shasta ground sloth (*Nothrotheriops shastensis*) known to occur in the Southwest. Ruminant dung is finely chewed and therefore could be eliminated from comparison. The newly discovered dung was dominated by very coarse, long strands of graze and resembled dung of the African elephant (*Loxodonta africana*).

Three preliminary trips to the new discovery, now named Bechan Cave, have determined that the cavern is roughly 53 m deep, 32 m wide, and up to 9 m in height. The cavernous entrance and the orientation permits the entire cave to be well-lit throughout the day. A 2 x 2 m test pit, test auger holes, and a profile of the sediments at the entrance have determined that a blanket of dung occurs throughout most of the cave; we estimate that approximately 300 m^3 of dung is preserved in the deposit. Between 20 cm and 100 cm of sand, including some cultural material, covers the dung blanket which ranges from 10 cm to 40 cm in thickness.

Our first test pits produced what appear to be two complete boluses of unbroken dung. The larger measures 230 x 170 x 85 mm. Both boluses closely resemble the dung of the African elephant and lack the short, clipped woody twigs typical of the Shasta ground sloth diet. For these reasons we believe this large dung from Bechan Cave represents the elephant of the Western Hemisphere, the mammoth (*Mammuthus,* probably *M. columbi*). The four m^2 of test pit permitted a thorough examination of the dung blanket of that region in the cave. The major component is mammoth dung in various states of com-

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pleteness; entire boluses are rare. Mixed in with the trampled dung is additional coprolites of a variety of other animals including rabbits, rodents, possibly mountain sheep or deer (*Ovis canadensis* or *Odocoileus* sp.), Shasta ground sloth, and some unidentified large, pellet-producing artiodactyl. In addition to the dung, the unit contains numerous plant macrofossils, pollen, bones from small animals, and hair. Preliminary anlaysis of the hair reveals the presence of elephant and possibly two types of ground sloths (Charles Bolen pers. comm.).

The remarkable specimens of dung from Bechan cave may not be the first record of fossil proboscidean coprolites found in temperate North America, but they appear to be the most complete and of the largest accumulation. A similar appearing dung blanket, but much smaller, was discovered in Cowboy Cave immediately west of Canyonlands National Park, Utah (Jennings 1980). Hansen (1980) reported that some of the dung might be from the mammoth and Shasta ground sloth, but much of the deposit apparently is from a ruminant such as the bison (*Bison*).

Six radiocarbon ages have been determined on the mammoth dung from the upper, middle, and lower sections of the deposit in Bechan Cave: dates range from 11,670 ± 300 yr B.P. (A-3212) to 13,505 ± 580 yr B.P. (Gx-9371). When placed in stratigraphic order, the dates either indicate a mixing of the dung over a period of a few thousand years, or sporadic accumulation throughout a few millenia. We have not uncovered any evidence for the association of man with the dung blanket. If the skeletal remains of these large herbivores or the evidence of man is to be found in association with the late Pleistocene deposit, it should be recovered during the major excavation that we plan to begin in 1984.

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The Ivory Pond Mastodon Site in Western Massachusetts

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Abstract

The Ivory Pond site, discovered in June, 1982 during excavation for a pond on the edge of a 1 ha bog in the Housatonic River Valley, yielded several large mastodon bone fragments, chunks of ivory, and teeth associated with seeds of naiad (*Najas flexilis*) and white spruce (*Picea glauca*) cones. Radiocarbon dates of 11,440 ± 655 yr B.P. (Gx-9024-G) and 11,630 ± 470 yr B.P. (Gx-9259) were obtained on bone gelatin and white spruce cones respectively.

Besides being the first mastodon site found in western Massachusetts, this site is significant because (1) what were thought to be butchering marks on one bone, (2) minimal disturbance, and (3) associated organic materials. While there has been a strong reliance upon pollen studies in paleoenvironmental reconstruction, a balanced picture is not always possible due to selective preservation from different tree species or different depositional contexts (Jacobson and Bradshaw 1981). This site presents a fine opportunity for a detailed picture of the environment immediately preceding the advent of man in this area (Moeller 1984).

