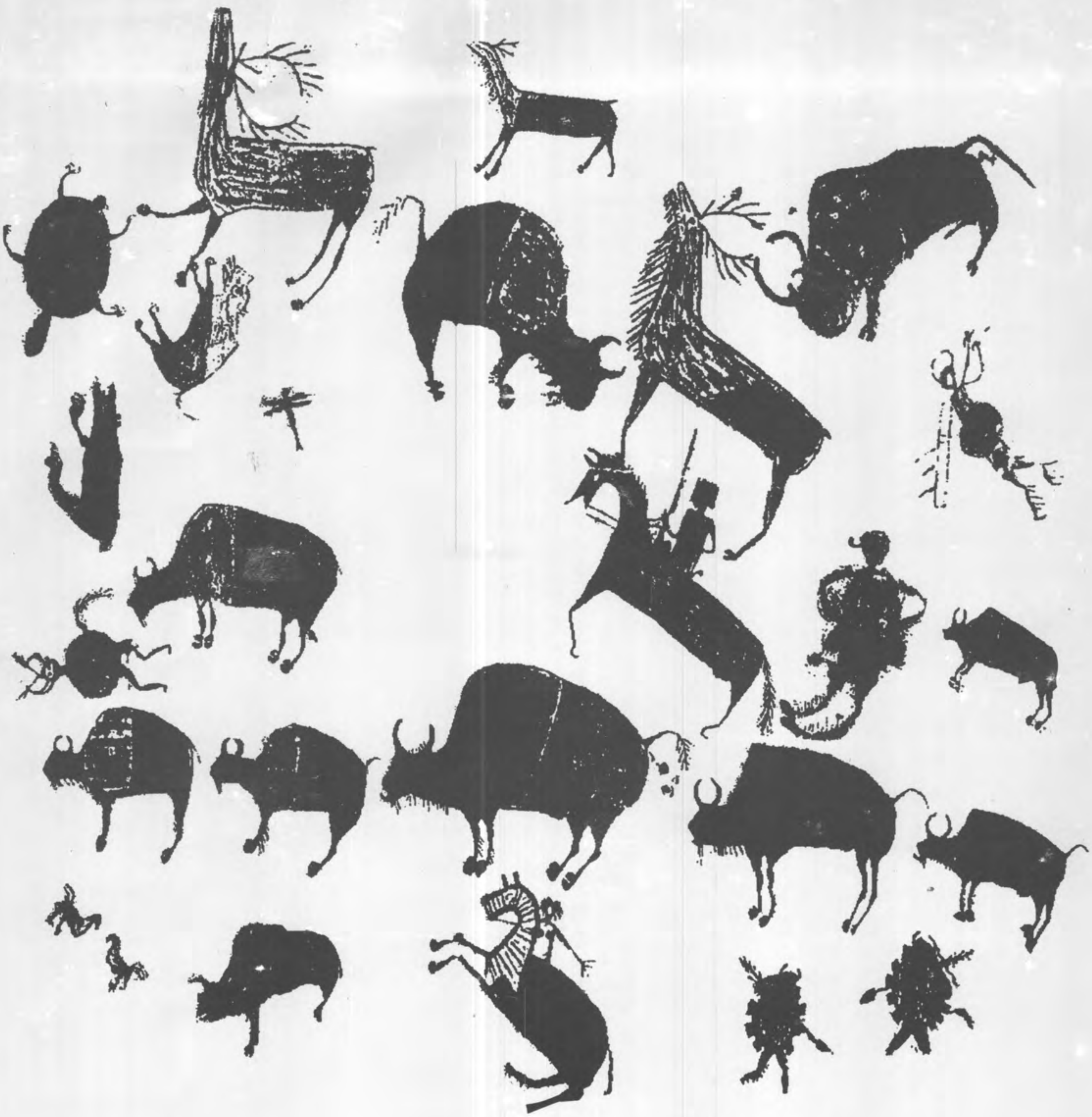


Archeology and Paleoecology of the Central Great Plains

A Volume in the Central and Northern Plains Archeological Overview

940008

Tri-Services Cultural Resources Research Center
USACERL Special Report 97/3
December 1996

U.S. Department of Defense
Legacy Resource Management Program

U.S. Army Corps of Engineers
Construction Engineering Research
Laboratory

Archeology and Paleoecology of the Central Great Plains

edited by Jack L. Hofman, with contributions by Mary J. Adair, Matthew E. Hill, Jack L. Hofman, William C. Johnson, Karolyn K. Kinsey, William B. Lees, Brad Logan, Larry D. Martin, Douglas W. Owsley, Kyeong Park, Karin L. Bruwelheide

A Volume in the Central and Northern Plains Archeological Overview

Arkansas Archeological Survey Research Series No. 48
1996

Arkansas Archeological Survey
Fayetteville, Arkansas
1996

Library of Congress Cataloging-in-Publication Data

Archeology and paleoecology of the Central Great Plains/ edited by
Jack L. Hofman; with contributions by Mary J. Adair [et.al.].
p. cm. — (Arkansas Archeological Survey research
series; no. 48) (USACERL special report: 97/3)
"A volume in the Central and Northern Plains archeological
overview."
Includes bibliographic references and index.
ISBN 1-56349-079-X
1. Indians of North America—Great Plains—Antiquities.
2. Paleoecology—Great Plains. 3. Great Plains—Antiquities.
I. Hofman, Jack L. II. Adair, Mary J. III. Arkansas Archeological Survey. IV. Series. V. Series: USA-CERL special report; N-97/3.
E78.G73A75 1996
987'.01—dc21 96-46225
CIP

ABSTRACT

The status of archeological research and current archeological interpretations in the northern Kansas, Nebraska, and northeastern Colorado region, referred to herein as the Central Great Plains has being addressed by a team of archeologists with the aid of bioanthropologists, geographers and paleontologists. The goal was to bring together current perspectives on human occupation of the region as viewed through the archeological, biological, and paleoenvironmental records, and to define research arenas, data limitations, and problems in need of further investigation. The consideration of prior research in spatial and temporal scales aids in the definition of critical research issues. The integration of information from paleoecological studies, late Pleistocene and Holocene paleontology, human skeletal evidence, and insights from archeological specialists enables a new assessment of our knowledge of the archeology of the central plains region. Although thousands of archeological sites occur in the region of concern here, relatively few of these have received intensive study and documentation. A summary of the current and past environments provides a framework within which to review and discuss changes in prehistoric and historic subsistence economies, technologies, mobility/sedentism, organization, and group interactions. A brief history of archeological investigations in the region outlines some of the developments and changing methods and goals of archeological research. A traditional cultural historical summary is provided for the region from about 20,000 years ago to the historic period. One integrative chapter uses the concept of Adaptation Types to summarize the current status of information and research needs from a broadly defined ecological-functional perspective across the region as a whole.

Series Editor: Hester A. Davis
Cover Design: M. Jane Kellett
(after a Sioux buffalo robe, Museum fur Volerkunde, Berlin)
Production: Mary Lynn Kennedy
Offset Printing: Western Newspaper Publishing, Indianapolis

Contents

Figures and Tables iv

Foreword v

Acknowledgments vi

1 Introduction,
by Jack L. Hofman 1

2 Late Wisconsinan and Holocene Environmental History,
by William C. Johnson and Kyeong Park 3

3 A History of Archeological Research on the Central Plains,
by Matthew E. Hill, Jack L. Hofman and Karolyn K. Kinsey 29

4 Early Hunter-Gatherers of the Central Great Plains: Paleoindian and Mesoindian (Archaic) Cultures,
by Jack L. Hofman 41

5 Woodland Complexes in the Central Great Plains,
by Mary J. Adair 101

6 The Plains Village Period on the Central Plains,
by Brad Logan 123

7 The Protohistoric Period on the Central Plains,
by Brad Logan 134

8 Historical Archeology on the Central Plains,
by William B. Lees 140

9 Bioarcheological Research in Northeastern Colorado, Northern Kansas, Nebraska, and South Dakota,
by Douglas W. Owsley and Karin L. Bruwelheide 150

10 Prehistoric Adaptation Types and Research Problems,
by Jack L. Hofman, Brad Logan, and Mary J. Adair 203

Appendix: Paleobiogeography of Post-Sangamonian Vertebrates in the Central Plains,
by Larry D. Martin 221

References Cited 228

Index 289

Figures

1. The Central Plains study area 1
2. Physiographic map of the Central Plains 3
3. Precipitation in for the Central Plains 4
4. Air mass types in North American regions 4
5. Native vegetation of the Central Plains 5
6. Distribution of dune fields and sand sheets 6
7. Stratigraphic succession in Kansas and Nebraska 7
8. Stratigraphy of Wilson Ridge 11
9. Pollen and macrobotanical sites 13
10. Aridity index from Eustis ash pit 14
11. $\delta^{13}C$ values from loess deposits 15
12. $\delta^{13}C$ values from Great Bend Sand Prairie 15
13. Magnetic susceptibility, Kansas and Nebraska sites 16
14. Agreement between curves. Eustis ash pit 17
15. Magnetic frequency dependence, Summer Hill 17
16. Magnetic susceptibility, Manhattan Airport site 17
17. Cooper's Canyon section soil 20
18. Magnetic susceptibility from two loess sites 21
19. Alluvial stratigraphy from Wolf Creek 24
20. Alluvial radiocarbon ages from the Holocene 25
21. Stable carbon isotope values, Sargent site 27
22. Magnetic frequency dependence, DB site 28
23. Location of selected reservoirs 38
24. Location of selected Paleoindian sites 45
25. Occurrence of Clovis points in the Central Plains 50
26. Clovis point/knives of the Central Plains 51
27. Selected Busse site artifacts 52
28. Occurrence of Folsom points in the Central Plains 57
29. Folsom artifacts from the Central Plains 58
30. Late Paleoindian artifacts 63
31. Cody complex artifacts 71
32. Artifacts from the Norton Bonebed 73
33. Location of selected Mesoindian sites 83
34. Logan Creek complex artifacts 86
35. McKean complex artifacts 88
36. Munkers Creek complex artifacts 92
37. Late Mesoindian artifacts 96
38. Location of Woodland complexes 102
39. Marshelder and sunflower plants 107
40. Achene and seeds from the Traff site (23JA159) 108
41. Middle Woodland Kansas City Hopewell ceramics 109
42. Middle Woodland point types 109
43. Excavation at the Avondale mounds 112
44. Plan view of Houses 2 and 3 , 14MY305 113
45. Plan view of Houses 1 and 2, 14JF307 117
46. Achenes and seeds from the Two Deer site 118
47. Bone objects from the Mugler site 131
48. Riley Collared Pinched vessel 132
49. Reconstructed effigy vessel 132
50. Ceramic disks and clay pipe 132
51. Persons >15 years old in mortality distribution 162
52. Age-specific mortality distributions 163
53. Age at death distribution 164
54. Male, female mortality distribution 164
55. Femur lengths, gestational ages of perinatal infants 165
56. Comparison of perinatal infant skeletons 165
57. Osteolytic destruction of the acetabulum 170
58. Localized, mild periosteal reaction 170
59. Cranial vault of a child 176
60. Musket ball wound 185
61. Changes in femora of Arikara adults 189
62. Paleoindian projectile point recording form 210

Tables

1. Wood and charcoal ages for late Wisconsinan deposits 9
2. Brady soil radiocarbon ages 19
3. $\delta^{13}C$ values and radiocarbon ages, Brady soil 21
4. Chronology of Younger Dryas 22
5. Reservoir and watershed projects 34
6. Federal legislation supporting archeology 36
7. Key Central Plain preceramic period sources 42
8. Reported pre-11,500 B.P. Central Plains sites 44
9. Selected western sites, pre-11,000 B.P. 45
10. Excavations and assemblages, Clovis sites 50
11. Clovis sites in the Central Plains 50
12. Paleoindian lithic caches in the Central Plains 50
13. Radiocarbon dates from Early Paleoindian sites 54
14. Selected Folsom sites outside the Central Plains 56
15. Selected Folsom radiocarbon dates 56
16. Folsom sites in the Central Plains 58
17. Bison bonebed projectile points and number of bison 60
18. Late Paleoindian sites in the Central Plains 64
19. Radiocarbon dates from Late Paleoindian sites 64
20. Paleoindian human remains in the Great Plains 67
21. Cody complex projectile point types 68
22. Radiocarbon dates for Cody complex 69
23. Mesoindian radiocarbon dates 85
24. Sites, radiocarbon dates for Plains Woodland period 103
25. Archeobotanical remains from Plains Woodland sites 105
26. Accelerator dates, Kansas City Hopewell sites 111
27. Radiocarbon dates from Pomona sites 124
28. Other Radiocarbon dates from Pomona sites 124
29. Radiocarbon dates from Steed-Kisker sites 127
30. Other radiocarbon dates from Steed-Kisker sites 127
31. Radiocarbon dates from Smoky Hill sites 129
32. Other Radiocarbon dates from Smoky Hill sites 129
33. Radiocarbon dates from White Rock sites 136
34. Archeological periods of the burial sites 153
35. Archeological sites with black or white human remains 155
36. Sites and burials reported in the four states 155
37. Remains reburied or repatriated 155
38. Organizations reporting human remains 155
39. Burial sites investigated by selected organizations 156
40. Sites with human remains by type of investigation 157
41. Recovery provenience of human remains 158
42. Plains Village burials by tradition 158
43. Sites and individuals assigned to phases 158
44. Sites and individuals assigned to Coalescent variants 159
45. Sites and individuals assigned to Middle Missouri variants 159
46. South Dakota sites grouped by variant 159
47. Burial artifacts in two Omaha Indian cemeteries 160
48. Abridged life table values for sites, 1650-1832 163
49. Rib periostitis in Coalescent sites, South Dakota 169
50. Selected cases of periostitis and osteomyelitis 172
51. Frequency of cribra orbitalia 173
52. Selected cases of cribra orbitalia 174
53. Selected cases of ectrocranial porosis/porotic hyperostosis 175
54. Macrocephaly and craniosynostosis 176
55. Spina bifida occulta 176
56. Comparisons of antemortem trauma in three skeletal series 177
57. Selected sites with cases of fracture 178
58. Frequencies of cranial and postcranial fractures 180
59. Selected sites with cases of enthesophytosis 180
60. Enthesophytes in skeletons from Crow Creek site 181
61. Enthesophytes by bone and sex, Larson cemetery site 181
62. Selected sites with cases of dislocations 182
63. Spondylolysis in samples from two states 182
64. Incidence of separate neural arches at two sites 182
65. Osteophyte formation and spondylolysis at two sites 182
66. Plains Village sites with evidence of warfare 184
67. Sites with trophy skulls and modified crania 184
68. Thickness and lengths of femurs from three variants 188
69. Femoral measurements by sex and time period 188
70. Lines of arrested growth in tibiae 190
71. Enamel hypoplasia in samples from two states 191
72. Dental caries in Late Woodland and CPT samples 193
73. Dental caries in South Dakota Coalescent tradition samples 193
74. Dental caries in Nebraska Coalescent samples 193
75. Dental caries in samples from three time periods 194
76. Dental caries and alveolar bone pathology 194
77. Carious teeth in protohistoric and historic Pawnee 195
78. Dental caries in Plains Village adults by gender 195
79. Alveolar bone pathology in Plains Village samples 196
80. Alveolar bone pathology, Nebraska 196
81. Alveolar bone pathology, South Dakota 197
82. Alveolar bone pathology by age and sex 197
83. SEM of molar enamel microwear 200
84. Interproximal grooves in Woodland Coalescent collections 200
85. Interproximal grooves in mixed South Dakota collections 201
86. Sites with artificially deformed crania 202

Foreword

This research was coordinated by the Arkansas Archeological Survey under the Department of Defense Legacy Resource Management Program. The contracts were administered by the Tri-Services Cultural Resources Research Center at the U.S. Army Construction Engineering Research Laboratories (USACERL), Champaign, IL. The contract manager and Principal Investigator was Dr. John S. Isaacson. Col. James T. Scott is Commander and Dr. Michael J. O'Connor is Director of USACERL. Mr. Larry Banks, formerly U.S. Army Corps of Engineers Southwestern Division archeologist, consulted extensively on the project.

The Central and Northern Plains Archeological Overview project includes four studies: the northern Great Plains (the Rockies east to the Minnesota River), the northwest woodlands (the Minnesota River east to the Great Lakes), the central Great Plains, and the central prairie-timberlands of Missouri. Using the concept of human adaptation, these overviews place cultural resources within cohesive environmental and cultural areas rather than arbitrary political boundaries such as states. These syntheses make clear why properties are significant, where there are gaps in archeological and bioarcheological knowledge, and what the future directions are for cultural resources planning by Department of Defense installations, the U.S. Army Corps of Engineers, and other federal agencies. In addition to the four archeological volumes, all citations are being entered in the National Archeological Citation Data Base. Other volumes included as part of this project are management guidelines, an executive summary, the bioarcheological sections of each area combined into a single volume, and a citations CD. Taken together with the volumes from the Southwestern Division of the U.S. Army Corps of Engineers Overviews (Arkansas Archeological Series Nos. 31-38), there are now syntheses of the current archeological record for almost one-half of the United States.

The Legacy Resource Management Program was established by the Congress of the United States in 1991 to provide the Department of Defence with an opportunity to enhance the management of stewardship resources on over 25 million acres of land under DoD jurisdiction.

Legacy allows DoD to determine how to better integrate the conservation of irreplaceable biological, cultural, and geophysical resources with the dynamic requirements of military missions. To achieve this goal, DoD gives high priority to inventorying, protecting, and restoring biological, cultural, and geophysical resources in a comprehensive, cost-effective manner, in partnership with Federal, State, and local agencies, and private groups.

Legacy activities help to ensure that DoD personnel better understand the need for protection and conservation of natural and cultural resources, and that the management of these resources will be fully integrated with, and support, DoD mission activities and the public interest. Through the combined efforts of the DoD components, Legacy seeks to achieve its legislative purposes with cooperation, industry, and creativity, to make the DoD the Federal environmental leader.

Acknowledgments

Many people have contributed in a variety of ways to enable and facilitate the completion of this project. I must thank the numerous contributors without whose efforts, which went well beyond the minimum required, this volume would not have been completed. At the Arkansas Archeological Survey, Charlie Ewen, Tom Green, and Mary Lynn Kennedy have been extremely patient and supportive. Mary Lynn has enabled the completion of this volume through her persistent and careful editing and production efforts. Others involved in the review and contribution to the design of the project include Larry Banks, Ruthann Knudson, and W. Raymond Wood. Archaeologists in Kansas, Nebraska, Colorado and elsewhere have been most supportive and helpful including Al Johnson, Jeff Eighmy, Rob Bozell, Steve Holen, Mike Metcalf, Marcel Kornfeld, Rhoda Lewis, Teresa Jacobs, Larry Todd, Daniel Amick, Vance Haynes, Vance Holliday, David Meltzer, James Gunnerson, Sally Greiser, Rolf Mandel, John Reynolds, Martin Stein, Larry Schmits, Randy Theis, Virginia Wulfkuhl, Tom Witty, and others. Numerous individuals in the Kansas region have aided this study through their contributions to fieldwork and in allowing access to collections. These include Charlie Norton, Dan Busse, Rod Laird, Wayne Miller, Jerry and Donna Ashberger, Ted McMillan, Pete Bussen, Matt Ford, Harlan House, Walt Lambkin, Charlie Drew, Jim Coons, Milton Reichart, Gerald Steele, Edith Dobbs, Don McDaniel, Delbert Powell, Rich Edmiston, and others. At the University of Kansas, many people have supported this work and enabled its completion. These include Dave Frayer, Don Stull, Carol Archinal, Barbara Michaels, Karolyn Kinsey, Matt Hill, Dean Sather, Jeannette Blackmar, Margaret Beck, Will Banks, and Rosemary Miller. Special thanks are due to Pat and Jessi for putting up with lost evenings and weekends.