The bog matrix removed by the backhoe was closely examined because: (1) we had to know the nature of data present before planning further research, (2) the material in the spoil pile was decaying and would soon be lost regardless of what we did, and (3) an association with the peat lens containing the mastodon bones could be made due to its unique characteristics (i.e., highly organic and unpleasantly aromatic). Troweling, sifting, and flotating more than 90% of the redeposited matrix yielded hundreds of seeds (*Najas flexilis*) associated with the bones, white spruce cones, and ivorý. *Najas flexilis,* an annual plant flowering between July and October (Fernald 1950) grows in shallow fresh water in a climate no more extreme than that of modern southern New England.

The stratigraphic profile of the bog derived from coring and probing consists of a modern fiber and earth mat mixed with historic glass and metal fragments overlying a water-saturated, densely organic layer (peat) about 0.5 m thick. Beneath this is a very fine-grained sand (nearly a clay) which prevents the water from seeping into the underlying coarse gravel. In its uncompressed state the entire profile does not exceed 1.5 m in the sections from which mastodon bones have come.

A total of 14 mastodon teeth fragments, ivory, and portions of a left antero-lateral proximal tibia, right antero-medial diaphysis (mid-shaft) humerus, and a probable portion of the lesser trochanter of a left humerus have been identified. A portion of humerus having long rows of striations, which appeared

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to be cut marks, was studied using a scanning electron microscope. The grooves are relatively shallow, broad, and somewhat rounded. While there is a superficial resemblance to carnivore tooth scratches (Potts and Shipman 1981), their length and orientation are different. A series of tiny ridges running longitudinally within the grooves are not characteristic of scratches caused by animal teeth, claws, or stone tools. They are, in fact, typical of anatomical features such as vascular grooves (Pat Shipman pers. comm.).

The data recovered from the bog, the observations from probes and cores, and the topography of the present ground surface suggest that no large, articulated portions of the animal remain. Given the good, but fragmentary condition of the bone recovered initially, there is no likelihood that the beast was articulated when sealed in the bog. Because the edges of these pieces do not bear recent breaks, it is assumed that the backhoe removed *in situ* bones and ivory which were already broken. Since the identified fragments are portions of the most massive bones of the animal (tusks, teeth, hindlimbs, and forelimbs), there seems to be little hope that the skeletal elements remaining in the bog will be in better condition. Thus, if the backhoe removed well-preserved fragments of these massive bones, then they must have been split, fragmented, and/or decayed long ago.

Radiocarbon dates on associated materials in the bog matrix 11,440 ± 655 yr B.P. (Gx-9024-G) from bone gelatin and 11,630 ± 470 yr B.P. (Gx-9259) from white spruce cones - are consistent with the known glacial geology, previously dated mastodons (Meltzer and Mead 1982), and pollen profiles from the general vicinity. The closeness in age of samples from bone and white spruce cones argues for the validity of the association among the bones, seeds, and cones. While everything recovered to date need not have been buried in the bog on the same day, the case has been made for their general contemporaneity.

The project is now dormant awaiting the identification of the contents of the core samples. If the results are encouraging, then funding should be sought for a multi-disciplinary paleontological, palynological, zoological, and paleoenvironmental study.

I would like to thank Thomas Marino for all of his efforts to encourage the recovery, preservation, and conservation of this rare resource and for his unfailing good humor and hospitality. Bartlett Hendricks of The Berkshire Museum and Jim Parrish of the Berkshire County Regional Planning Commission provided invaluable assistance and encouragement.

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Paleoenvironments: Geosciences

Periglacial Features in the High Appalachians South of the Glacial Border: Current Research; The University of Tennessee

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Present periglacial research in the High Appalachians concentrates on features that should prove most diagnostic of the environments of origin. In harmony with objectives of the Program for Quaternary Studies of the Southeastern United States, this research is in concert with reconstruction of Quaternary climatic and vegetational history (Delcourt and Delcourt 1981). Areas where detailed research of previously reported features (Ciolkosz *et al.* 1971; Clark 1968, 1975) is nearing publication stage are shown in Figure 1. Additional sites are under investigation, and reconnaissance is nearing completion to establish elevational, latitudinal, and exposure gradients.

References cited here are not intended to be exhaustive; a comprehensive analysis of recent research will be published elsewhere. Péwé (1983) presents an excellent summary of published literature on features in the eastern United States.

This paper reviews the occurrence, distribution, and inferred genesis of features believed to be of paleoperiglacial origin. Excluded are certain forms found at relatively low elevations on steep slopes (Hupp 1983) which show evidence of contemporary mass wasting activity. Included are large scale sorted patterned ground forms (Clark 1968) as polygons, nets, steps, and stripes widely distributed from the glacial border (Fig. 1) southwestward to the Great Smoky Mountains along the Tennessee-North Carolina border. These features are interpreted as fossil features that formed during cold phases of the Quaternary, based on relative age dating criteria and other field relationships.

Certain block fields, block slopes, and block streams are similarly distributed, show evidence of long term inactivity, and are interpreted as having analagous origin. At selected sites such features can be traced downslope to fanlike deposits, where Mills (1982) has demonstrated convincingly that prolonged and discrete episodes of weathering are represented in mountain foot slope deposits.

The large scale paleoperiglacial features are interpreted to indicate the former presence of deep and intense seasonally frozen ground and/or sporadic to discontinuous permafrost during the times that these features formed in the High Appalachians. An emerging bipartite nature of Central Appalachian versus Southern Appalachian forms suggests that environmental conditions may have differed markedly north and south of the position of the polar front. As Quaternary paleoenvironmental zones fluctuated widely through both space and time, it is necessary to develop a chronology for such events in the study region.

Ongoing and planned research include instrumentation and monitoring of

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active small scale micropatterns, long term observations on slope deposits of questionable stability, and application of absolute age dating techniques to samples from critical soil stratigraphic horizons. The study of pollen and macrofossils from organic rich horizons will permit reconstruction of vegetational history at selected sites.

The possible implications for early peoples in the High Appalachians will remain unknown until the chronologies of feature development and hillslope formation can be determined. To place the late Quaternary events in proper age date perspectives, a paired dating methodology will be employed. Both radiocarbon and thermoluminscence (TL) dates will be obtained from critical soil stratigraphic horizons; resulting calibration of TL dates with ^{14}C ages will provide a methodology for correlation with sites lacking organic remains. Such reconstructions can then be used to extend pioneering research at high elevations (cf. Watts 1979) throughout the Appalachians south of the glacial border.