The bioarcheological research project has required the participation and cooperation of a number of people of which only a few are formally tied to the effort. Karolyn Kinsey conducted the bibliographic data entry for NADB. Dean Sather assisted repeatedly with the NADB work and other aspects of the overview. Carol Schweda performed the record keeping. General support in a variety of ways and encouragement were provided by Al Johnson, Dave Frayer, Will Banks, John Reynolds, Randy Thies, Martin Stein, Virginia Wulfkuhle, Jeff Eighmy, Rob Bozell, Amanda Jacobs. Douglas Owsley was in charge of documentation of human remains and their analyses. Many thanks to Charlie Ewen and Tom Green for facilitating this project through their consistent support and encouragement.

1 Introduction, by Jack L. Hofman

The Central Plains archeological overview represents part of a continuation and expansion of the U.S. Army Corps of Engineers overview project completed for much of the trans-Mississippi South. The current Central and Northern Plains archeological overview is divided into four principal regions with the Central Plains region joining the area already covered by the Southern Great Plains and Southwest overviews (Hofman et al. 1989; Simmons et al. 1989). The Central Plains region includes the northern half of Kansas, all of Nebraska, and northeastern Colorado (Figure 1). Because information has been developed at the state sale, the base maps used here will generally include all of Kansas, Nebraska, and Colorado. This region extends from the Rocky Mountains on the west to the Missouri River trench on the east. From north to south the region encompasses much of the Niobrara, Platte (South Platte), and Kansas river basins. This is an area of approximately 140,000 square miles (ca. 364,000 square km). While this specific area was the focus of the present volume, in reality southern Kansas has been included in many of the discussions which follow, generally with more detail and updated from that found in the Southern Plains volume (Hofman et al. 1989). Also, sites, finds, and complexes from areas adjacent to the study area are often included when relevant or critical information occurs outside the "boundaries" of the study area.

The overview is intended to provide a synopsis of available information about the paleoecology, bioarcheology, and archeological record from the period of earliest human use of the region through the historic period. One aspect of the project is to assist in the development of a national archeological literature data base (NADB). The Central Plains project has added approximately 600 new entries to this already expansive archeological bibliography which will be of value to researchers interested in accessing local or topical literature available for the region. This volume of the overview was completed by a number of researchers with complementary expertise in archeology and related fields.

On a regional scale archeological problems of preservation, recovery, pattern recognition, and interpretation need to be addressed through multiple perspectives and from a variety of research frameworks. These multiple approaches are critical because of the diverse contents and nature of the archeological record and the variety of questions that we ask of it. Therefore, in developing the present overview the aid of several archeological and nonarcheological specialists was enlisted.

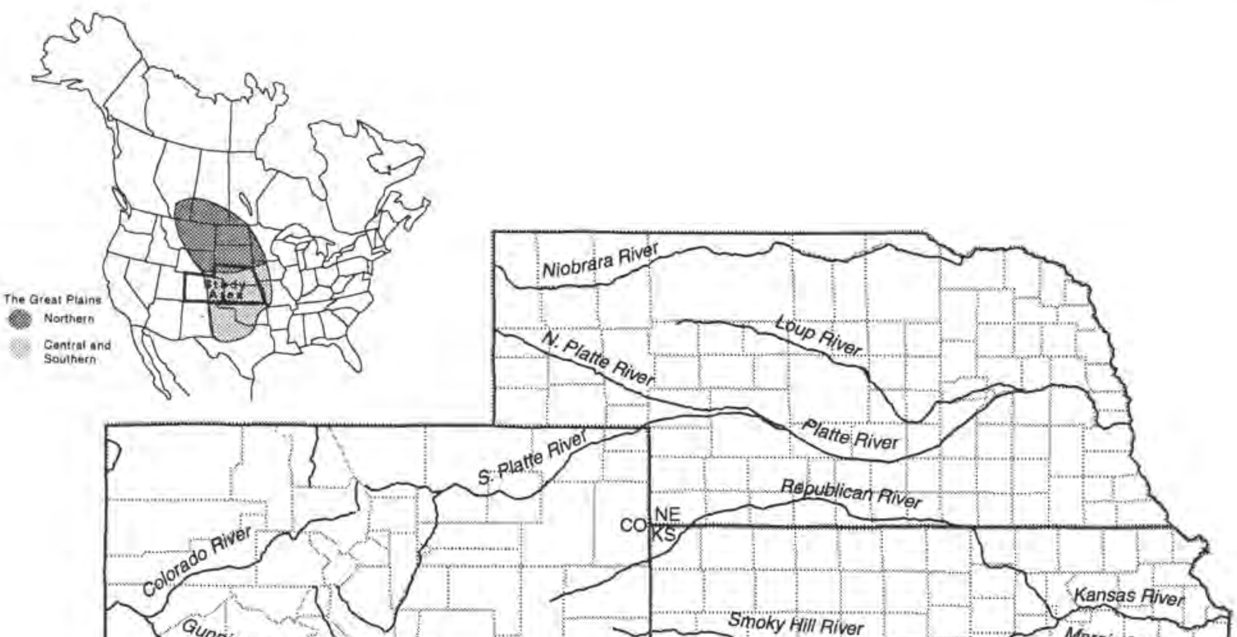


Figure 1. The states of Colorado, Kansas, and Nebraska in the Central Plains study area.

Given that the environments of this region are diverse and have been dynamic throughout the period of human habitation (Dort and Jones 1970; Caldwell et al. 1983; W. C. Johnson 1987), research specialists in paleoecology are working to summarize available studies of importance to archeology. Bill Johnson and Kyeong Park of the Department of Geography at the University of Kansas have prepared the geographic and paleoecological background for the region using geomorphology, soils, palynology, and the invertebrate records. This perspective is critical to developing realistic and useful models of paleoeconomy and land surface changes which have affected the archeological record and therefore site preservation, burial, recognition, and interpretation (e.g., Holliday 1987a; W. C. Johnson 1987; Johnson and Logan 1990; Mandel 1992, 1995).

The evidence from skeletal biology for the region is provided by Doug Owsley and Karen Bruwelheide. Information on more than 3,900 burials is provided for northern Kansas, Nebraska, and northeastern Colorado. This detailed analysis provides a summary of information by time period, cultural groups, patterns of mortality, pathologies, stress, warfare, and behavioral patterns.

The zooarcheological record and developments in the study of archeofaunas in the Plains region is also addressed. To an important extent developments in taphonomic research in the Plains region have been mutually beneficial between paleontology and archeology with significant feedback and interaction between practitioners in each discipline. Also, the paleobotanical evidence acquired primarily through the region's archeological record is reviewed by Mary Adair. This evidence, like that from zooarcheology, is critical to effective economic and seasonal interpretations from the archeological record. Such study is central to the problems of cultural change in the region (Adair 1988). Also, spatial and temporal data gaps in the paleobotanical record are evident. Adair has also prepared the summary of Woodland or early ceramic period archeology for the region. The record for the late prehistoric or Plains Village tradition is reviewed by Brad Logan, Museum of Anthropology, University of Kansas, and a synopsis of the archeological record for the historic period was completed by Bill Lees of the Oklahoma Historical Society. Some emphasis was given to the synopses for the preceramic hunter-gatherer cultures on the Central Plains, as these groups have often been lumped into overly simplified and stereotypic categories of Paleoindian and Archaic in the past with little concern for the diversity and variety of economies and technologies represented.

Adaptation types are used as a framework for grouping and comparing multiple archeological taxa or complexes into broadly similar economic-social groups which span large regions and crosscut modern political boundaries. These relatively static and functional summaries provide a useful basis for addressing some major research needs and problems in archeological interpretation.

2 Late Wisconsinan and Holocene Environmental History, by William C. Johnson and Kyeong Park

This chapter is intended to summarize what is currently known about the paleoenvironmental history of the Central Plains, i.e., the states of Kansas, Nebraska, and eastern Colorado (Figure 2). Objectives are to summarize the current status of knowledge about environmental changes in the Central Plains during the late Quaternary and to briefly identify gaps that exist in the data base. Such a summary provides necessary context for understanding the cultural history of the region. Archeologists have long recognized that the data base is not inherited in a pristine state, i.e., the archeological record preserved in the landscape is an incomplete rendering of past cultural activities that formed vulnerable fossil remains subjected to a variety of postdepositional processes. Consequently, the record must be extracted and the extent of modification be appreciated.

Less is known about environmental conditions in the Central Plains during the late Pleistocene and Holocene than many other regions of North America, due primarily to an inability to widely apply the more traditional investigative tools such as palynology and dendroclimatology. Consequently, that which is known has been and is being derived using some of the newer approaches to late Quaternary environmental reconstruction such as stable isotope analysis, opal phytolith analysis, and rock magnetism. Those sedimentological contexts being explored include loess, eolian sand sheets and dunes, alluvial fill, and to a lesser extent isolated lake and peat deposits. The loess deposits of the region, which represent some of the thickest and most complete loess accumulations in North America, hold the potential to provide a particularly promising avenue for the pursuit of the paleoenvironmental record.

We address only the Wisconsinan Stage of the Pleistocene and the Holocene since this is the period for which the most data are available and of greatest relevance to a prehistoric cultural context. Further, the establishment of radiocarbon chronostratigraphies permits correlations with the cultural overlays. First, however, the climatic and physiographic settings are presented as a backdrop.

Climatic Setting

The principal climatic features of the Central Plains are its continentality and Rocky Mountain-induced rainshadow. The Prairie Wedge, which dominates the study region, is a consequence of the zonal westerly airflow crossing the western mountains and penetration of modified Pacific air mass (Borchert 1950, 1971). Isohyet patterns exhibit a longitudinal orientation, with mean annual precipitation decreasing from over 40 inches (1,000 mm) at the southeastern margin to less than 15 inches (380 mm) in the western and northern parts (Figure 3). Winters are typically cold with relatively little precipitation, mostly as snow; summers are hot with increased

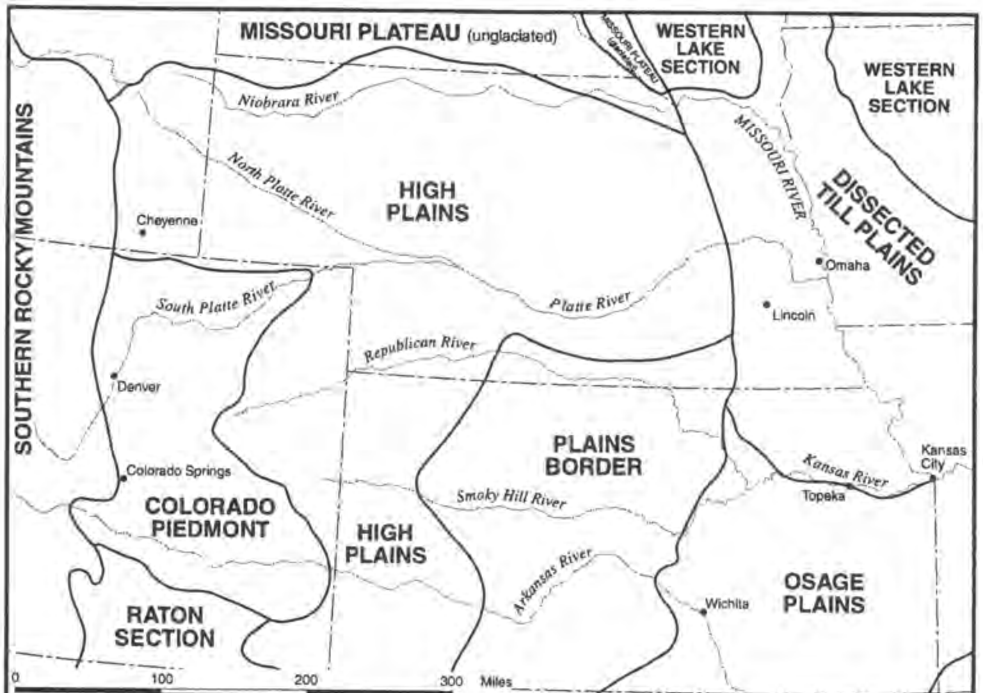


Figure 2. Physiographic map of the Central Plains study area.

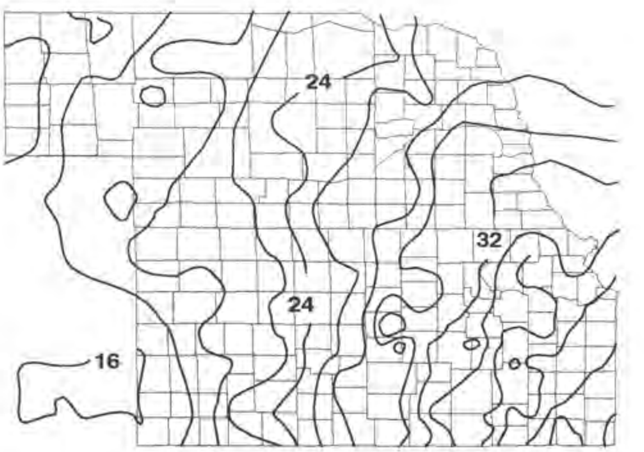


Figure 3. Mean annual total precipitation (inches) for the Central Great Plains (after Climatic Atlas of the United States 1983).

precipitation, chiefly associated with collision of Pacific (mP) and Arctic (cA) air masses with warm, humid air masses (mT) from the Gulf of Mexico. Since it determines the carrying capacity of the region, drought is the most significant climatic element of the Great Plains environment from the ecological, historical, and prehistoric standpoints (Weakley 1943; Barry 1983; Wedel 1986). Vegetation is mostly prairie grassland, due to the subhumid-semiarid, markedly seasonal climate. The mean tropical Atlantic airflow (mT) that influences the grassland east of about the 100th meridian in normal summers has tended to give way during the summers of drought years to continental flow (Figure 4).

Figure 4. Regions dominated by the various air mass types. The shaded regions are occupied more than 50% of the time by the indicated air mass (after Bryson 1966).

The prairie crosses the region from north to south in three broad zones (Figure 5). In the west, the grama-buffalograss prairie consists of short grasses, while the bluestem prairie with its tall grasses and many forbs prevails in the east. Between them lies the mixed prairie with tall, medium, and short grasses (Küchler 1964; 1974). In the sand sheets of southeastern Colorado, west-central Nebraska and central Kansas, edaphic conditions promote the existence of a sandsage-bluestem prairie. The sensitivity of prairie composition and boundaries to short-term climatic variation during the historical period is well documented for the region (Tomanek and Hulett 1970). Similarly, long-term prairie expansion and contraction, presumably in response to climatic variation, is documented at the prehistoric time scale (e.g., Watts and Wright 1966; Grüger 1973; Bernab and Webb 1977; Bradbury 1980). The consequence of short- and long-term climatic variations within the Central Plains and attendant changes in the vegetation probably had measurable impact on prehistoric peoples, but the magnitude of such is, however, certainly open to question (cf., Wedel 1961a; Reeves 1973; Johnson 1990).

According to Borchert (1950), regional distinctiveness of the grassland climate lies basically in the precipitation. Low snowfall and low rainfall in the region are typical of winter. There is a greater risk of a large rainfall deficit in summer within the grassland than in the bordering regions of forests. The short-grass steppe receives markedly less rainfall than the remainder of the continental United States east of the Rockies during the summer. The grassland is distinguished from the forest region to the north by fewer days with precipitation, less cloud cover, and lower humidity, on the average, during July and August. The grassland is characterized by large positive departures from average temperature and by frequent hot winds during summer.

Physiographic Regions

The Great Plains physiographic region lies east of the Rocky Mountains and extends from southern Alberta and Saskatchewan almost to the United States-Mexico border (Figure 2). The Central Plains is a large region of generally low relief sloping eastward from the Rocky Mountains toward the Missouri and Mississippi rivers. Multiple continental glaciations, starting perhaps as early as 2.5 million years ago (Boellstorff 1978), caused reorientation of the Missouri River system southeastward tō the Mississippi River, resulting in many stream captures and other geomorphic changes (Wayne et al. 1991). Each time the ice blocked eastward-flowing rivers, proglacial lakes formed, spilled across divides, and developed new courses around the glacial margin. The present course of the Missouri River through North and South Dakota is chiefly along a late Illinoian ice margin. The Platte River evolved through spasmodic uplift of the Chadron arch (Stanley and Wayne 1972) and several early and middle Pleistocene glacial advances into eastern Nebraska and northeastern Kansas (Aber 1991). In the middle Pleistocene, the Platte River joined with the glacially diverted Missouri River and formed a wide alluvial plain across east-

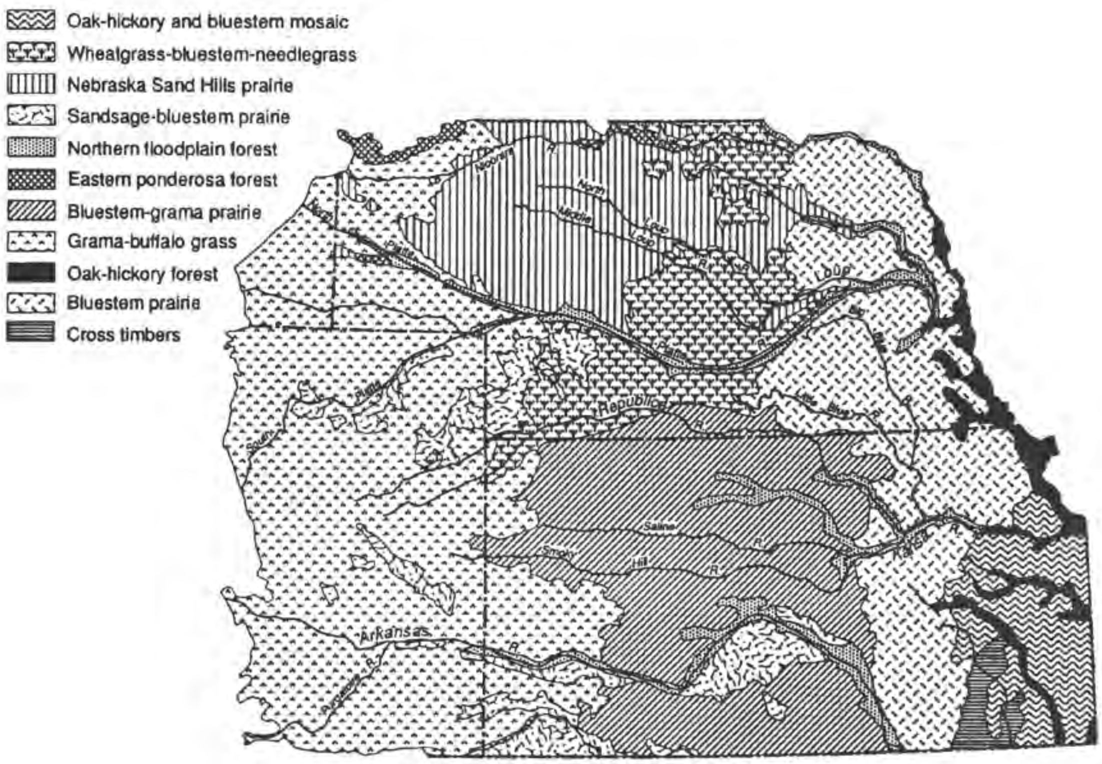


Figure 5. Native vegetation of the Central Great Plains (after Kuchler 1964).

central Nebraska and northeast Kansas. Quaternary erosion of the Central Plains, which largely is drained by the Missouri River, has been mostly by fluvial processes. However, the channel network in much of the Missouri River basin is the result of drainage rearrangements by glaciation.

In extreme southeastern Kansas, a small portion of the Ozark Plateau extends into Kansas. The streams of this region have carved the thick, flint-bearing Mississippian limestones into the present-day topography. To the west of the Ozark Plateau is the broad Cherokee Plain, a region developed on thick shale beds of the Cherokee Formation of middle Pennsylvanian age. The low-gradient, shallow streams have planed the surface of this low-relief region.

West and north of the Cherokee Plain, the topography consists of a series of parallel northeast-southwest trending cuestas. Cuesta topography is developed as a series of ridges having a sharp slope on the east side and a gentle slope on the west side. A series of relatively erosion-resistant limestone strata exposed at the surface descend gently westward until they dip under the outcrop of thick overlying shale. The shale underlying the capping limestone is less resistant to weathering and erodes to form an abrupt east-facing escarpment.

To the west of the Osage Cuestas is a band of grass-covered limestone hills, the Flint Hills, a preserve of the Kansas tallgrass prairie. The Flint Hills are located at the eastern edge of a huge expanse of grass-covered plains that extends continuously westward to the Front Range of the Rocky Mountains, northward into Canada, and southward into northern Texas. At the western margin, the Flint Hills dip gently under younger rocks which, on the north, slope gently westward under the Smoky Hills escarpment. To the south, these strata dip below the McPherson-Wellington Lowlands. Extending from north of Salina, Kansas southward to the Oklahoma border, the McPherson-Wellington Lowlands mark the outcrop belt of the thick Wellington shale.

Along the southern border of Kansas, from Harper and Kingman counties to eastern Meade County, erosion has exposed the Red Hills. The badlands topography of the Red Hills is unique to the Central Plains. In some areas, erosion-resistant dolomite caps the red Permian strata resulting in buttes and mesas.

Extensive areas of grass-covered sand dunes lying south of the Arkansas River constitute the Great Bend Sand Prairie. A similar region exists south of the Cimarron River in the southwestern corner of Kansas. During the late Pleistocene and Holocene, strong winds eroded fine sediments from alluvial surfaces of the Arkansas River and transported them to the dune area, which covered hundreds of square miles. North of the Great Bend Sand Prairie, Cretaceous rocks, exposed over a large portion of western Kansas, constitute the Smoky Hills, named such because of their dark shales.

From Saskatchewan to northern Texas, lie the High Plains. Viewed from a broad perspective, the whole of the High Plains surface is upheld by a huge wedge-shaped, alluvial apron consisting of sediment derived from erosion of the eastern Rocky Mountains. These sediments, the Ogallala Formation, represent Miocene stream deposition similar to that presently occurring in the Arkansas River to the south. The Ogallala Formation is composed not only of river-borne sands and gravels, but also of loess, volcanic ash beds, and diatomite deposits.

The eastern part of the Central Plains is an area of rolling hills that was invaded by one or more glacial ice masses during the Pleistocene. With the abandonment of the classic Nebraskan and Kansan nomenclature for glacial stages, the intrusions of ice into this region are designated as pre-Illinoian, with the exception of extreme northeastern Nebraska, which experienced glaciation during the Wisconsinan Stage. The use of the traditional terms has been confused and has become ambiguous, e.g., coring "Nebraskan" till yielded three separate tills separated by distinct soils (Hallberg 1986). Despite the lack of a chronology and nomenclature, glaciers occupied the eastern fifth of Nebraska and northeastern Kansas. Glaciers apparently advanced into Kansas twice from two different directions, the second of which did so between 600 ka and 700 ka (Aber 1991).

Central and western Nebraska is mantled by extensive deposits of Wisconsinan to late Holocene eolian sands known as the Sand Hills. The age and origin of this spectacular eolian feature are yet uncertain. Ahlbrandt et al. (1983) suggested that the dunes are late Holocene features, possibly derived from older, unconsolidated sediment that mantled the Great Plains. In contrast, Wells (1983) regarded the Sand Hills as a coarse, upwind facies of a single late Pleistocene sand-silt unit.

There are three dune fields in northeastern Colorado (Figure 6). The relatively small Greeley dune field is located immediately north of the South Platte River, and the larger Fort Morgan dune field lies south of the river. The Wray dune field, the largest, is on the High Plains to the east and southeast of the other two. The Fort Morgan and Wray sands were probably derived from sediment of the South Platte River under northwest winds during late Holocene time. The source and direction of movement of the Greeley sand hills are, however, uncertain (Muhs 1985).

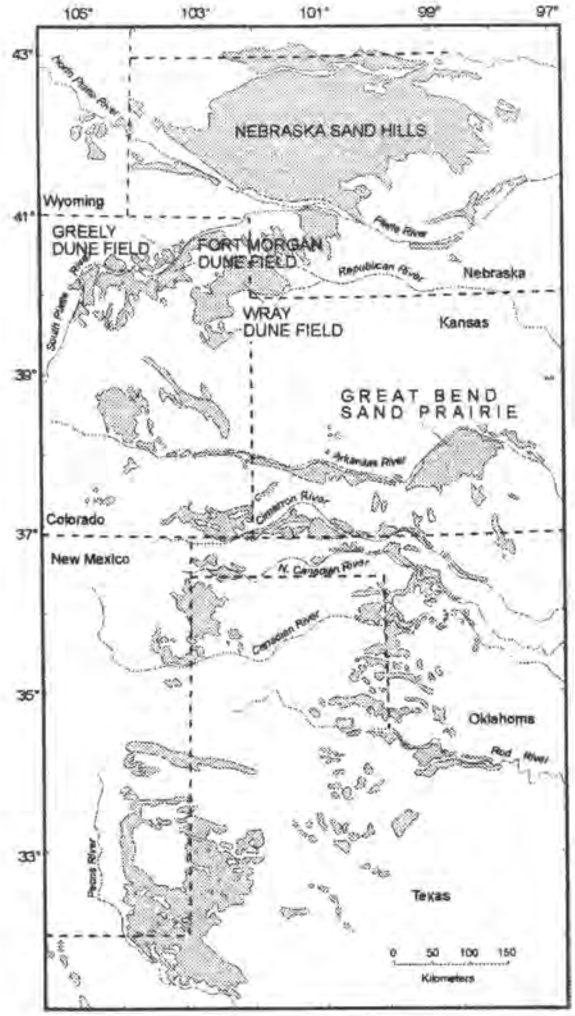


Figure 6. Distribution of dune fields and sand sheets in the Central Great Plains (after Muhs and Holliday 1995).

Late Wisconsinan Stage

Due to its relative youth, the Wisconsinan Stage has the greatest chronostratigraphic resolution. Based on the chronology from Illinois, five substages of the Wisconsin have been traditionally recognized: the Altonian (70,000-28,000 yr B.P.), Farmdalian (28,000-22,000 yr B.P.), Woodfordian (22,000-12,500 yr B.P.), Twocreekan (12,500-11,000 yr B.P.), and Valderan (11,000-5000 yr B.P.) (Willman and Frye 1970; Frye and Willman 1973). This chronology of substages has, however, limited stratigraphic application in Nebraska, Kansas and eastern Colorado, and has therefore not been adopted literally.

In Nebraska, Reed and Dreeszen (1965) identified four Wisconsinan units: the Gilman Canyon Formation (an upland loess with soil development), Peoria Formation (fluvial sand and silt in valleys and loess on the uplands), Brady Interstadial soil, and Bignell Formation (dune sand and loess). For the Wisconsin of Kansas, Frye and Leonard (1952) recognized early Wisconsinan alluvial deposits and the Sanborn Formation. The late Wisconsinan units of the latter included the Peoria loess, Brady soil and Bignell loess (Figure 7). Since these early statements of stratigraphic succession, the Bignell loess has been assigned to the Holocene.

During the 1960s, the record of past climate was based primarily on continental deposits, but these were rarely continuous sedimentary records, and consequently the picture of past climatic variations that developed was therefore incomplete (Bradley 1985). In the next decade, studies of marine sediments revolutionized our understanding of climatic variations and enabled models of the causes of climatic changes to be tested. Undoubtedly, studies of marine sediments have provided data bases which continue to expand in quantity and quality (Ruddiman 1985). However, the 1980s experienced a renewed focus on continental records of climate, which complement the perspective provided by marine sediment (COHMAP Members 1988). Continental deposits often provide a

Time-Stratigraphic		Eolian	Fluviatile		Glacial	Soils	Terrace Surfaces	
		Classification — Rock-stratigraphic						
Wisconsinan	Late	Bignell Loess and Dunesand	Bignell Formation	Silt / sand-gravel	Absent		2a / 2b	2
Wisconsinan	Medial	Peoria Loess and Dunesand	Peoria Formation	Silt / Todd Valley Sand	Hartington Till	Brady	3	
Wisconsinan	Early	Gilman Canyon Formation	Gilman Canyon Formation		Absent	Unnamed		3
Sangamonian	Late	Loveland Loess	Loveland Loess	Silt / sand-gravel	Absent	Sangamon	4	4

b

Time-stratigraphic units	Rock-stratigraphic units: Northeastern area		Southeastern area		Central and Western area	
Recent stage	Eolian and fluvial deposits					
Wisconsinan Stage	Bignell Formation	Fluvial deposits	Bignell Formation	Fluvial deposits	Bignell Formation	Fluvial deposits
	Brady Soil					
	Peoria Formation / G.C.F	Fluvial deposits	Peoria Formation	Fluvial deposits	Peoria Formation	Fluvial deposits
Sangamonian Stage	Sangamon Soil					
Illinoian stage	Loveland Formation	Fluvial deposits	Loveland Formation	Fluvial deposits	Loveland Formation / Crete Formation	
	Yarmouth Soil					
Pre-Illinoian	Loess	Fluvial deposits	Fluvial deposits		Sappa Formation	
	Cedar Bluffs Till / Fluvial deposits / Nickerson Till / Atchinson Formation				Grand Island Formation	
	Atfon Soil					
	Loess	Fluvial deposits	Fluvial deposits		Fullerton Formation	
	Iowa point Till / David City Formation				Holdredge Formation	

Figure 7. Late-Quaternary stratigraphic succession in (a) Kansas (Bayne and O'Connor 1968) and (b) Nebraska (Reed and Dreeszen 1965).

more detailed information about short-term (high-frequency) changes of climate than most marine records (Broecker et al. 1986).

Geomorphology and Stratigraphy

From Nebraska, loess deposits in the Central Plains extend west across eastern Colorado and south across most of Kansas. The thickest deposits of loess are adjacent to and underlie the Nebraska Sand Hills (Kollmorgen 1963; Ahlbrandt et al. 1980). The oldest laterally extensive loess unit in the region is the Loveland loess, found at least as far west as the Colorado/Kansas state line. In Kansas, exposures of Loveland loess are patchy and are found mostly on ridges near drainages (Welch and Hale 1987). The Peoria loess is the thickest and most laterally continuous loess deposit (Frye and Leonard 1951), whereas the overlying Holocene Bignell loess is found discontinuously in the Central Plains and is not identified east of the Missouri River.

Until recently, little age control existed for the timing of loess deposition in the Central Plains; age assumptions were based largely on the classical continental glaciation sequence, similar to that used for the loess stratigraphy in the Mississippi and Missouri river valleys. However, younger loesses and associated paleosols exposed at a number of localities in Kansas and Nebraska have been systematically radiocarbon dated and, to a lesser extent, thermoluminescence-dated (e.g., Souders and Kuzila 1990; Johnson 1993a; Martin 1993; May and Holen 1993; Feng et al. 1994a, 1994b; Maat and Johnson 1996). According to these age estimates, the Gilman Canyon Formation was deposited from at least 40 ka to about 20 ka, Peoria loess about 20 ka to 10.5 ka, and Bignell loess from about 9 ka to at least 5.5 ka.

Unconformably overlying the Loveland loess and the Sangamon soil that caps it is the loess of the Gilman Canyon Formation (Reed and Dreeszen 1965). The upper two-thirds of this loess are organic-rich and contains one or more cumulic A horizons that represent a period of slow accumulation and pedogenesis. Similarities in stratigraphic position, soil development and molluscan assemblages indicate it may be equivalent to the Farmdale interstadial soil (Johnson 1990, 1993). Recent age estimates also support correlations with the Roxana silt of the Upper Mississippi River valley (Leigh and Knox 1994) and the Pisgah Formation of western Iowa (Forman et al. 1992a). A transitional zone of loess, characterized by upwardly decreasing organic content and increasing color value (brightness), represents a slowly accelerating rate of loess deposition and separates the Gilman Canyon Formation from the overlying Peoria loess.

Peoria Loess

Late Wisconsinan loess deposits mantle much of upland surfaces of the region covering the Central Plains from the North Dakota/South Dakota border to that of Kansas and Oklahoma and provide a terrestrial record of late Quaternary climate. Thickest deposits lie adjacent to the Missouri River and its major tributaries (Ruhe 1983).

Leverett (1899) first proposed the name Peoria for an interglacial period between the Iowan and Wisconsinan glacial stages. When Alden and Leighton (1917) demonstrated the Peoria was younger than the Iowan, usage shifted to that of a loess, rather than of a weathering interval. Within the Midcontinent, several names have been used for post-Farmdalian loess. Ruhe (1983) preferred the term "late Wisconsin loess" because of the uncertainties in the stratigraphic equivalency from one region to another.

The Peoria loess is typically eolian, calcareous, massive, light yellowish-tan to buff silt that overlies the Loveland loess or an approximate equivalent of the Gilman Canyon Formation. Based on conventional and accelerator radiocarbon ages, deposition of the late Wisconsinan Peoria loess in Kansas and Nebraska began about 19.5-21 ka. In cold and arid conditions of the late Wisconsin, a high depositional rate was probable; at the Bignell Hill type section in southwestern Nebraska, for example, the sedimentation rate for the late Wisconsinan Peoria loess averaged 5.7 mm/year. This rapid deposition rate seems to be comparable to marine records and rapid enough to preserve high-resolution data for the late Wisconsinan environmental changes. The rate of accumulation for the Peoria loess was certainly variable, but apparent annual laminae are present at many localities near the Platte River valley of Nebraska, including the Bignell Hill and the Eustis ash pit sites (Johnson 1993b). Loess accumulation rates decreased as the regionally expressed Brady soil began developing between 10.6 and 10.1 ka.

The lack of any well developed, buried soils or other inconformities suggests that Peoria loess in the region represents a continuous deposit and that the faunal zonation reflects a change in the rate of deposition. Evidence that Peoria loess deposition was episodic has emerged from western Iowa (Daniels et al. 1960; Ruhe et al. 1971), central Kansas (Arbogast 1995) and southwestern Illinois (McKay 1979), where deposits exhibit dark, organic-rich bands that are thought to represent incipient soils formed during periods of slower deposition. Differential abundance and preservation of fossil mollusks in the loess have also been cited as evidence of episodic loess deposition (Frankel 1957).

The loess thickness decreases gradually with distance to the south and southeast of the Platte River valley. Except for the loess of the Loess-Drift Hill area in southeast Nebraska, loess south of the Platte was deposited rather evenly on a nearly level surface of old alluvial sands and gravels. In the Loess-Drift Hill area of southeast Nebraska and in most of the area north of the Platte River, the loess mantles a previously dissected and hilly topography.

Little is known about the environmental conditions in the Central Plains during Peoria loess deposition. Early studies, however, postulated that loess likely accumulated under dry conditions (e.g., Schultz and Stout 1948). Evidence from modern depositional environments suggests, however, that well-vegetated rather than barren surfaces favor loess deposition (Martin 1993). Additionally, the rich landsnail fauna of Peoria loess in the Great Plains implies deposition on a vegetated surface (Leonard 1952; Ostlie 1986; Wells and Stewart 1987a).

Recent findings indicate that trees were present in the Central Plains during Peoria loess deposition, although the distribution and density of tree cover is unknown. Wells and Stewart (1987b) recovered *Picea glauca* (white spruce) cones, needles, and wood from Peoria loess at several sites in south-central Nebraska; radiocarbon ages on the wood range from 14,700 to 13,000 yr B.P. (Johnson 1989). Wells and Stewart (1987) also report charcoal in Peoria loess at two locales in north-central Kansas. At the Coyote Canyon site in south-central Nebraska, bands of charcoal near the base of the Peoria loess afforded additional radiocarbon ages which range from 21,250 to 19,730 yr B.P. (Martin 1993). At the nearby Sindt Point site, Johnson also reports an additional age determination of 21,440 yr B.P. for *Picea* (spruce) charcoal (Table 1).

An upland pollen record from southeastern Kansas suggests that a *Populus* (aspen) parkland was present during the late Pleistocene (Fredlund and Jaumann 1987). Watts and Wright (1966) conclude that *Picea* was the dominant vegetation cover in the Nebraska Sand Hills until 12,500 yr B.P., when it was gradually replaced by *Pinus* (pine) and herbaceous vegetation. Recent surveys of the Midcontinent pollen record by Webb et al. (1983) and Baker and Waln (1985) postulate parkland vegetation with treeless openings on the Central Plains during the late Pleistocene.

Ruhe (1983) noted three major features of late Wisconsinan (Peoria) loess: it thins downwind from the source area, decreases in particle size systematically away from the source area, and is strongly time transgressive at its base. The last feature is problematic and causes correlation problems. Ruhe (1969) realized a decrease in the age of the soil under the loess from 24,500 yr B.P. near the Missouri River to about 19,000 yr B.P. eastward across southwestern Iowa. A decrease from 25,000 to 21,000 yr B.P. was noted for the base of the loess along a transect in Illinois (Kleiss and Fehrenbacher 1973). The top of the loess also seems to be time transgressive, ranging from about 12,500 yr B.P. in Illinois (McKay 1979) to about 14,000 yr B.P. in central Iowa (Ruhe 1969).

Despite the attention given to the Peoria loess in Central Plains, the source of the silt is not completely certain. From their review of available data, Welch and Hale (1987) concluded that a single source was not likely for all loess deposits in Kansas and that the loess was derived from a combination of three sources: glacial outwash river floodplains, present sand dune areas, and fluvial and eolian erosion of the Ogallala Formation. The Platte River undoubtedly contributed massive quantities of loess during glacial stages, as presumed (Swineford and Frye 1951). Loess is thickest immediately south of the Platte River valley, which suggests that the alluvium in the valley was the source of the loess, at least for those deposits adjacent to the valley (Kollmorgen 1963). Some local thickening of loess occurs to the southeast of the Platte River wherever streams enter from the Sand Hills to the northwest. With prevailing northwesterly winds, these locally thick deposits are probably partially derived from alluvium brought into this valley by these streams. In addition, nonglacial rivers in western Kansas and Nebraska probably contributed substantially more to the volume of loess in the area. Local loess deposits in excess of 23 m have been measured along the southeastern bluffs of the Arikaree and Republican rivers (Swineford and Frye 1951). Swineford and Frye (1951) concluded that the Arkansas River carried too sandy a sediment load to act as a major loess source and suggested that most of the loess deposited south of the Arkansas River in southwest Kansas was derived from northern sources.