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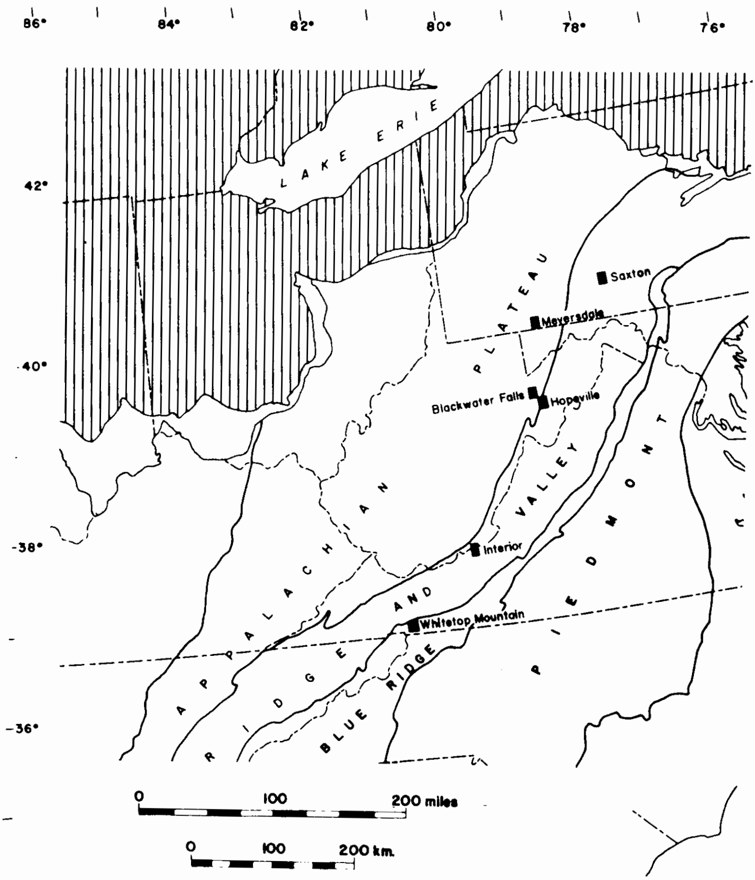

Fig. 1. Research region south of the glacial border; Wisconsin Drift, bold-striped pattern; area of pre-Wisconsin Drift, dotted pattern. Named 7 ½-minute quadrangles contain sites where detailed research has been completed on previously reported features.

Observations on the Geologic Setting of Paleoindian Sites on the Southern High Plains

VANCE T. HOLLIDAY

Most well-documented Paleoindian sites on the Southern High Plains of northwest Texas and eastern New Mexico are located in ephemeral drainages or draws. Recent geologic investigations, part of the continuing research of the Lubbock Lake Project (The Museum, Texas Tech University), have focused on the stratigraphy and depositional environments of Paleoindian age units along the draws in the region. The research has been conducted along middle Running Water Draw in the vicinity of and including the Plainview site (Holliday 1983), the upper, middle, and lower reaches of Blackwater Draw at the Clovis site (Haynes 1975), Marks Beach site (Honea 1980), and BFI Landfill (Holliday 1983), respectively, and lower Yellowhouse Draw at the Lubbock Lake site (Holliday 1983; Holliday *et al.* 1983).

The oldest, widespread valley fill is of Clovis age (11,500-11,000 yr B.P.) and consists of bedded sand and gravel. The unit indicates that competent streams were flowing through most reaches of most draws during the Clovis period. The only exception is at and in the vicinity of the Clovis site. Haynes (1975) suggests that alluvial deposition in the area ceased several thousand years prior to the Clovis occupation due to a lowering of the water table and decrease in spring discharge.

The stream flow in Clovis time was probably supported by increased effective precipitation. This is suggested by microfaunal data from Lubbock Lake (Johnson 1983). It is likely that spring discharge also contributed to stream flow but how much influence springs may have had and how precipitation affected the springs is difficult to determine. The decrease in spring activity proposed for upper Blackwater Draw in the area of the Clovis site would not necessarily negate the possibility of continued spring activity downstream or in other drainages. The Clovis area is upslope from the other localities so the water table could drop in the Clovis area yet remain high enough to support spring discharge in the downslope regions.

Lacustrine deposition begins rather suddenly at about 11,000 yr B.P. (beginning of the Folsom period) in lower Yellowhouse and middle and upper Blackwater draws. In lower Yellowhouse and middle Blackwater draws, the change was from flowing to standing water, whereas in upper Blackwater Draw, Haynes (1975) suggests that lacustrine deposition was the result of reactivation of the springs. Along lower Blackwater and middle Running Water draws stream activity continued until about 10,000 yr B.P.