In Nebraska and Kansas, radiocarbon and thermoluminescence dating indicates that Peoria loess in those areas correlates temporally with the Peoria loess of Iowa, Illinois, and Indiana (e.g., Johnson et al. 1993a; May and Holen 1993; Martin 1993; Maat and Johnson 1996). However, much of the loess in Kansas and Nebraska occurs upwind of or distant from late Wisconsinan continental glacial outwash sources. In addition, some of the thickest deposits of loess in Nebraska occur upwind of the Platte River (Swinehart 1990). Flint (1971) pointed out that the volume of loess on the Great Plains is surprisingly high if it was all generated from glacial outwash derived from the Rocky mountains. At the present time, the source of loess in the Kansas and Nebraska portion Central Plains is unknown, and more than one source may be involved (Welch and Hale 1987).

Welch and Hale (1987) concluded that loess in northwest, north-central, west-central, central, southwest, and south-central Kansas was derived from regional sand dune areas in central and western Nebraska (Sand Hills area), whereas loess in southwest Nebraska, eastern Colorado, southwest and south-central Kansas from alpine glacial-outwash sediments of the floodplains of the Platte and Arkansas rivers and from floodplain

Table 1. Wood and Charcoal Ages from Late-Wisconsinan Deposits in Kansas and Nebraska.

Location	Material	Sample	Age	Source
Kansas				
Mt. Hope Sand Co., Sedgwick Co.	*Picea* litter	Dic-3101	19,340±200	Jaumann,1991
GMD5 site 9, Edwards Co.	*Picea* charcoal	TX-6479	17,970±330	Johnson,1991a
Coon Creek, Graham Co.	*Picea* charcoal	GX-9355G	17,930±550	Wells and Stewart,1987b
Courtland Canal, Jewell Co.	*Picea* charcoal	Beta-9320	14,450±140	Wells and Stewart,1987b
Nebraska				
North Cove, Harlan Co.	*Picea glauca*	Beta-12986	14,700±100	Wells and Stewart,1987b
Coyote Canyon, Harlan Co.	*Picea* charcoal	TX-7294	21,250±530	Martin, 1993
Coyote Canyon, Harlan Co.	*Picea* charcoal	TX-7295	19,730±300	Martin, 1993
Sindt Point, Harlan Co.	*Picea* charcoal	Tx-7711	21,440±200	Johnson (unpublished data)
Bloomington, Franklin Co.	*Picea* or *Larix*	Beta-42015	18,830±180	May and Holen,1993
South Loup River, Buffalo Co., Grant Co.	*Abies balsamea*	Tx-6128	14,080±190	May 1989; Swinehart, 1990
	fragments	Beta-27758	13,160±450	

sediments of nonglacial rivers such as the Arikaree, Republican, Solomon, Saline, Smoky Hill, Pawnee, and Cimarron.

Trace element analysis (e.g., cerium, strontium, yttrium, zirconium) is being employed to gain insight into loess source and paleowind directions (Johnson et al. 1993b). Concentrations of many of the considered elements decrease south/southeastward away from the Platte River valley and Sand Hills of Nebraska. Superimposed on the overall trend is an increase in concentrations at sites adjacent to major river valleys due to a 'refreshening effect' (Johnson and Muhs 1996).

Peoria loess deposition appears to relate to the formation of the Sand Hills of Nebraska. Kutzbach and Wright (1985) argue that the Sand Hills of Nebraska is the source for much of the Peorian loess in the region, and that formation of the huge transverse dunes within the Sand Hills must have occurred during a period of extreme aridity. Although strong circumstantial evidence links the Sand Hills to the adjacent body of Peoria loess, this hypothesis is not universally accepted (e.g., Ahlbrandt et al. 1983).

The question of the Sand Hills formation and Peoria loess deposition is germane to the investigation because, if the arguments of Kutzbach and Wright (1985) are correct, the Woodfordian, or at least some portion of it, was relatively xeric. This presumed Woodfordian aridity conflicts with at least some paleobotanical evidence in the region, particularly that related to the widespread occurrence of spruce and other taiga-like plant taxa (Table 1). These taxa, typically associated with the modern boreal forest, do not suggest moisture stress. The Woodfordian macrofossil record from the Central Plains includes several well documented and dated occurrences of *Picea* remains, indicating a cool, mesic environments.

Leonard (1952) subdivided the Peoria loess of Kansas into four zones on the basis of the molluskan fauna assemblages present. The basal zone is equivalent to a leached interval above the Gilman Canyon Formation and is void of molluskan material. The lower molluskan zone, or Iowan, produced an assemblage containing 14 species, two of which are diagnostic of the zone. A transitional zone, located between the upper and lower faunal zones contains elements of both assemblages and does not imply any abrupt changes in the depositional environment, although the depositional rate may have slowed somewhat. The upper molluskan zone, or Tazewellian, contains 26 species, 14 of which do not occur in the lower zone. Because of the relative youth of the Peoria loess, little of the upper zone has been removed from the upland.

Although readily visible stratigraphic breaks, such as the Jules soil recognized in Illinois (Frye and Willman 1973; Ruhe 1976; McKay 1979) and the soil zones in Iowa (Ruhe et al. 1971), have not yet been widely identified in Kansas and Nebraska, evidence of one or more stable or vegetated surfaces is common. One of the few indications of soil development recognized is that of a Bt horizon in the Medicine Creek valley (May and Holen 1993); interestingly, the soil has a probable Paleoindian association (May 1990, 1991). Other indications of soil development in the Peoria loess come from the magnetic data obtained at Fort Riley, Kansas (Johnson 1996b).

Many of the age determinations were made from *Picea* remains, indicating a cool, moist environment. For example, a radiocarbon age of 18,830 yr B.P. on *Picea* charcoal was obtained from the Woodfordian/Peoria-age deposits near Bloomington, Franklin County, Nebraska (May and Holen 1993). Although radiocarbon data documents the burial of vegetative material throughout the Woodfordian, two temporal clusters of ages appear from the limited data: 18-17 ka and 14-13 ka. The 18-17 ka time interval represents the Last Glacial Maximum, and the 14-13 ka interval represents the time of major deglaciation (Ruddiman 1987). By interpreting ice-core data from Greenland, Paterson and Hammer (1987) recorded a dramatic decrease in atmospheric dust content from about 13 ka; this period of reduced atmospheric dust may relate to the time of relative surface stability and tree establishment. May (1989) identified deposition of the Todd Valley Formation in the South Loup River of central Nebraska at about 14 ka; the Todd Valley was subsequently buried by loess. Furthermore, C. Martin (1990) identified entrenchment in the Republican River of south-central Nebraska at about 13 ka, after which valleys were filled with late Peoria loess.

Eolian Sand Deposits

Perhaps the most controversial of the geologic aspects of the Sand Hills is the age of eolian activity that produced the dunes. Traditionally, they have been considered to be as old as the late Pleistocene Peoria loess. Lugn (1968), Wright et al. (1985) and others have hypothesized that deposition of loess and the development of large sand dunes occurred contemporaneously. Smith (1965) hypothesized two main periods of eolian activity in the late Pleistocene. The first period formed the large crescentic dunes, and, following a period of dune stabilization, the second episode rejuvenated the earlier dunes and produced linear dunes. Recent attempts to model climatic changes of the last 18,000 years (COHMAP Members 1988) have modeled the Sand Hills as dating primarily from the late Pleistocene. However, no stratigraphic evidence has been reported that would lend support to these hypotheses. Some eolian sand was deposited during the last glacial episode, but the sand dunes of the Nebraska Sand Hills appear to have formed during the episodes of aridity and eolian activity occurring within the Holocene (Ahlbrandt and Fryberger 1980).

Landscape stability has also been episodic on the Great Bend Sand Prairie in the last 20,000 years (Arbogast 1995). During the late Wisconsin, Peoria loess accumulated periodically, and the prevailing northwest winds created lunettes on southern margins of playa-lake basins. A brief period of soil formation occurred during the Last Glacial Maximum about 18 ka (Figure 8). Floral materials recovered from the late Wisconsinan sediments suggest that the climate was more mesic than at present (Johnson 1991b).

Alluvial Deposits

Much of the chronology of late Wisconsinan landform evolution for the region was compiled in the 1940s and early 1950s, prior to the use of radiocarbon dating (e.g., Lugn 1935;

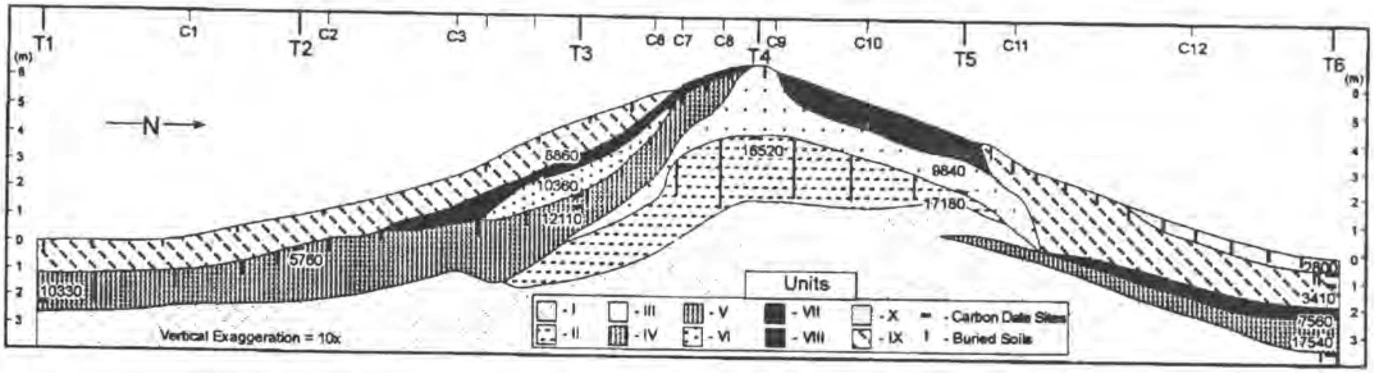


Figure 8. Cross sectional stratigraphy of the Wilson Ridge lunette, Kansas (after Arbogast 1995).

Schultz and Stout 1945; Frye and Leonard 1951), and focused to a large degree on the upland rather than valley deposits. Additionally, erosion has removed a large part of late Quaternary record from most drainage basins in the Central Plains (Knox 1983). Accordingly, a comprehensive sedimentation and erosion chronology for the region during the late Wisconsin is lacking.

It is becoming increasingly apparent that entrenchment occurred in the channels of the Kansas River basin sometime during the late Wisconsin. A basal soil buried within the fill of both tributary and major stream valleys of the Kansas River basin has an age of 10,500-10,000 yr B.P. (Johnson and Martin 1987; Johnson 1987; Johnson and Logan 1990), thereby providing a minimum age on the entrenchment. May (1989) has radiocarbon dated the Todd valley fluvial sand of central Nebraska to about 14,000 yr B.P., although Condra et al. (1950) had postulated a much earlier Wisconsinan age. Martin (1990; 1993) recognized a late Wisconsin fill in the Republican River valley that was largely removed through entrenchment about 13,000 yr B.P. A radiocarbon age of 14,700 yr B.P. was obtained on spruce wood situated above crossbedded fluvial sand and gravel at the North Cove site located in that same reach of the Republican River valley (Wells and Stewart 1987b; Johnson 1989). At the Prairie Dog Bay site in the Republican River valley, the stratigraphy and radiocarbon ages suggest downcutting before 11,800 yr B.P. (C. Martin 1990, 1993). Speculation about the cause of this entrenchment centers on an increase in effective moisture as climatic conditions ameliorated towards the end of the Pleistocene. Spring deposits dating to this time at the North Cove site possibly formed during the increase in moisture (Johnson 1989, Martin 1990).

Brice (1964) studied alluvial fills and terraces in the valleys of the North Loup, Middle Loup, and South Loup rivers of central Nebraska, and identified two major terraces in the Loup valleys. The Kilgore terrace occurs as remnants 26 to 30 m above stream level along the South Loup River. Brice suggested that valley fill underlying the Kilgore terrace is Peorian (late Wisconsin) in age. The adjacent Elba terrace, which stands 11 to 12 m above stream level, is the most prominent and extensive terrace in the main valleys with fill dating to the late Pleistocene and Holocene.

Climatic Proxies

Two general quantitative methods have been applied to the reconstruction of past climates. The first is to determine past climate through the analysis of local or regional field data with the aid of transfer functions. The other method uses large-area climate modeling with the boundary conditions determined by calculation or from field data. Neither supplants the other, for the reconstructions have different spatial scales and degrees of precision. Most models of past climates also require inputs that can only be obtained from field investigations (Smiley et al. 1991). Transfer functions refer to a quantitative relation between a climatic indicator, such as $\delta^{13}C$ data from buried soils, as an independent variable, and a climatic element or complex of elements, expressed as a dependent variable. The use of analogs for estimating past climates involves considerable uncertainty, brought about both by the complex mix of factors that constitute climate and by the complex response of most proxy climatic indicators in the record. In a sense, the use of analogs involves the construction of a mental transfer function based on the assumption of appropriate modern analog selection (Smiley et al. 1991). Because each source of paleoenvironmental data records a somewhat different aspect of climate, comparing reconstructions based on two or more environmental sensors can broaden and deepen our understanding of past climate changes.

With few suitable species and settings for dendroclimatological study and few natural wet environments to preserve fossil pollen for palynological studies, the nature and timing of late Quaternary vegetation and climate change in the Central Plains remain poorly understood. The region's late Quaternary climate and vegetation conditions are inferred from the palynological records obtained from sites peripheral to the Central Plains or from limited pollen records available at a limited number of sites in the region (Fredlund and Jaumann

1987; Fredlund 1995). However, some of the climatically sensitive parameters that have recently been examined in the Central Plains include fossil pollen, opal phytoliths, stable carbon isotopes, and rock magnetism. In addition to an expanding proxy base, recent research has indicated that the extensive loess deposits of the region contain an extractable climatic proxy record comparable to the marine isotopic record.

Fossil Pollen and Botanical Macrofossils

Several factors in the interpretation of Great Plains fossil pollen assemblages warrant consideration. Any interpretation of pollen assemblages for vegetational reconstruction must be based on appropriate analog studies of modern vegetation and pollen (Fredlund and Jaumann 1987). Additionally, in the Central Plains region where ideal wet depositional sites are rare, differential pollen preservation is a problem. Modern analogs are a basis for late Quaternary environmental reconstruction only where pollen deterioration has not significantly biased the informational content of the fossil pollen assemblage (Delcourt and Delcourt 1980). For example, differential preservation has been shown to be responsible for tremendous over representation of *Pinus* in some situations, while elsewhere rendering *Populus* invisible. Poor pollen preservation is therefore the limiting factor for many of the late Quaternary records in the Central Plains. Although temporally and spatially limited, several sites in the region have produced a picture of past environments (Figure 9).

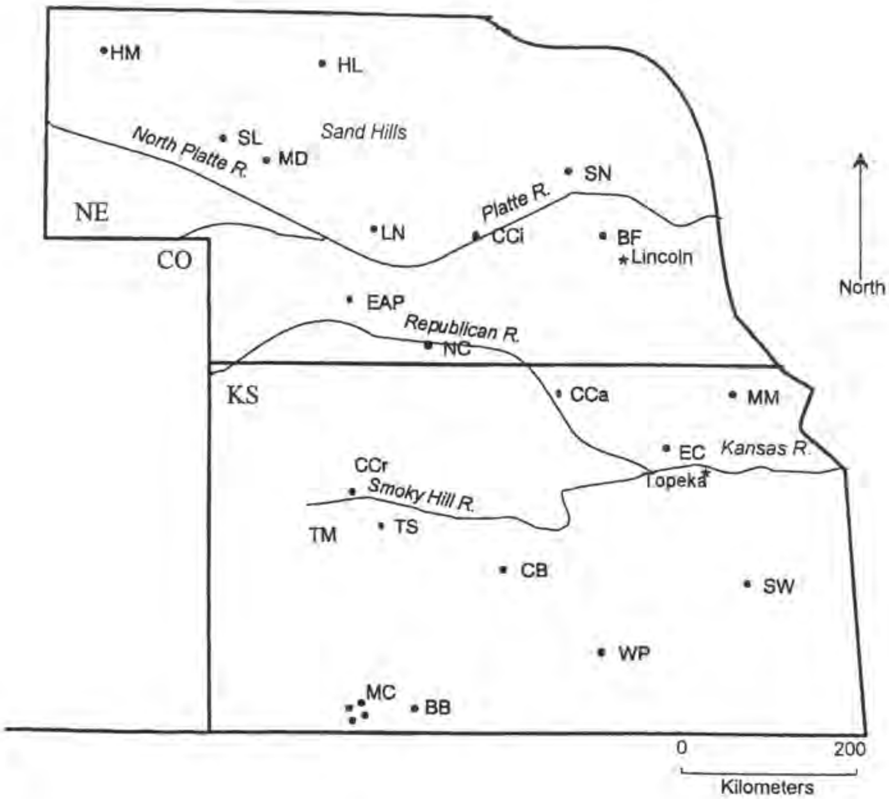
By the time ice lobes in Iowa and the Dakota had reached their maxima at about 14 ka (Clayton and Moran 1982), *Picea* had begun to spread its range northward into the Des Moines area (Baker and Waln 1985). By 12 ka, spruce forest was replaced along its southern margin by prairie in southern South Dakota. About 11 ka, *Quercus* (oak), *Populus, Fraxinus* (ash), and other hardwoods, which were probably confined to the central Unites States in glacial time, expanded their northern ranges and mixed with *Picea* in the eastern part of the northern Great Plains and the Midwest. This admixture of trees has no close analogs in the present day, but the vegetation is presumed to have been open and dominated by spruce, with some hardwoods and no pine.

The western limit of the forest is not known. At two sites in the glaciated region of northeastern South Dakota (Pickerel Lake: Watts and Bright 1968; Medicine Lake: Radle 1981), deciduous tree pollen replaced that of *Picea* about 11 ka, and prairie taxa appeared at about 10 ka. Pollen data from east-central North Dakota indicate a similar sequence. From the eastern fringe of the Central Plains, in Iowa and Missouri, pollen and macrofossil evidence suggests that open jack-pine forest of the Farmdalian period yielded rapidly to open white spruce forest around 22 ka (Fredlund and Jaumann 1987). A similar record of Woodfordian spruce forest comes from Muscotah Marsh in northeastern Kansas. According to Grüger (1973), a somewhat open vegetation, with pine, spruce, and birch as the most important tree species and local stands of alder and willow, changed about 23,000 yr B.P. to a spruce forest, which prevailed in the region until at least 15,000 yr B.P. Because of a hiatus in the sedimentary record, vegetation changes resulting in the spread of a mixed deciduous forest and prairie present in the region from 11,000 to 9000 yr B.P. remain unknown.

According to Wells and Stewart (1987b), the central and northern Rocky Mountains harbor extant populations of most of the boreal-subalpine species thus far recovered from Pleistocene sediments in the Central Plains. Moreover, even within the Northern Plains, there are numerous refuges for Pleistocene-relict species of trees, landsnails and small mammals on forested ecological islands surrounded by steppe, an outstanding example being the Black Hills of South Dakota. Cones and needles from Harlan County, south-central Nebraska enable the positive identification of the spruce as *Picea glauca* (Johnson 1989), the boreal white spruce of the neoarctic taiga that now grows from Alaska to Newfoundland and along the eastern flank of the Rocky Mountains to Montana, with outliers to the East on the Great Plains in the Cypress Hills of Saskatchewan and Black Hills of South Dakota.