The reasons for the change to lacustrine sedimentation at 11,000 yr B.P. along some reaches of some draws while alluvial sedimentation continued for another 1,000 years in other reaches of the draws is not understood. It is likely that the reasons include a climate change toward decreased runoff combined

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with development of some sort of damming mechanism, the latter possibly related to the former. Such a climate change has been documented in the region (e.g., Johnson 1983). A possible dam has also been discovered in trenching along lower Yellowhouse Draw. The feature is a 2 m-thick sand deposit. A paleotopographic map of the surface of the lacustrine sediments along a 3 km reach in lower Yellowhouse Draw including the area of the possible dam and the Lubbock Lake site shows that the lacustrine sediments occur in stair-step fashion down the draw, which would be expected from a lacustrine deposit in a valley, as opposed to one long, continuous deposit down the valley as suggested by Stafford (1981:Fig. 13). The possible dam also is located at the break between the two "steps" mapped along the draw, which further suggests that it is in fact a dam.

The origins of such dams are less clear. The feature at Lubbock is located just above a marked constriction of the valley in a sinuous reach of the draw. Perhaps the sand was reworked by wind from the underlying alluvial deposits and clogged the draw at the same time discharge was decreased due to the climate change at 11,000 yr B.P. On a regional basis the lacustrine sedimentation at this time may have been the result of the same factors. An examination of topographic maps of the area show that Yellowhouse and middle and upper Blackwater draws are considerably more sinuous and narrow than lower Blackwater and middle Running Water draws. Perhaps the climate change at 11,000 yr B.P. was such that discharge decreased and left underfit streams with relatively broad, sandy floodplains. Eolian activity then reworked the sand and clogged the more constricted reaches of the draws, impounding what water was available. In lower Blackwater and middle Running Water draws the drainages were sufficiently wide and less sinuous to allow water to continue to flow for another 1,000 years.

The well-stratified nature of Paleoindian age deposits along the draws of the Southern High Plains allows for the relatively detailed reconstruction of the local environments of human occupation. However, reconstructing the regional climate at the time and determining the causes of the marked changes in hydrology and sedimentation, beyond very general, qualitative statements is very difficult at this point. Investigation into these topics is a continuing research problem.

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Late-Glacial and Early Holocene Drainage Basins in Northern Maine

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Geological studies in northern Maine indicate that Paleoindian and early Archaic peoples were adapted to drainage basins that were very different from modern basins. Ice-dammed lakes were important features during deglaciation and large drift-dammed lakes lasted until at least 10,000 yr B.P. An episode of unstable stream channels occurred between 10,100 and 7,700 yr B.P.

Geological Events

The breakup of the Laurentide Ice Sheet left an isolated ice cap in northern Maine and adjacent Canada (LaSalle *et al.* 1977; Kite and Lowell 1982). Due to ice-flow and ice-retreat patterns large lakes formed between the northwestern margin of the ice cap and the southeastern flank of the Notre Dame Mountains. Many lakes experienced several drops in water level as new outlets were uncovered. At their maximum extent, most of the ice-dammed lakes in the upper St. John drainage basin probably were interconnected by northeastward-flowing outlets, which were aligned parallel to bedrock strike. Runoff from this system may have emptied into the St. Lawrence drainage via the Rimouski River. Lake-bottom dates from the region show that glaciers disappeared from most lake basins by 11,500 yr B.P.

Seven radiocarbon dates from two localities show that the largest of the extinct lakes, Lake Madawaska, lasted until about 10,000 yr B.P., at least 1,000 years after glaciers disappeared from the region. The last stages of Lake Madawaska were probably dammed by a thick accumulation of outwash and ice-contact stratified drift near Grand Falls, New Brunswick. Other lake sediments in northern Maine also are associated with extensive cross-valley drift accumulations; late stages of these may have been drift-dammed also.

Two external controls may have contributed to the persistence of drift-dammed lakes. First, the Laurentide Ice Sheet remained within 100 km of the upper St. John headwaters until nearly 10,000 yr B.P. (LaSalle *et al.* 1977); the headwaters of the St. John were isostatically depressed relative to downstream reaches. This differential isostatic warping produced extremely low gradients in some reaches of the St. John River, depriving the stream of energy to erode major drift dams. Second, the extremely cold late-glacial climate did not favor large floods, further diminishing the ability of the St. John to erode cross-valley drift dams.

Radiocarbon dates from channel-fill deposits along the St. John River indicate an episode of channel instability between 10,100 and 7,700 yr B.P., which

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far exceeds that of any other Holocene episode. The channel may have been unstable because it was developing a meander belt on fine-grained former lake bottoms. Alternatively, the channel may have been unstable because of an increase in stream energy produced by climatic change of isostatic rebound of the headwaters.

Significance to Archaeological Studies

Paleoindian and early Archaic sites in northern Maine (Bonnichsen 1983; Nicholas *et al.* 1981), near the Maine-New Hampshire border (Gramly and Rutledge 1981), and in Nova Scotia (MacDonald 1968) suggest the region has a rich early prehistory. However, our work suggests that models for predicting early sites must include consideration for the late-glacial and early Holocene geology. Because of the ice cap, interior Maine was not available for occupation until at least 1,000 years later than coastal Maine and the St. Lawrence Lowlands. Paleoindian sites, such as those near Munsungun Lake, may be older than 11,000 yr B.P.; however, the hypothesis that Paleoindians lived on glacier margins (Bonnichsen 1983) must be rigorously tested.

The landscape available to the earliest inhabitants was quite different than today's. Paleoindian and early Archaic sites on old lakeshores may be located well above modern lake levels, or in valleys that no longer contain lakes. Unstable early Holocene stream channels may have eroded many late-glacial and early Holocene sites soon after they were occupied. Late Holocene aggradation has probably buried some of the old sites that escaped erosion.

Status of Studies

This study has been supported by the Maine Geological Survey and the U.S. Army Corps of Engineers. Radiocarbon dating has been provided by Robert Stuckenrath of the Smithsonian Institution. Fieldwork during the summer of 1984 will concentrate on mapping the disintegration of the ice cap in northwestern Maine and on finding additional exposures of lacustrine sequences. Detailed mapping of lake deposits in the Fish and Aroostook River basins is planned for subsequent field seasons.

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Archaeogeology and Geomorphology of Parts of Idaho and Wyoming: Progress Report

MORT D. TURNER, JOANNE C. TURNER, AND DWAIN WINTERS

A field party of three (Mort D. Turner, Joanne C. Turner, and Dwain Winters) carried out a reconnaissance survey of portions of eastern Idaho and western Wyoming during mid-July to late August 1983. Areas of emphasis were the Birch Creek/Lemhi River valleys, Idaho, and Pinedale area, Wyoming. Prior field work in the 1960's by Mort Turner and Joanne Turner in the Birch Creek area had suggested the surface occurrence of crude coarsely-flaked quartzite artifacts (?) in geomorphic context indicative of pre-projectile point age. Goals of the 1983 reconnaissance were to determine, in each of the areas: (1) if sequences of alluvial surfaces could be identified, and assigned relative or estimated ages, in different parts of the survey area; (2) if quartzite occurred on these surfaces; (3) whether such quartzite showed evidence of fracture consistent with breakage associated with human activity, such as concoidally-fractured surfaces difficult to have been produced by natural forces; and (4) how the previous geological investigations and assignments of geological ages to geomorphic landforms might be applied to this project.

Several sets of dissected alluvial fans were found on both the east and west sides of the Birch Creek and the Lemhi River valleys. These have been related in origin and in age to specific glacial episodes and related moraines in the Lemhi Range on the west and the Beaverhead Range on the east by Dort (1962), Dort and Turner (1965), and Knoll (1973). A series of alluvial terraces border the Lemhi River downstream (to the north) that could be related to specific glacial episodes by glacial geological research. A complex series of moraines, fans, and terraces in the Wind River Mountains, especially near Pinedale, Wyoming, have been mapped and related to specific glacial episodes, as summarized by Richmond (1965). In each of these areas quartzite-rich surfaces and sediments were present and could be related to particular glacial events ranging in age from Holocene to mid-Pleistocene or possibly, earlier.