The Rosebud site, near the northern edge of the Sand Hills on the Nebraska-South Dakota border, provides a pollen record of late Pleistocene vegetation. The pollen and plant macrofossil records indicate that a boreal forest existed at that location about 12,600 yr B.P., and that soon afterward a pine forest and subsequently prairie vegetation rapidly replaced the spruce (Watts and Wright 1966). Seeds and leaves of aquatic macrophytes at the site suggest that a fresh, open-water basin existed when spruce was prevalent, and that conditions changed to a species-poor, alkaline reed swamp with the change to prairie vegetation. This vegetational and limnologic history implies change from a cooler, probably somewhat moister climate to one of increased aridity and higher temperatures that characterizes the Sand Hills today. The pollen record of prairie vegetation at Rosebud does not significantly differ from that of modern surface samples in this area. The rapid disappearance of *Picea* pollen and its immediate replacement by *Pinus* and prairie herb pollen suggest a depositional hiatus, which makes it difficult to interpret subsequent vegetational history. It is clear is that prairie vegetation existed sometime after 12,600 yr B.P., and that the lake subsequently dried up and either the upper pollen-bearing sediments were destroyed, or intermittent fluvial deposition with poor pollen preservation occurred.

The association of nonarboreal taxa from sand pits near Wichita, Kansas indicates a substantial presence of steppe or grassland taxa on the late Pleistocene landscape of south-central Kansas (Jaumann 1991). Not only do these taxa represent a significant portion of the pollen spectra, but they also occur in consistent numbers and presently comprise the most important herbaceous taxa of the North American grasslands. Some of these taxa include Graminaeae (grass family), Asteraceae (sunflower family), *Artemisia* (sage), *Iva* cf. *xanthifolia* (marsh elder), *Xanthium* (cocklebur), *Amorpha* cf. *canescens* (lead plant), *Phlox* cf. *pilosa* (prairie phlox), *Petalostemon* cf. *purpureus* (purple prairie clover), *Potentilla* sp. (cinquefoil), *Ambrosia* type (ragweed), *Chenopodium/Amaranthus* (goosefoot, pigweed), herbaceous Rosaceae (rose family),



Key	Site, State	Depositional Environment	Time range	References
BB	Big Basin, KS	karst sink	late Holocene	Schumard 1974
BF	Barteck farm, NE	prairie fen	Pre-Wisconsin	Kapp 1965, 1970
CB	Cheyenne Bottom, KS	marsh	Wisconsin	Fredlund 1991
CCa	Courtland Canal, KS	loess/colluvium	Woodfordian	Wells 1983
CCi	Central City, NB	loess/colluvium	Woodfordian	Martin 1986
CCr	Coon Creek, KS	colluvium/loess	Woodfordian	Wells 1983
EC	Elbow Creek, KS	alluvial/paleosol	late Holocene	Kurmann 1985
EAP	Eustis ash pit, NE	loess/paleosol	pre-Wisconsin Holocene	Johnson 1993
HL	Hackberry Lake, NE	interdunal lake	Holocene	Sears 1961
HM	Hudson-Meng, NB	colluvium	early Holocene	Agenbroad 1978
LN	Litchfield, NB	alluvium	Farmdalian(?)	Rogers 1985
MC	Meade County, KS	karst sinks, springs/alluvium	pre-Wisconsin	Hibbard 1970, Kapp 1965, 1970
MM	Muscotah Marsh, Arrington Marsh, KS	bogs/marshes and alluvial	Farmdalian Holocene	Grüger 1973
MD	McPherson CO. Drill Hole, NE	lake(?)	Farmdalian	Swinehart 1986
NC	North Cove, NE	spring deposits	Woodfordian	Johnson et al. 1986
SL	Swan Lake, NE	interdunal lake	early Holocene	Wright et al. 1985
SN	Schuyler, NE	loess/colluvium	Woodfordian(?)	Wayne 1984
SW	Sanders's, KS	spring-fed bog	Farmdalian	Fredlund and Johnson 1985, Fredlund and Jaumann 1986
TM	12 Mile Creek, KS	alluvium	early Holocene	Rogers and Martin 1984
TS	Trapshoot site, KS	loess/paleosol	Woodfordian (?)	Stewart and Rogers 1984
WP	Wichita peat, KS	bogs(?)/alluvium	Woodfordian	Rogers and Martin 1985, Jaumann et al. 1985

Figure 9. Late-Quaternary pollen and macrobotanical sites in the Central Plains (from Fredlund and Jaumann 1987).

Fabaceae (bean family), *Epilobium* cf. *angustifolium* (willow-herb), Euphorbiaceae (spurge family), Cannabaceae (hemp family), and *Tradescantia* (spiderwort).

The closest vegetation type showing such a compositional mix can be found along the southern rim of the boreal forest on the Canadian Prairies. Mapping of the southern limits of coniferous trees indicate that the southern natural distribution of *Picea glauca, Picea marina* (black spruce), *Larix laricina* (tamarack), *Pinus banksiana* (jack pine), and *Pinus contorta* (limber pine) is confined to a narrow transitional zone between the taiga and aspen parkland (Jaumann 1991). Mosaics of grasslands and forests characterize the aspen parkland. The fossil plant communities recorded in the Wichita sand pits and Mt. Hope Sand Company pit pollen assemblages look very much like the vegetation types in this narrow transitional zone, which prominently extend eastward into the prairie or aspen parkland.

According to Fredlund (1995), the high relative frequency of Artemisia (sage) pollen in the Farmdalian record from Cheyenne Bottoms in central Kansas indicates that one or more species of sage were an extremely important element in the upland grassland-steppe. This vegetation assemblage does not, however, appear to be exactly analogous to the modern sagebrush steppe of the northwestern High Plains. The pollen evidence suggests that the regional vegetation, although dominated by grassland-steppe, was not totally treeless. Most of the arboreal elements present are boreal or taiga-like in their modern distribution. The most common trees of the Pleistocene vegetation in the region were not, however, coniferous. The low percentages of both *Picea* and *Pinus* pollen could be the result solely of long-distance transportation; this is especially likely for *Pinus* which could represent forests as far away as 400 km. In the case of *Picea*, however, it is more likely that local populations of trees were scattered along river valleys or fire-protected escarpments. It is extremely unlikely that the *Pinus* and *Picea* pollen signals from the Farmdalian portion of the record represent coniferous parklands or savannas, rather it is more likely that these low pollen percentages represent small populations of conifers limited to edaphically mesic and fire-protected situations.

Opal Phytoliths

Growing plants absorb water containing dissolved silica through their roots. Microscopic amorphous silica bodies are subsequently produced by the precipitation of hydrated silicon dioxide ($SiO_2 nH_2O$) within the plant's cells, cell walls, and intercellular spaces. Silica bodies with shapes characteristic of specific plants or group of plants are called opal phytoliths. Phytolith is derived from the Greek words phyton, meaning plant, and lithos, meaning stone, and opal is the common name for hydrated silicon dioxide. Opaline bodies formed in plants without specific shapes are simply plant opal or biogenic opal.

It is well known that three different photosynthetic pathways exist among plant species: C_3 (Calvin-Benson cycle), C_4 (Hatch-Slack cycle) and CAM (Crassulacean Acid Metabolism). Twiss (1987) suggested that grass-opal phytoliths could serve as indicators of C_3 and C_4 pathways in grasses. On the Great Plains, two grass subfamilies commonly employ the C_4 pathway: the Panicoideae and the Eragrostoideae. The panicoids include such common prairie grasses as the bluestems *(Andropogon* spp.), panicums *(Panicum* spp.), and Indian grass *(Sorghastrum nutans)*, as well as domesticated grasses, e.g., sorghum and corn. The grama grasses *(Bouteloua* spp.) and buffalograss *(Buchloe doctyloides)* of the Chloridoideae tribe of the Eragostoideae subfamily are the two most important of these grasses in the arid southwestern region of the Great Plains. Pooideae grasses such as the bromes *(Bromus* spp.), wheatgrass *(Agropyron* spp.), fescues *(Festuca* spp.), and many of the cereal grains, including wheat *(Thriticum aestivum)* and oats *(Avena* spp.), are C_3 pathway types. The overall pattern, where pooids (C_3) dominate the cool north-Central Plains, panicoids on the moist, warm eastern and southeastern margins, and chloridoids primarily in the western and southwestern Great Plains, is consistent with the pattern expected from general C_3 and C_4 adaptations of grasses.

Few workers have reported opal phytolith data from sites in the Central Plains. Among them, Fredlund et al. (1985) tabulated the abundance and type of phytoliths from a vertical loess section at the Eustis ash pit in south-central Nebraska. Pooid phytoliths were the most abundant forms, followed by significant vertical variation in the chloridoid and panicoid types. They concluded that increases in the chloridoid type in paleosol complexes indicated that the soil forming periods must have been warmer and drier than the periods of loess accumulation. The phytolith assemblages from the soil of the Gilman Canyon Formation is unique at the Eustis ash pit: nowhere in the entire 620,000-year record of loess accumulation at the site has anything similar been recorded. The high relative frequencies of panicoid-class phytoliths are even higher than those found in the tall-grass, panicoid-dominated prairies today. In general, the phytolith evidence of warmer soil-forming periods and cooler episodes of increased dust accumulation fits the traditionally accepted models for loess deposition and other proxy records.

Ongoing opal phytolith analysis of the Peoria loess is producing a climatic signal consistent with that of the carbon isotope data (Johnson et al. 1993a). Phytolith data can be represented as a composite parameter, the aridity index (Figure 10). A cool, mesic climate is apparent by the occurrence of arboreal phytolith types and C_3 grass types in the loess of the lower Gilman Canyon Formation and the Peoria loess.

Stable Carbon Isotopes

There are few quantitative techniques in use today for paleoecological reconstructions in terrestrial depositional systems. One recently adopted approach to quantitative reconstructions is to estimate the proportion of C_3 (cool-season) to C_4 (warm-season) plants once present at a site using

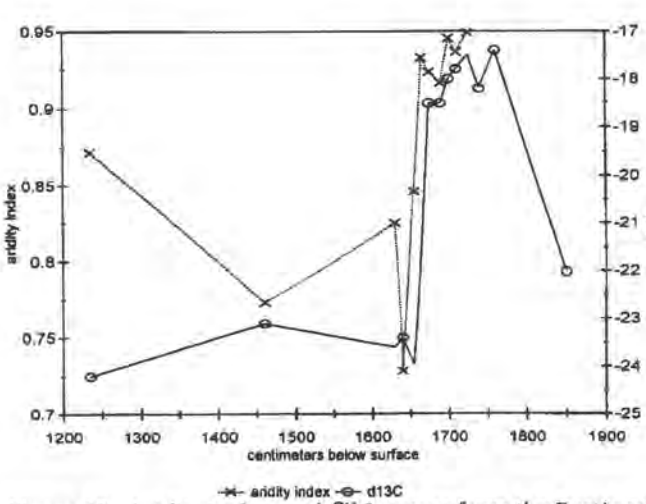


Figure 10. Aridity index and $\delta^{13}C$ curves from the Eustis ash pit, Nebraska. The abrupt change in both parameters at about 16.5 m depth is indicative of the shift from the warm season grasses of the Gilman Canyon Formation soil to the cool season grasses of the overlying Peoria loess (from Johnson et al. 1993).

carbon isotopes from the bulk carbon content in sediments, primarily in buried soils.

The natural difference in the stable carbon isotopic composition of C_3 and C_4 plant species provides an opportunity to assess the long-term stability of plant communities and climate of a given region (Troughton et al. 1974; Stout et al. 1975). The basis of this approach is that during photosynthesis C_4 plants discriminate less against $^{13}CO_2$ than C_3 plants (Vogel 1980; O'Leary 1981). This difference in carbon isotope fractionation during photosynthesis results in a characteristic carbon isotope ratio in plant tissue that serves as a diagnostic indicator for the occurrence of C_3 and C_4 photosynthesis. The $\delta^{13}C$ values of C_3 plant species range from approximately -32 to -20%, with a mean of -27%, whereas $\delta^{13}C$ values of C_4 species range from -17 to -9%, with a mean of -13%. Thus, C_3 and C_4 plant species have distinct, non-overlapping $\delta^{13}C$ values and differ from each other by approximately 14% (Nordt et al. 1994). The stable isotope ratios for $^{12}C/^{13}C$ are measured by mass spectrometry, and the isotopic data are expressed as the difference, or delta value (δ), between the sample or standard. The δ value for a carbon isotope in soil is defined as

$$\delta^{13}C\ soil = (\delta^{13}C_{c4})(x) + (\delta^{13}C_{c3})\ (1-x),$$

where $\delta^{13}C_{C4}$ is the average of $\delta^{13}C$ values of C_4 plants (-13%); ($\delta^{13}C_{C4}$) is the average of $\delta^{13}C$ values of C_3 plants (-27%); and x is the proportion of carbon from C_4 plant sources.

Isotopic composition of soil organic matter or pedogenic carbonate in soils with a high-respiration rate is a direct indicator of the fraction of the biomass using the C_3 or C_4 photosynthetic pathways. Humus from buried soils probably represents organic matter from the last few hundred years before burial, given the short residence times typical for humus in most modern soils (Birkeland 1984).

Teeri and Stowe (1976) found that the strongest correlation with the percent C_4 in the continental United States was given by the normal July daily minimum temperature, with a correlation coefficient of 0.97. This temperature was a better predictor of the percent C_4 than either the normal July average temperature or the normal July maximum temperature. Based on their analysis, the percent of C_4 species in a grass flora in the continental United States is most accurately predicted by a linear combination of the normal July minimum temperature, mean annual degree-days and the log of the length of the freeze-free period.

For the Gilman Canyon Formation, $\delta^{13}C$ values exhibit a good correlation with coincident phytolith data (Figure 10). $\delta^{13}C$ data acquired in association with the correction of radiocarbon ages for the Peoria loess in Kansas and Nebraska indicate that C_3 plants were dominant during most of Peoria loess deposition (Figures 11 and 12). This reflects the cooling associated with the Last Glacial Maximum within early-middle Peoria time (ca. 18 ka). Conversely, C_4 plants were dominant for most of the Gilman Canyon time of pedogenesis (Figure 10), indicating that vegetation and thus climate during Gilman Canyon time was similar to present warm, semiarid conditions in the Central Plains (Johnson 1993b).

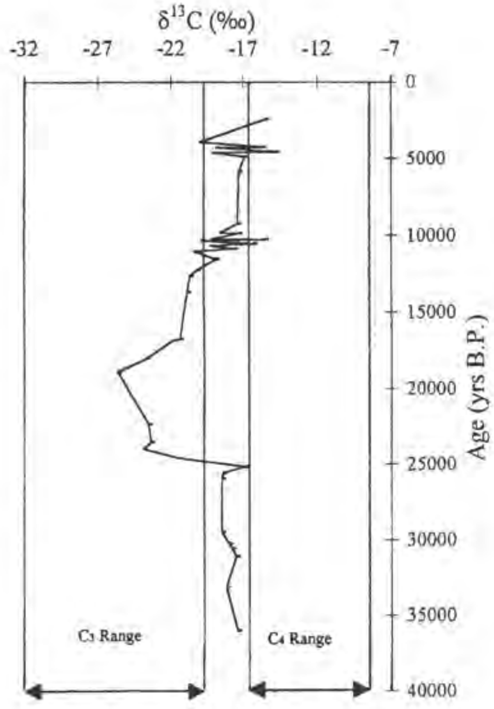


Figure 11. $\delta^{13}C$ values obtained from loess deposits of Kansas and Nebraska. The ranges in C_3 (cool season) and C_4 (warm season) plants indicate mixed communities for much of the last 35,000 years (after Johnson et al. 1993).

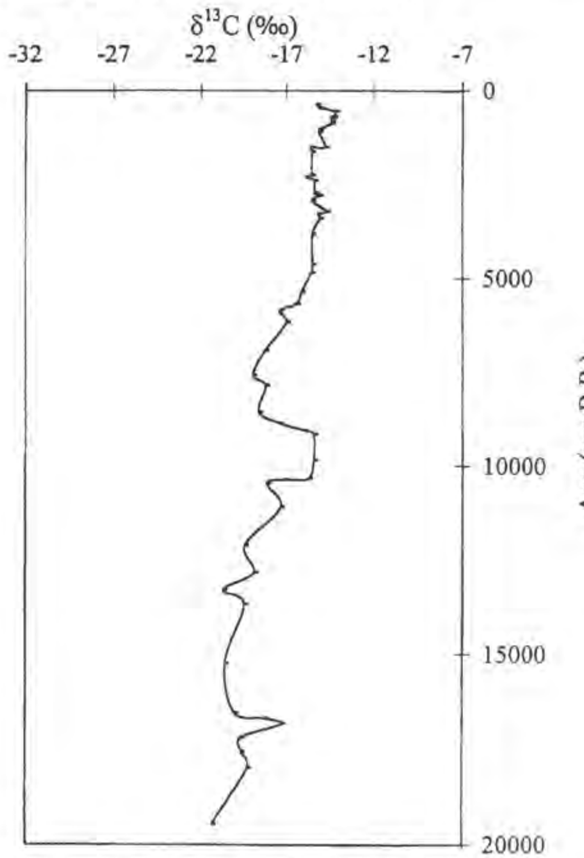


Figure 12. $\delta^{13}C$ values from the Great Bend Sand Prairie, Kansas for the past 21,000 years; data are smoothed (from Arbogast 1995).

Site-specific factors should be borne in mind when interpreting $\delta^{13}C$ data from soil humates. For example, the 17,000 yr B.P. buried soil on the north flank and crest of the dune at Wilson Ridge in the Great Bend Sand Prairie (17,180 ± 240, Tx-7824: 16,520 ± 200, Tx-7825) yielded a $\delta^{13}C$ value of -11.9% (Figure 12). During the Last Glacial Maximum, the dune temporarily stabilized and a soil formed. The $\delta^{13}C$ value suggests that warm-season or edaphic plants dominated, a finding contradictory with regional late Wisconsinan mesic climatic conditions. Following landscape stability, the soil was buried by sand, presumably during another period of increased aridity and prevailing northwesterly winds (Arbogast 1995).

Rock Magnetism

Loess is perhaps the closest terrestrial analog to marine sediments in that both result from more-or-less continuous deposition of fine-grained sediment. A great deal of attention, therefore, has been given to magnetic measurements of loess-paleosol sequences, particularly in China and in Europe (e.g., An et al. 1991; Kukla et al. 1988; Kukla 1977). Although much research has focused on paleomagnetic events such as excursions, recent studies in China have suggested that bulk magnetic susceptibility varies systematically in loess sections and can be visually correlated with the well-known marine oxygen curve (Kukla 1987), indicating that changes in the magnetic susceptibility of loess constitute a terrestrial proxy climatic signal. Further direct relationships between magnetic susceptibility and oxygen isotope variations have recently been demonstrated within some marine cores (Heller et al. 1991). Ongoing research is demonstrating that rock magnetism may be used to successfully reconstruct the climatic sequences of the Central Plains (e.g., Park et al. 1993; Farr et al. 1993; Johnson and Park 1996).

Magnetic susceptibility measures magnetization temporarily induced in a soil or loess by an artificially applied, low-amplitude magnetic field. The strength of the susceptibility signal depends on the concentration and grain size of the magnetic minerals. Magnetic susceptibility intensities measured at the Eustis ash pit and Bignell Hill sites in southwestern Nebraska, the Beisel-Steinle site in north-central Kansas, and Barton County landfill site in central Kansas indicate that magnetic intensities are strong in the Gilman Canyon Formation soil, i.e., susceptibilities are nearly twice that of the unweathered Peoria loess (Figure 13). Weaker intensities associated with the Peoria loess indicate that either the depositional rate was faster than in times of soil development or that biologic/soil forming activity was weaker in Peoria time, presumably the latter. Susceptibility curves from the region correlated well despite the distance from each other, testifying to the regional synchroneity and direction of change in climate.

Magnetic analysis from the Eustis ash pit produced a climatic signal consistent with that of the carbon isotope data (Figure 14). Weaker intensities throughout the Peoria time likely reflects the more moist and cooler C_3 plant types and the cooling associated with the Last Glacial Maximum. The terrestrial plant ecology of the Gilman Canyon Formation apparently is characterized by primarily C_4-type grasses, or warm, possibly dry climate (Johnson 1993b). From the magnetic susceptibility data, it is evident that an environment suitable for more active pedogenesis existed.

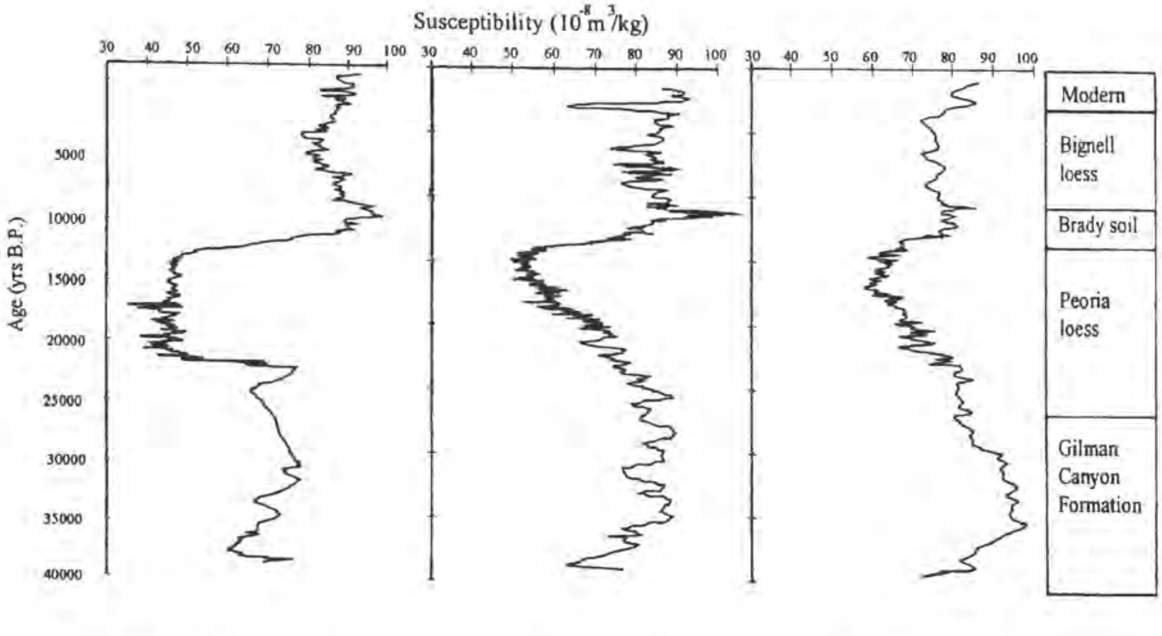


Figure 13. Magnetic susceptibility from sites in south-central Kansas (Barton County, Beisel-Steinle) to southwestern Nebraska (Eustis ash pit, Bignell Hill). The Gilman Canyon Formation and Brady soils are well represented in the curves, as is the Last Glacial Maximum (Johnson et al. 1993).

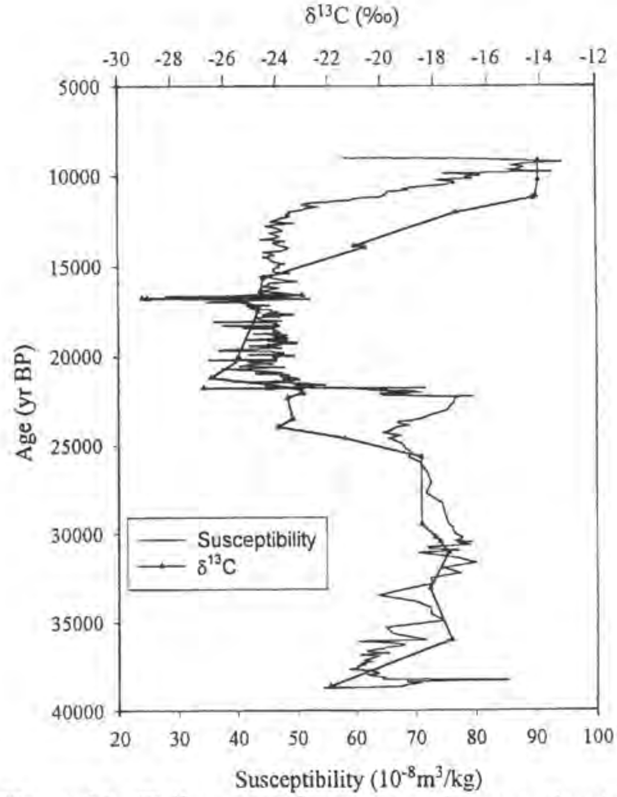


Figure 14. Well-expressed agreement between the stable carbon isotope and magnetic susceptibility curves from the Eustis ash pit, Nebraska (Johnson 1996b).

Recent research on the Fort Riley military reservation in east-central Kansas has produced magnetic data supporting the regional late Quaternary climatic model. The frequency dependence data extracted from a 13 m-thick loess mantle on the bluff top adjacent to the Kansas River valley exhibits the higher values anticipated for soils and lower values from the relatively unweathered loess, as well as good correlation to the $\delta^{13}C$ curve (Figure 15). The Manhattan Airport site consists of Pleistocene and Holocene alluvial fill within a high terrace of the Kansas River valley. The bulk of the fill at this site is Pleistocene, but, on the basis of a single radiocarbon age, the upper 1 to 1.5 m is Holocene (Figure 16). Physical attributes from about 2.75 m to the bottom of the trench indicated the Sangamon soil, but the relatively weak magnetic signal, particularly for susceptibility, is probably due to poor drainage conditions of the alluvial surface during that time. The Gilman Canyon soil does not appear magnetically, but the 19,990 yr B.P. age, a terminal Gilman Canyon age, should identify the top of that soil forming period. Soils present presumably represent the alluvial, or valley phases of those expressed regionally on the uplands (e.g., Sangamon, Gilman Canyon).

Climatic Modeling

Kutzbach (1987) summarized the behavior of the North American jet streams during the late Wisconsin. In July, the split flow around the North American ice sheet modeled at 18 ka persisted to 15 ka, with almost no changes having occurred. By 12 ka, two important changes appeared: first, the northern

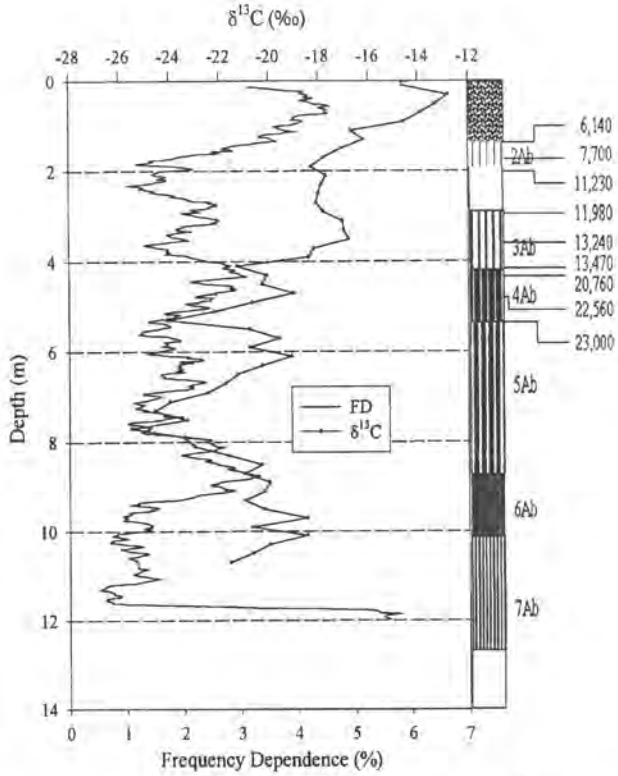


Figure 15. Magnetic frequency dependence and $\delta^{13}C$ curves from Sumner Hill at Fort Riley, Kansas. Humate-derived radiocarbon ages are indicated on right (Johnson 1996b).

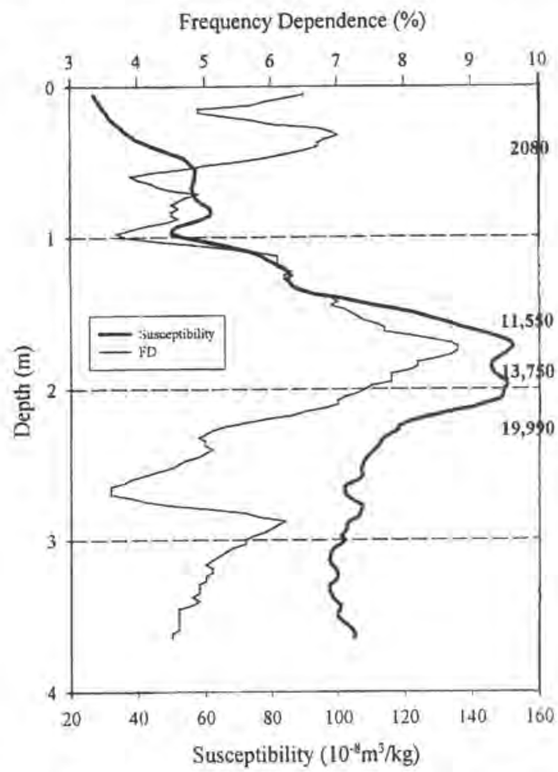


Figure 16. Magnetic susceptibility and frequency dependence from the Manhattan Airport site at Fort Riley, Kansas. Humate-derived radiocarbon ages are indicated on the right (Johnson 1996b).

branch of the jet moved south, over and along the southern flank of the ice sheet, and merged with the southern branch over the northeastern United States. The second change was the reduced intensity of the North Atlantic extension. The jet at 9 ka followed about the same track as at 12 ka, but with weakened intensity. At 6 ka and thereafter, only a single jet core was simulated over Alaska and Canada, and winds were weak compared to reconstructions of earlier periods. Specifically, the modern single jet core of July follows generally the same track as the northern branch of the split jet in July during the glacial maximum.

In January, like July, the split flow around the North American ice sheet and the intense North America/North Atlantic jet cores at 18 ka persisted to 15 ka with almost no change. At 18 ka the simulated temperatures over the continent were much lower than at present, especially over the elevated and highly reflective ice sheets (COHMAP Members 1988). By 12 ka, the flow had adjusted to a single core of high velocity winds that followed the west-coast-ridge, east-coast-trough pattern of today, and the jet maximum was almost as strong as at 18-15 ka.

The north-central region, from the Rockies to the Appalachians and from immediately south of the ice sheet to 40°N, had summer temperatures of 16°C at 18-15 ka, about 7°C below present. Precipitation was less than present at 18-15 ka (colder, with storm track shifted south of the region) and precipitation-minus-evaporation was slightly increased at 18-15 ka (evaporation decreased more than precipitation).

Pleistocene/Holocene Transition

The last deglaciation was a period of intense and rapid climatic changes that affected the global climate from about 20,000 to 5000 yr B.P. Paleoclimatologists have reconstructed global variations, including chemical composition of the atmosphere (30% increase in CO_2 and CH_4 decrease in dust content, etc.), temperature of the atmosphere and surface of the ocean (mean global change of about +4°C), and major reorganization of the ocean circulation and sea-level rise of about 120 m, followed by slow rebound of the continents below the ice caps.

The transition between the Last Glacial Maximum and the present inter- or postglacial episode has drawn much attention from investigators for many decades. At first, the last deglaciation was believed to have been a simple, unidirectional shift, but more recent detailed studies revealed that it was a two-step process (Duplessy et al. 1981; Broecker et al. 1989). During the last deglaciation, intervals of rapid warming between about 13 ka and 11 ka and at about 10 ka were separated by a distinct, brief, cool climate episode occurring between about 11 ka and 10 ka.

Between about 12 ka and 9 ka, the climate and vegetation of central North America underwent dramatic changes (Wright 1970; Watts 1983; Webb et al. 1983). Spruce trees had been replaced by widely distributed deciduous trees in northeastern Kansas, and deciduous trees persisted until about 9 ka when grasslands expanded (Webb et al. 1983). It is clear that megafaunal extinction and dissolution of disharmonious faunas began about 12 ka, and the mesic conditions under which the regionally expressed Brady soil developed persisted until about 8 ka, when the modern climate first appeared. Changes in vegetation and faunal assemblages at this time reflect a shift to warmer and drier conditions with increased seasonality (COHMAP Members 1988) and stronger zonal air flow at the surface (Kutzbach 1987). This was a time of major atmospheric circulation change within the Central Plains, as well as elsewhere.

Geomorphology and Stratigraphy

The beginning of the Holocene, about 10 ka (Hopkins 1975), is a time of dramatic environmental change and attendant stratigraphic discontinuities. In general, this boundary is considered only geochronometric without specific stratigraphic reference, although a stratotype in Sweden has been proposed for the boundary (Mörner 1976); the Swedish unit has a reported age of 10,000 ± 250 yr B.P. (Fairbridge 1983). According to Richmond and Fullerton (1986), a stratigraphic boundary of regional extent of the Pleistocene-Holocene boundary age has not been identified in the United States, and that major climatic or environmental changes at 10,000 yr B.P. are documented only locally (Watson and Wright 1980). This contention seems faulty on the regional scale in that research of the last several years in the Central Plains has identified the Brady soil (Schultz and Stout 1948) as a major pedostratigraphic marker (e.g., Johnson and Martin 1987; Johnson and Logan 1990; Johnson and May 1992).

Brady Soil

Classically, the Brady soil was associated with the upland loess deposits, but recent investigations have identified a contemporaneous soil in upland eolian sands and in alluvial valley fill (Johnson and May 1992). It therefore appears that the Brady soil development represents a time of extensive, broad-scale landscape stability. The Brady soil represents the most important break in the sedimentation recorded since development of the cumulic soil of the Gilman Canyon Formation, and also marks the position of a distinct faunal discordance (Frye and Leonard 1955). At least the early and perhaps all of the Brady soil-forming interval coincides with the Younger Dryas cold interval of the North Atlantic region.

The Brady soil was first named and described by Schultz and Stout (1948) at the Bignell Hill type locality, a loess sequence exposed along a roadcut in the south valley wall of the Platte River of western Nebraska. The soil is developed within the Peoria loess and is overlain by the Bignell loess. The name was subsequently adopted by researchers in Kansas (Frye and Fent 1947; Frye and Leonard 1951; Frye et al. 1949). The soil is regionally extensive only in the northwestern and west-central parts of Kansas, but even there it occurs discontinuously on the landscape. Frye and Leonard (1951) and Caspall (1970, 1972) recognized Brady development in northeastern and other parts of Kansas. Without the overlying Bignell loess, the Brady soil does not exist; the modern surface soil has incorporated post-Bradyan loess fall into its profile. The Brady soil is typically dark gray to gray-brown and better developed than the overlying surface soil within the Bignell loess. Strong textural B horizon development and carbonate accumulation in the C horizon are typical, although it occasionally displays evidence of having formed under poorer drainage conditions than have associated surface soils (Frye and Leonard 1951). Feng (1991) noted that the Brady soil, as expressed in Barton County, is strongly weathered both physically and chemically.

Table 2. Radiocarbon Ages from the Brady Soil.

Site	Age (BP)	Lab. No.	Source
Nebraska			
Bignell Hill			
	8,080±180	n.a.	Lutenegger, 1985
	9,160±250	W-234	Dreeszen, 1970
	9,750±300	W-1676	Dreeszen, 1970
	9,240±110	Tx-7425	Johnson, 1992
	10,670±130	Tx-7358	Johnson, 1992
North Cove			
west	10,550+160	Tx-6319	Johnson, 1989
	10,220±140	Tx-6112	Johnson, 1989
	10,270±160	Tx-6320	Johnson, 1989
east	11,530±150	Tx-6321	Johnson, 1989
	11,025±90	PITT-824	Martin, 1993
Prairie Dog Bay			
	10,140±110	DIC-3310	Cornwell, 1987
	10,360±130	Tx-5909	Martin, 1993
	10,370±70	PITT-824	Martin, 1993
	11,780±60	PITT-0961	Martin, 1993
	9,020±95	PITT-825	Martin & Johnson, 1992
Naponee			
	10,130+140	Beta-33939	Souders and Kuzila. 1990
Kansas			
Speed	87850+140	Tx-6626	Johnson, 1990
	10,050+160	Tx-6627	Johnson, 1990
Barton County			
	9,820±110	Tx-7045	Feng, 1991
	10 550±150	Tx-7046	Feng, 1991

Note: Ages represent the eolian phase only. An alluvial phase has been well documented throughout the Kansas River basin (Johnson and Martin 1987, Johnson and Logan 1990) and adjacent river systems, such as the Loup River of central Nebraska (Brice 1964; May 1990) and the Pawnee River (Mandel 1991, 1994) and Walnut River (Mandel 1991) of the Arkansas River system.

Until recently the age of the Brady soil was uncertain, even at the type section: Dreeszen (1970) reported two ages of 9160 and 9750 yr B.P., both of which were believed to be too young because of contamination. Lutenegger (1985) reported an age of 8080 yr B.P. without any stratigraphic context. Johnson (1993) reported two ages of 10,670 and 9240 yr B.P. on the lower and upper 5 cm, respectively, of the Brady A horizon at the type section. Souders and Kuzila (1990) dated a core at a site in the Republican River valley and reported an age of 10,130 yr B.P. Similar ages from the eolian phase have been obtained in south-central Nebraska and north-central and central Kansas (Table 2). According to age data, soil development began at about 10.5 ka and ended 9-9.5 ka, suggesting a soil forming interval of greater than 1,000 years.

Arbogast (1995) obtained several Brady era radiocarbon ages from soils buried within the eolian sand of the Great Bend Sand Prairie. Following a period of instability after a short period of stability during the Last Glacial Maximum, soil formation occurred at the Pleistocene/Holocene boundary, which correlates temporally with the loessal Brady soil. Two radiocarbon ages of 10,330 ± 100 and 10,360 ± 100 yr B.P. were obtained at Wilson Ridge, a lunette in the Great Bend Sand Prairie.

The Brady soil is also well expressed in an alluvial facies, i.e., an isochronous alluvial soil found throughout the region is temporally equivalent to the Brady soil identified within loess of the uplands. Since a large number of radiocarbon ages have been obtained from alluvial fill in the Central Plains (Johnson et al. 1996), the patterns of alluviation, erosion and particularly soil formation during the late Pleistocene through Holocene have become relatively well established.