Gross, uncomfirmed observations appeared to indicate that unmodified quartzite cobbles, associated with projectile point-related cultural materials, were characteristic of Holocene and late Pleistocene age surfaces. Much fractured quartzite, associated with possible crude, coarsely-flaked artifacts (?), were common on the mid-Pinedale to mid-Pleistocene age surfaces.

These distributions of datable surfaces, unmodified quartzite cobbles, and fractured quartzite suggest to us that a statistical analyses of occurrence of quartzite by degree and type of modification and by degree of surface weathering, in relation to age of geomorphic surface on which they occur, may yield useful data on the possible presence of the pre-projectile point cultures in the Rocky Mountain area. Selected samples and bulk samples of unmodified and broken

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quartzite were collected for statistical and physical analyses.

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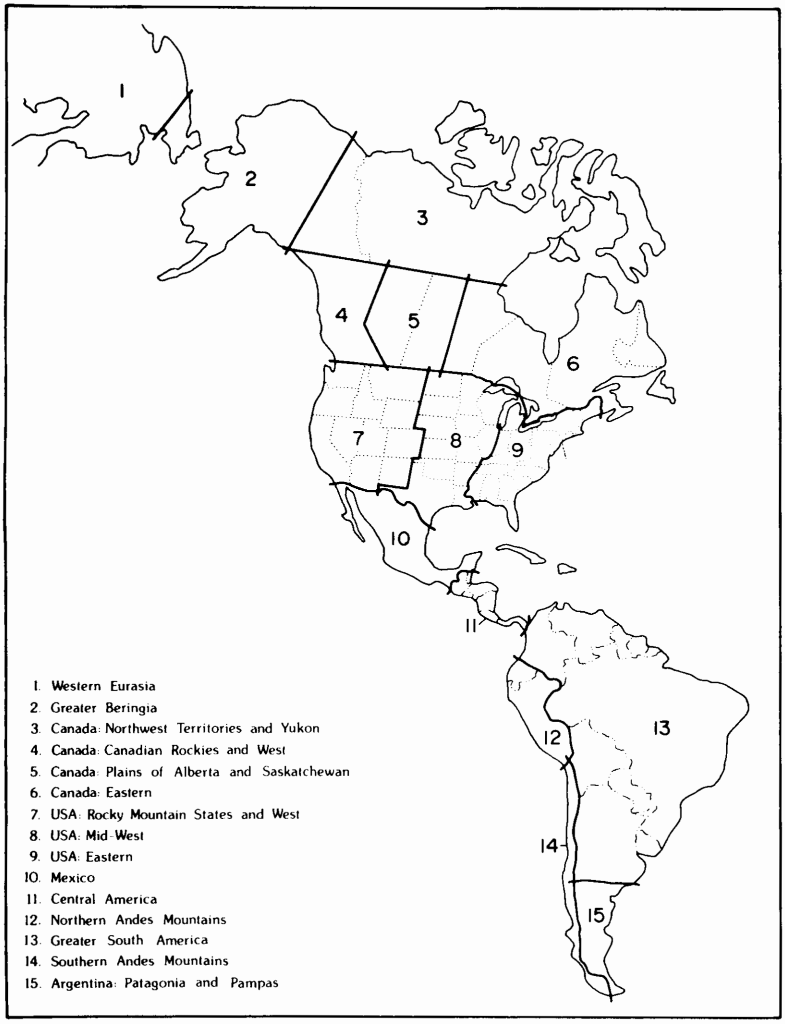
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Fig. 2

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