In northwestern Nebraska, Agenbroad (1978) examined alluvial deposits at the Hudson-Meng site (25SX115) in Whitehead Creek Valley. Four stratigraphic units were identified beneath a loess-mantled terrace. The lowermost unit, designated Unit 1, consists of alluvium and contains a bonebed and many artifacts; charcoal from the bonebed yielded a radiocarbon age of 9820 yr B.P., and bone apatite and collagen yielded ages of 8990 and 9380 yr B.P., respectively. Agenbroad suggested that the site was buried by alluvial sands and silts sometime after about 9000 yr B.P., and that a soil developed at the top of Unit I (ca. 4800 yr B.P.) during Altithermal time.

The two ages of 8274 yr B.P. and 9880 yr B.P. determined from alluvial fill (Fill 2A) at archeological sites Ft-50 and Ft-41 on Harry Strunk lake in southwestern Nebraska (Schultz et al. 1951; Libby 1955) were the first radiocarbon determinations obtained on the Brady soil. At Cooper's Canyon, which is southeast of Elba, Nebraska, May (1990, 1991), in a reinvestigation of site studies by Brice (1964), reported radiocarbon ages on humates in the silt and clay fractions of buried soils, of which two ages agree well with both those in the fill from other localities in the Loup River basin and eolian facies. Ages included, 10,290 yr B.P. from the lowest 10 cm of Cooper's Canyon gley soil, and 9250 yr B.P. on the uppermost 10 cm of the Brady soil (Figure 17).

In Kansas, Holien (1982) derived a radiocarbon age of about 10.5 ka from a well developed soil situated in the lower part of Newman terrace fill along the lower Kansas River. Johnson (Johnson et al. 1996) obtained an age of 9820 yr B.P. from a soil buried in alluvial fill at the Ade site within the Saline River valley near Salina, Kansas.

Clovis Level Soil of the Colorado High Plains

The Dutton and Selby sites lie on the High Plains of eastern Colorado in shallow, internally drained, surface depressions. The Dutton site contains a Clovis level between two clay-rich paleosols formed in reworked Peoria loess that fills the depression. A collagen age of 11,710 ± 150 yr B.P. on mammoth bone from near the E-B horizon boundary of the lower soil may be related to the Clovis level (Reider 1990). Camel bone ages from the bonebed in Peoria loess, in conjunction with the Clovis or perhaps largely pre-Clovis level, provide evidence that the lower soil formed between about 13,600 yr B.P. and the time of

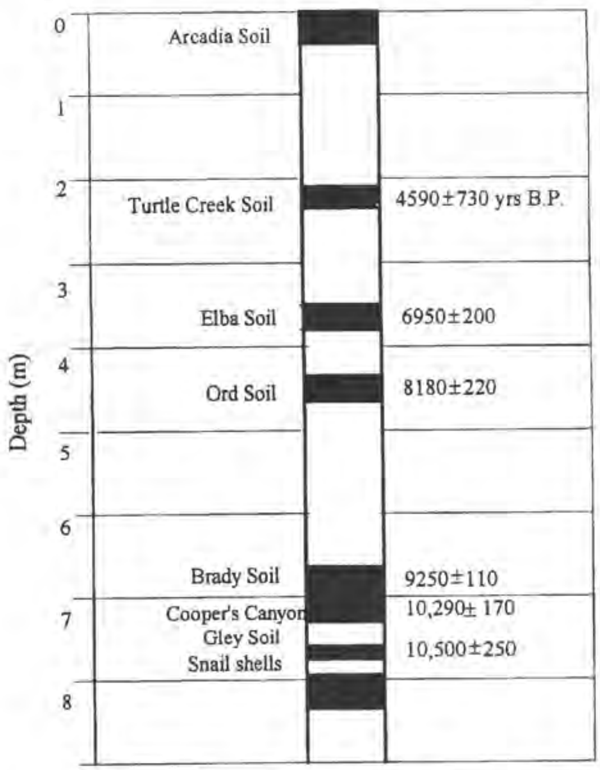


Figure 17. Cooper's Canyon section, located near Elba, east-central Nebraska (after May 1990, 1991).

Clovis occupation (ca. 11,400 yr B.P.). Both paleosols are regarded as late Pleistocene, but the upper soil (and to a lesser extent the lower soil) were altered by Holocene pedogenesis. Stratigraphic correlation with the Brady soil has not, however, been made at this point.

Climatic Proxies

Fossil Pollen and Botanical Macrofossils

The most detailed description of the nature of late Pleistocene/Holocene environmental changes in the Central Plains comes from palynological studies undertaken along the eastern and northern periphery of the region. At Muscotah and Arlington Marshes in northeastern Kansas, Grüger (1973) documented spruce forest from 23,000 to 15,000 yr B.P. followed by the spread of a mixed deciduous forest and prairie, which was present in the region from 11,000 to 9000 yr B.P. The nature and duration of the climatic changes which precipitated vegetation changes are not certain, because of a hiatus in sedimentation. Fredlund and Jaumann (1987) have suggested that pollen records represent an expansion of an aspen parklandlike community across the Great Plains.

According to Wright (1989), pollen records from the Great Plains can not show the effects of minor climatic fluctuations like the Younger Dryas because climate had become too warm by 11 ka to permit introduction of spruce. General circulation model results also show that the temperature for winter was deeply depressed far across Eurasia but was little changed in North America (Mathewes et al. 1993). The critical vegetation change identified by Shane and Anderson (1993) in east-central North America involves the recurrence of spruce, which is limited in its southern range by summer rather than winter temperatures. The southerly position of the polar front across the North Atlantic could have resulted in a southward displacement of the jet stream and associated storm tracks, thus enhancing the cyclonic storms that could deliver cold northwesterly winds not only to the Maritime Provinces, but inland to the Ohio area as well (Wright 1989).

Another source of paleoenvironmental information comes from peat beds and logs, radiocarbon dated from 10,500 to 8400 yr B.P., buried in valley fills associated with the North Loup River (Bradbury 1980). The peat is buried by alluvium which is in turn mantled by dune sand. The stratigraphic association of these deposits and the presence of marsh plants like *Equisetum* (horsetail) indicate that locally, fluvial processes and riparian environments, similar to those that exist today, were followed by sand movement (Bradbury 1980). Most recently, Ponte et al. (1994) dated a peat recovered in a core from the central Sand Hills and radiocarbon dated it to 12,260 yr B.P.; the peat contained 70% *Picea* pollen, indicating that the spruce forests of the late Wisconsin existed farther south into the Sand Hills than previously reported.

Stable Carbon Isotopes

Temporal changes in $\delta^{13}C$ data derived from carbon contained within soil and sediment (Figures 11, 12, and 15) are sufficiently large to show major shifts in vegetation during the late Wisconsin. The interval between 12,000 and 9000 yr B.P. can be interpreted as transitional between the cooler and more xeric late Pleistocene to warmer and drier Holocene. Based on a slight decrease in the $\delta^{13}C$ values from the Brady soil at six sites in the region, climatic conditions shifted to more xeric conditions (C_3 to C_4) from the beginning to the end of the Brady time, a period of major landscape stability and pedogenesis (Table 3).

The isotopic data agree with that of other climatic proxies for the region. The fossil pollen record from Muscotah Marsh in northeastern Kansas indicates that spruce had essentially disappeared from the region by about 10,500 yr B.P. As this decline occurred, deciduous tree species increased until about 9000 yr B.P. From a site in central Texas, Nordt et al. (1994) interpreted the time between 11,000 and 8000 yr B.P. as transitional between late Pleistocene conditions and warmer and drier Holocene conditions based on a slight increase in the abundance of C_4 plant biomass using stable carbon isotopic data.

Rock Magnetism

The Eustis ash pit, Beisel-Steinle site and Barton County landfill site each produced magnetic susceptibility curves characterized by a pronounced increase in the upper Peoria loess as the depositional rate decreased dramatically and Brady

Table 3. $\delta^{13}C$ Values and Radiocarbon Ages Derived from the Brady Soil A Horizon (Upper and Lower 5 cm).

Location	Age Range	$\delta^{13}C$	(%)	Source
Nebraska				
Bignell Hill	9240-10,670	-17.40	-19.3	Johnson and May 1992
North Cove	10,360-10,550	-16.30	-18.9	Johnson 1989
Sargent Site	9920-10,620	-16.1	-20.1	Dort 1996
Elba Valley	9250-10,290	-15.4	-20.0	May 1991
Kansas				
Speed Roadcut	8850-10,050	-18.8	-17.5	Johnson 1993
Barton County	9820-10,550	-18.6	-19.0	Feng 1991

pedogenesis began (Figure 13). Frequency dependence of susceptibility exhibited a notable but not dramatic increase in the basal Brady soil for the Sumner Hill site on Fort Riley, Kansas (Figure 15), suggesting perhaps that the intensity of Brady pedogenesis varied spatially according to microclimatic conditions.

Magnetic susceptibility intensities measured at the Bignell Hill site in Nebraska and the Beisel-Steinle and Barton County landfill sites in central Kansas indicate that magnetic intensities are very high in the Brady soil, e.g., susceptibility intensities (80-100x10^{-8} m^3kg/) are nearly twice that of the unweathered Peoria loess (40-50x10^{-8} m^3kg/) and slightly higher than the modern soil (Figure 18). On a hemispheric scale, the abrupt decrease in atmospheric dust noted in the Greenland ice core at about 10,750 yr B.P. (Paterson and Hammer 1987) reflects decreased loess transportation and deposition, and probably increased Brady-age pedogenesis associated with relative terrestrial stability.

Climatic Modeling

Significant deglaciation did not begin until 14 ka and ended by 6 ka. This conclusion is validated by maps of ice area, by marine $\delta^{18}O$ records, and by terrestrial and marine records (Ruddiman 1987; Crowley and North 1991). With increased summer insolation during the termination, the mass imbalance of ice sheet would have increased. Ice sheet decay may also have been affected by a number of processes. For example, CO_2-induced air temperature changes were apparently sufficiently large enough to cause disintegration of the extensive marine-based ice sheet on Eurasia. Broecker et al. (1988) suggested that changes in the coupled ocean-atmosphere circulation in the North Atlantic were responsible for the changes.

The structure of deglaciation within this 8000-year interval is uncertain. There is evidence supporting (1) a smooth deglaciation model with fastest ice wastage centered on 11 ka; (2) a two-step deglaciation model with rapid ice wasting from 14 to 12 ka and 10 to 7 ka, and a mid-deglacial pause with little or no ice disintegration from 12 to 10 ka; and (3) a Younger Dryas deglaciation model with two rapid deglacial steps as in (2) above, interrupted by a mid-deglacial reversal with significant ice growth from 11 to 10 ka.

The critical data supporting the smooth deglaciation model are maps of Laurentide ice area based on radiocarbon-dated glacial deposits. Although there are subtle suggestions of more rapid retreat at or near the time of the two steps mentioned above, these curves indicate a steady progressive retreat of North American ice, with significant oscillations in retreat rate only at local spatial scales. Some marine $\delta^{18}O$ curves also show a smooth progressive decrease toward Holocene values.

The step deglaciation model is also supported by some marine $\delta^{18}O$ records (Mix 1987). In addition, the distinctive patterns of change in sea-surface temperature of the North Atlantic Ocean and in Greenland ice-core $\delta^{18}O$ values also show abrupt steplike warmings at 10 ka and approximately 13 ka; these warmings might be associated with steplike decreases in Laurentide ice volume. Regionally integrated rates of pollen change in eastern and central North America also show a rapid change centered on 13.7 and 12.3 ka. (Ruddiman 1987).

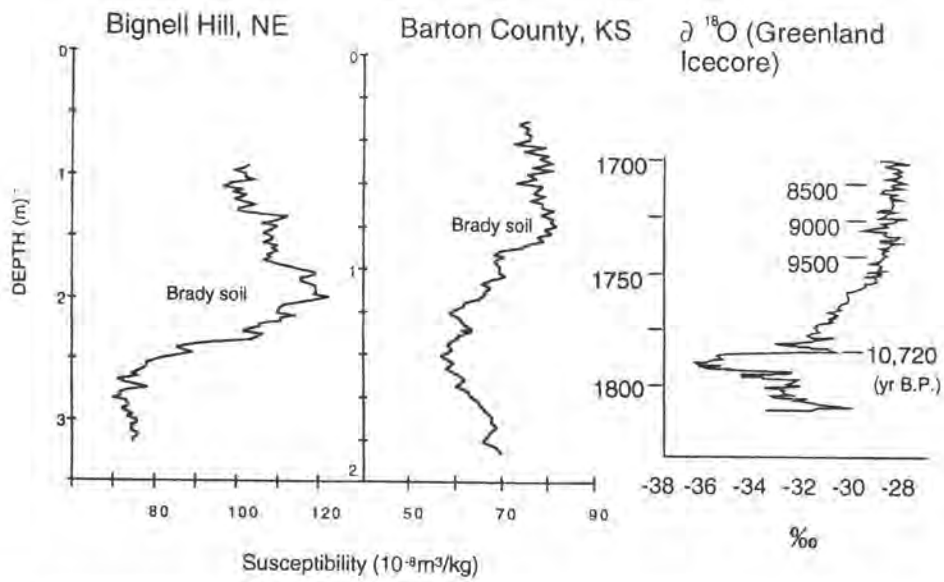


Figure 18. Magnetic susceptibility from two loess sites, and the $\delta^{13}C$ curve from a Greenland ice core. A Younger Dryas-type climatic fluctuation is apparent at the Pleistocene/Holocene boundary (Johnson et al. 1993; Dansgaard et al. 1985).

The Younger Dryas deglaciation model is suggested by sea-surface temperature cooling between 11 and 10 ka in the North Atlantic Ocean. At least early and perhaps all of Brady pedogenesis coincides with an abrupt and brief cool interval correlative with the classic Younger Dryas cold interval of the North Atlantic region.

Younger Dryas

The Younger Dryas, as the last glacial cold spell, was an abrupt and well-defined event (Dansgaard et al. 1989; Broecker et al. 1988), which has been absolutely dated at about 11 ka to 10 ka. (Table 4). In this short period of time, the return to near-glacial conditions interrupted the Pleistocene/ Holocene climatic transition, during which most of the Northern Hemisphere ice sheets melted. A leading explanation for the Younger Dryas cooling depends primarily on a mechanism for cooling of North Atlantic waters, rather than on the radiation distribution or directly on the presence of the ice sheets (Wright 1989). During deglaciation, large quantities of meltwater flowed from the melting Laurentide Ice Sheet. Appreciable evidence exists to suggest that the Younger Dryas coincided with changes in the routing of meltwater between the Mississippi and St. Lawrence drainage basins (Broecker et al. 1988; Broecker et al. 1989; Lehman and Keigwin 1992; Taylor et al. 1993). The influx of fresh water to high latitudes of the North Atlantic has been suggested as inhibiting the generation of dense, saline North Atlantic deep water, which, in turn, led to a reduction in heat transport to the North Atlantic (Broecker et al. 1988). For this reason, the Younger Dryas was recorded much more distinctly in Europe and Greenland than in North America, and is thought to be confined to amphi-Atlantic region. General circulation model results also support that conclusion, i.e., they show that temperatures for winter were deeply depressed far across Eurasia but were little changed in North America (Rind et al. 1986).

Many recent studies, however, demonstrate that the varied climatic deterioration was felt well beyond the North Atlantic (e.g., An et al. 1993; Mathewes et al.1993; Kudrass et al. 1991; Engstrom et al. 1990; Wright 1989). In their study of pollen and chemical stratigraphy in southeastern Alaska, Engstrom et al. (1990) suggested that a significant climatic reversal occurred in this region between about 10,800 and 9800 yr B.P. The temporary return of tundra after full development of lodgepole pine parkland is regarded as a clear response to climatic reversal, even though it is not contemporaneous with any known readvance of glaciers in the area or elsewhere in the Pacific Northwest. More recently, Mathewes et al. (1993), in their study of the British Columbia coast, also reported a shift from forest to open, herb-rich vegetation after 11,000 yr B.P., in response to colder and wetter conditions identified by a pollen-climate function. Shane and Anderson (1993) argued that the recurrence of spruce between about 11,000 and 10,400 yr B.P. supports the interpretation of regional temperature decrease in the Till Plains region of Ohio, Indiana, Michigan, and Illinois.

Table 4. Chronology of Younger Dryas.

Beginning	End	Area	Source
	10,702±150	Greenland Icecore	Dansgarrd et al. 1989
11,000	10,000	Sully Sea, SE Asia	Kudrass et al. 1991
11,000	10,300	Ohio	Shane, 1987
11,000	10,000	EN32-PC4,0rca Basin	Broecker et al. 1988
l0,800	10,000	Alaska	Engstrom et al. 1990
11,290	10,170	British Columbia	Mathewes et al. 1993
11,000	10,000	Atlantic Canada	Mott et al. 1986
11,200	10,500	North Atlantic	Lehman and Keigwin,1992
—	10,580-10,950	China	An et al. 1993
11,010±170	10,390±130	South Portugal	Bard et al. 1987

Johnson and Park (1993) suggested that the timing of a magnetic susceptibility reversal within the Brady soil forming interval at the Bignell Hill type section matches with the Younger Dryas cooling record from the oxygen isotope data of a Greenland ice core. This minor but notable drop in the susceptibility intensity occurs immediately below or within the lowermost Brady soil, which may indicate climatic degradation comparable to the Younger Dryas cold spell (Figure 18). Extended use of AMS dating may provide the chronological framework needed to develop estimates of time and rates of changes during Younger Dryas time within the region.

Holocene

Geomorphology and Stratigraphy

Bignell Loess

The Bignell loess was first described and named at the same type locality as the Brady soil (Schultz and Stout 1945). It is typically a gray or yellow-tan massive, calcareous silt, seldom more than 1.5 m thick. Although Bignell loess is often less compact and friable than the underlying Peoria loess, no certain identification can be made without the presence of the Brady soil (Caspall 1970). The Bignell loess does not form a continuous mantle, but is most prevalent and thickest adjacent to river valleys, particularly the south side, and often occurs in depressions on the Peoria surface. Of the loesses comprising the late Quaternary stratigraphy of the Central Plains, the Bignell is the only one that appears to have been deposited during a warm, nonglacial climate.

Eolian Sand Deposits

Holocene history documented for the sand sheets of Nebraska, Colorado and Kansas has indicated significant activity. Global climate change, resulting in shifting temperature and precipitation patterns, has been the focus of many of the studies focusing on the sand sheets of the Central Plains (e.g., Forman et al. 1992b; Yuhas 1993; Arbogast 1995). For example, numerous years of drought during the spring growing season is an effective mechanism for reducing vegetative cover and resultant dune destabilization. In fact, during historic drought, the coverage of native short-grass vegetation was reduced, and soils were extensively eroded by eolian activity (Tomanek and Hulett 1970).

A record of late Holocene dune activity comes from the Nebraska Sand Hills through the research of Ahlbrandt and Fryberger (1980) and Ahlbrandt et al. (1983). The latter work, producing the first stratigraphically controlled radiocarbon ages from this large sand sea, reported that the most recent period of dune activity was not during the Wisconsinan glaciation, but rather during the late Holocene (ca. 3000-1500 yr B.P.). Their conclusions were based on data from seven stratigraphically controlled sites: three with maximum-limiting radiocarbon ages of about 3000 yr B.P. and four with maximum-limiting ages of about 10,000-5000 yr B.P. They correlate their age estimates for stabilization of the dunes around 1500 yr B.P., based on archeological and pollen evidence, with the interstade between the Triple Lakes and Audubon glacial advances in the Colorado front Range reported by Benedict (1973). Further evidence for a Holocene age of dunal development offered by Swinehart (1990) was a radiocarbon age of 13,160 yr B.P. obtained in alluvium 3-4.5 m below a 52-85 m-high barchan dune in the central Sand Hills. Vibracores from fens in Cherry County in the central Sand Hills collected by Ponte et al. (1994) indicated multiple peat layers. Radiocarbon ages outlined two major periods of eolian activity during the middle Holocene and two subsequent periods at about 3500-2800 yr B.P. and after 1000 yr B.P.

The Great Plains region of northeastern Colorado is also an area of extensive sand dunes. Parabolic dunes in the region provide primary paleoclimatic information: dunes are elongate parallel to prevailing winds, causing the limbs of parabolas, anchored by vegetation, to point up wind. The dominant northwest-to-southeast orientation indicates that winds from the northwest shaped the landforms. Such strong prevailing winds on the High Plains are associated with air masses originating from the North Pacific or Canadian Arctic, and they preclude significant influence of tropical or subtropical air masses (Borchert 1971). These dunes exhibit evidence for a late Holocene dry period (Muhs 1985), i.e., soils developed on these dunes have morphological and textural properties similar to soils on stabilized dunes in the Nebraska Sand Hills with maximum limiting radiocarbon ages of about 3000 yr B.P. Forman and Maat (1990), using thermoluminescence and radiocarbon dating, obtained ages of 7-9 ka on soils buried in dunes near Hudson, Colorado. Forman et al. (1992b) documented a succession of paleosols buried by eolian sand during the Holocene, indicating that there were four possible periods of eolian sand deposition in the Holocene—about 9500 to 5500 yr B.P., 5500 to >4800 yr B.P., 4800 to >1000 yr B.P., and <1000 yr B.P., separated by relatively short intervals. Using radiocarbon dating, archeological data and other information, Madole (1994) observed that the sand sheet of northeastern Colorado was mobilized within the last 1000 years. Stratigraphic evidence from Nebraska and northeastern Colorado indicates extensive sand sheet reactivation and dune formation during the late Holocene, with significant mobilization during the last 1,000 years in Colorado. Global climate change, resulting in different temperature and precipitation patterns, has been the focus of these studies of sand sheet activity in the Central Plains (e.g., Forman et al. 1992b; Yuhas 1993; Arbogast 1995).

Johnson (1991a) and Arbogast (1995) documented periods of dune activity in the Great Bend Sand Prairie of Kansas. The most intensive period of dune formation in the region apparently occurred between 9 and 6 ka, an interval of sand mobility widely recognized on the Great Plains. In the late Holocene, loess accumulated episodically on relatively flat landscapes, while sand sheets and dunes were mobilized from about 5700 - 4800, 2300 - 1700, 1600 - 800, and 200 yr B.P. The orientation of parabolic and barchan dunes indicates that prevailing winds during the Holocene have been generally southwesterly.

Recent geomorphic research in the Great Plains (Holliday 1987; Forman and Maat 1990; Swinehart 1990) has indicated that the middle Holocene, or Altithermal (Antevs 1955), was an episode of decreased precipitation and increased erosion. A number of studies suggest an Altithermal age for dune sand on the Great Plains. On the Southern Plains, Holiday (1985, 1989) identified two periods of dune sand movement at about 6500-5500 and 5000-4500 yr B.P. These latter episodes of dune sand movement have been correlated with similar-aged dune deposits in Bailey County, Texas (Benedict and Olson 1978). Thus, geomorphic evidence strongly supports Benedict's (1979) reconstruction of Great Plains paleoclimate based on archeological data.

It has been proposed that the Altithermal was the most likely time during which the large dunes of the Sand Hills formed (Swinehart 1990). Following about 2000 years of stabilization, the climate became dry enough to allow reactivation of much of the sand in the eastern part of the Sand Hills.

Alluvial Deposits

During the last decade, a great deal of attention has focused on the development of alluvial chronologies in the Central Plains, typically in connection with geoarcheological investigations. As a consequence, this research has resulted in a number of studies and a sizable radiocarbon data base; well over 400 radiocarbon ages have been obtained from alluvium in Kansas and Nebraska (Johnson et al. 1996). Only a sampling of the many studies is presented below.

Much of the research in Nebraska has focused on the Loup River basin. Brice (1964) recognized two major terrace systems in the basin and obtained early Holocene radiocarbon ages of 10,500, 9000, and 8500 yr B.P. on fill beneath the lower of these terraces, the Elba. In a recent reexamination of the Elba terrace, May (1990, 1991) secured radiocarbon ages ranging from nearly 11000 to 4670 yr B.P. from the Cooper's Canyon area (Figure 17). On the South Loup River, May (1986, 1989, 1992) recognized four alluvial fills, with the oldest one dating between about 10,200 and 4700 yr B.P., thereby correlating temporally with the Elba terrace of the North Loup. Elsewhere in the basin, Ahlbrandt et al. (1983) dated organic accumulations in alluvial sands at 8410 yr B.P. from a site on the Dismal River.

In the Kansas River basin, alluvial geomorphic studies have a relatively long history, beginning in the 1950s. The first dating of alluvial stratigraphy on the Kansas River proper was done by Holien (1982), who obtained an age of 10,450 yr B.P. on a soil buried within lower Newman terrace fill at the Bonner Spring site. Subsequent radiocarbon dating of Newman fill at this locality (Johnson and Martin 1987; Johnson and Logan 1990) and others (Bowman 1985) produced more early Holocene ages. The lower Holliday terrace was dated about 4300 yr B.P. and younger (Johnson and Logan 1990).

Many studies have been conducted elsewhere in the Kansas River basin on the many tributaries. Some of the first radiocarbon dating was carried out on samples collected from the Republican River basin by Schultz and his colleagues at the University of Nebraska; from varied locations they secured early to middle Holocene ages from buried soils. The most recent research in the basin was conducted by C. Martin (1990, 1992) who concluded from dating various alluvial fills that the majority of the fill was deposited less than about 4600 yr B.P.

Several geoarcheological studies were done in conjunction with cultural resource management projects focusing on federal impoundments within the Kansas River basin. Mandel (1987), in a study of the lower Wakarusa River, recognized two terraces, the lower of which produced radiocarbon ages of about 2900 yr B.P. and less. A study of the alluvial history of the Smoky Hill River in the vicinity of Kanopolis Lake (Mandel 1988, 1992) revealed a striking absence of early and middle Holocene fill in small valleys, and middle Holocene fill in the main valleys and in alluvial fans.

In their study of Wolf Creek basin in Kansas, Arbogast and Johnson (1994) (Figure 19) observed that alluviation of early Holocene floodplains in this small basin was episodic, with at least one period of floodplain stability and soil formation about 6800 yr B.P. During the middle Holocene (ca. 6500-5300 yr B.P.), lateral erosion and entrenchment flushed most early Holocene fill from the main valley of Wolf Creek and the lower reaches of its larger tributaries. Following the interval of mid-Holocene erosion, sediment accumulated on floodplains between 5300 and 3000 yr B.P. Late Holocene alluviation was episodic, with intervening periods of floodplain stability and soil formation about 1800, 1500, and 1200 yr B.P.

A number of studies have been conducted in the Arkansas River basin area of south-central and southeastern Kansas. Mandel examined terraces and associated fills in the Neosho (Mandel 1992, 1993) and Verdigris rivers (Mandel 1993), obtaining radiocarbon ages on fill to about 4200 yr B.P. The most extensive study in the Arkansas River basin was that of the Pawnee River basin by Mandel (1988, 1991, 1994). Two terraces were recognized in the higher order tributaries, with fill of the high terrace dating between about 10,000 and 5000 yr B.P., and that of the low terrace to 3000 yr B.P. and younger. Of the three terraces present in the lower part of the system, the lowermost one has Holocene fill and the others are Pleistocene. Holocene valley fills in the Pawnee River basin appear to lack soil development from about 7000 to 5000 yr B.P.

The alluvial record is temporally and spatially fragmented, i.e., the history of valley and stream evolution stored in alluvium is scattered and wrought with gaps. So, it is only by assembling this fragmentary information that one obtains a unified perspective on the record of stream evolution. Out of the many studies conducted in recent years, a pattern of change is emerging. Large stream valleys appear to contain, more or less, alluvial fill dating throughout the Holocene, whereas small stream valleys typically contain only fill dating in the late Holocene. This model has an intuitive basis in that the probability of survival of early and middle Holocene fill in smaller streams is greatly diminished by the limited storage capacity for alluvium and the relatively high stream gradients, large area in hillslope, and associated peaked flood waves. Exceptions to this pattern do, of course, exist (e.g., Lime Creek, Nebraska: May 1996; Wolf Creek: Arbogast and Johnson 1994), but are likely due to locally unusual valley width and other discernible factors.

A first approximation of this alluvial model was presented by Johnson and Martin (1987) in an examination of radiocarbon ages obtained from alluvial fill in the Central Plains. In recent years, the model has evolved with a vastly expanded data base and been articulated recently by Mandel (1995). He noted that fill in small valleys appears to be less than 4000 years old, and that the missing early and middle-Holocene record is frequently

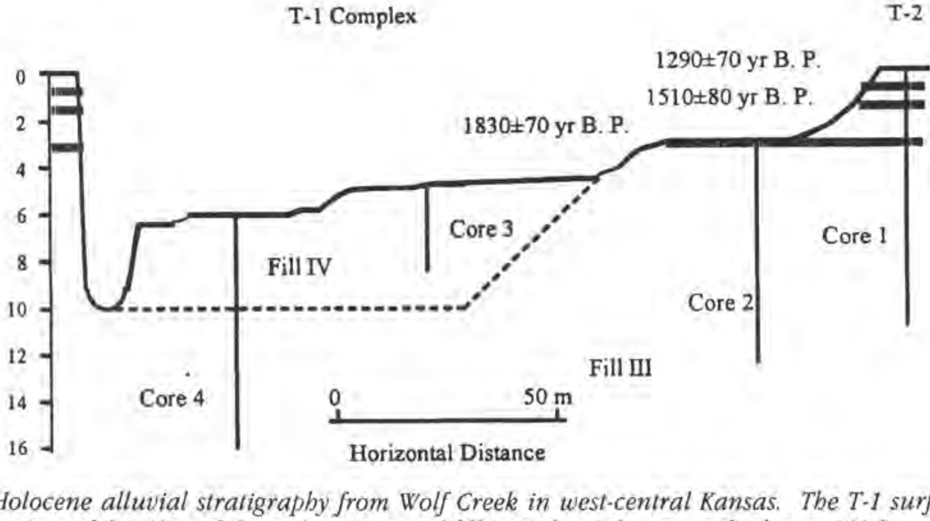


Figure 19. Late-Holocene alluvial stratigraphy from Wolf Creek in west-central Kansas. The T-1 surface complex has been created through cutting of the T-2 and through cutting and filling (after Arbogast and Johnson 1994).

preserved at the lower end of small stream valleys as terrace fill or alluvial fans.

From the alluvial chronologies, it is obvious that regional synchroneity of stream behavior exists in the Central Plains (Johnson and Martin 1987; Johnson and Logan 1990; Mandel 1995). When erosion and sedimentation are considered in a stream hierarchical sense, patterns of coincidence appear, such as similar times of floodplain stability and attendant soil formation. A frequency distribution of over 400 radiocarbon ages from alluvium of Kansas and Nebraska (Figure 20) provides an indication of the synchroniety. The high frequencies of the last 5,000 years reflect the age of the alluvium in large and small streams, whereas those prior to about 8000 yr B.P. represent the ages from the large valleys alone. Alluvial fans ages account for many ages within the 4000 to 8000 year range (Mandel 1995). The greatest frequency of ages occurs about 1200 yr B.P., a time when pronounced low terrace stability and soil development occurred throughout the stream systems. Another notable feature of the distribution is that when the ages obtained from alluvial fans are not considered, very few alluvial ages fall within the 5000 to 7000 yr B.P. period. This paucity of ages suggests little floodplain stability and/or preservation of alluvium from that interval, which coincides with the Altithermal climatic episode. Stream activity of this dry period may have been characterized by rapid sedimentation, thereby precluding soil development, in response to low-frequency, high-intensity convectional storms (Knox 1976, 1983).

Regional synchrony in Holocene fluvial behavior suggests that climatic fluctuation is the dominant external variable in stream systems (Wendland 1982; Knox 1976, 1983). Changes in climate during the Holocene were frequent and episodic (e.g., Wendland and Bryson 1974; Kutzbach 1985; COHMAP Members 1988), resulting in discrete periods of stream stability and instability (Knox 1983).

The concept of a middle Holocene, or Altithermal (ca. 7000-5000 yr B.P.) cultural hiatus on the Great Plains has become well-entrenched within the archeological literature. Of the various theories put forth to explain the hiatus (Reeves 1973), fluvial erosion or aggradation sufficient to dramatically alter the record for the region during the interval 7000-5000 yr B.P. is most pertinent (Johnson 1987; Mandel 1995). Some argued that the similarity in the alluvial stratigraphic record from eastern humid portions of the region to the more arid western areas, as well as with chronologies further afield, indicates that regionally anomalous erosion and deposition do not explain the hiatus completely; rather, the increased dryness during the Altithermal was likely sufficient to reduce populations on the Plains (Wedel 1961; Knox 1978; Wendland 1978). However, the rapidly expanding alluvial radiocarbon and stratigraphic data base for the region is indicating that much of the cultural record, namely that of the Archaic period, is buried, often deeply, or lost to erosion.

Climatic Proxies

Fossil Pollen

Palynological documentation of vegetation and climatic change within the Holocene presents some special challenges (Fredlund and Jaumann 1987). These problems are, at least in part, the result of the taxonomic limitation of pollen analysis. Many major grassland pollen types encompass entire families of plants (Fredlund 1991), and, consequently, large changes within grasslands can occur but not be readily apparent within the pollen record (Wright et al. 1985). This taxonomic limitation explains the lack of clear palynological definition of the middle-Holocene climatic drying in the Central Plains. Because of the limited records and inability to differentiate grass pollen, little Holocene vegetational change is apparent in the fossil pollen record (Baker and Waln 1985).

Abundant palynological evidence exists for middle-Holocene eastward migration of the prairie/forest ecotone.

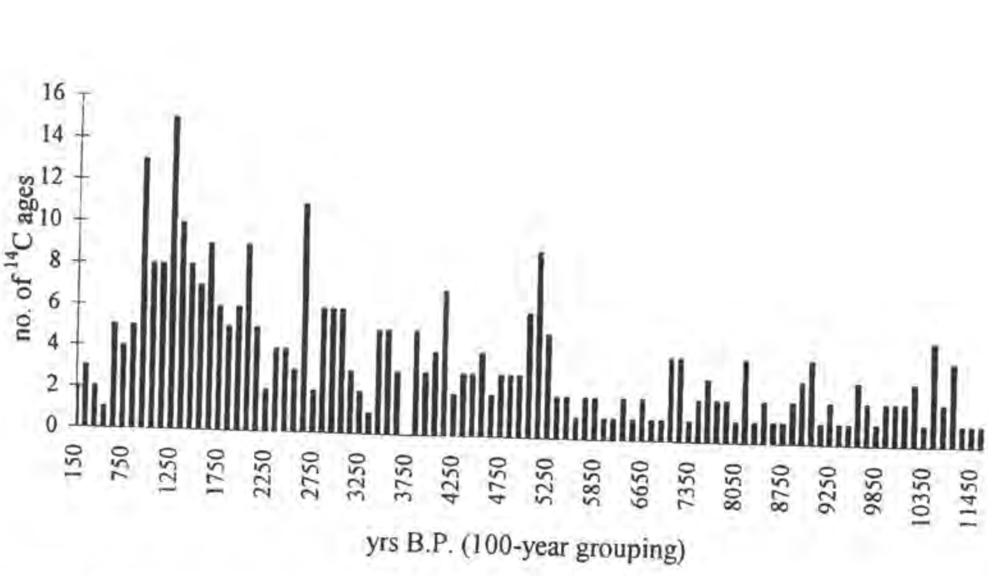


Figure 20. Frequency distribution of alluvial radiocarbon ages from the Holocene obtained in Nebraska and Kansas (Johnson et al. 1996).

Several palynological studies from areas peripheral to the Central Plains document middle-Holocene expansion of the prairie (e.g., Brush 1967; Watts and Bright 1968; Durkee 1971; Van Zant 1979). Barnosky et al. (1987) subsequently documented the eastward ecotonal shift between about 8,000 and 6,000 years ago through a review of data from the northern Great Plains. Using pollen/climate transfer functions, Bartlein et al. (1984) estimated that precipitation in the Minnesota area was about 20% less during the middle Holocene than it is today, but that temperature was only slightly higher.

In Nebraska, a paleoecological record comes from Sears' (1961) study of Hackberry Lake in the north-central part of the Sand Hills. A radiocarbon age indicates that organic deposition began at this site about 5040 yr B.P., and the sediments also record a fluctuating dominance of prairie vegetation that persists to the present, but with no discernible record of the Altithermal. Since the sand dunes that enclose the Hackberry Lake basin are well-preserved barchan and barchanoid-ridge dunes that indicate prevailing wind directions to the southeast, this site appears to represent a post-Altithermal stabilization of the dunes. On the southwestern margin of the Sand Hills at Swan Lake, Wright et al. (1985) analyzed a core with a basal radiocarbon age of about 8000 yr B.P. Sedimentation in Swan Lake appeared to be continuous to the present, and pollen analysis indicated a prairie vegetation with minor fluctuations of herbs and grasses throughout this time, but no Altithermal signal.

Two sites in Kansas provide palynological information for the Holocene: Muscotah Marsh (Grüger 1973) and Cheyenne Bottoms (Fredlund 1995). The Holocene portion of the record at Muscotah Marsh in north-central Kansas contains unconformities and lacks close-interval radiocarbon ages, but clearly portrays middle Holocene prairie expansion and contraction. At Cheyenne Bottoms in central Kansas, the Holocene is markedly different from the late Pleistocene Farmdalian grassland-steppe assemblage: lower Artemisia percentages and lower relative frequencies of arboreal pollen types characterize the Holocene. These differences suggest that the Holocene regional upland vegetation in the Holocene lacked the sage component which was so important during the Farmdalian. The Holocene vegetation also lacked diversity of tree and shrub taxa regionally present during the Farmdalian. Of all tree and shrub pollen taxa identified, only *Ulmus* (elm) and *Celtis* (hackberry) are more common during the Holocene. Fredlund (1995) divided the Holocene into four microzones based on changes in the local pollen signal. The latest Pleistocene-earliest Holocene zone (>9690 yr B.P.), through its abundance of diatoms and gastropods, suggests increasing moisture at the site. The soil developed above this zone appears to correlate temporally with the Brady soil. The high relative frequencies of *Cheno-Am* (*Chenopodium* sp.-*Amaranthus* sp.) type pollen throughout the Holocene are associated with the existence of mudflats periodically exposed as fluctuations of water levels occurred within the basin. In the middle Holocene (ca. 8500 to 3700 yr B.P.), frequencies of *Cheno-Am* pollen types decreased significantly, suggesting more stable, perhaps lower, water levels. The increase in Ambrosia (ragweed) pollen during the middle Holocene indicates less fluctuating and lower water levels. The late Holocene (>3700 yr B.P.) was characterized by a return to fluctuating water levels and exposed mudflats.

The timing of the Holocene dry/warm interval appears to vary geographically. In Minnesota the maximum of Altithermal warmth and dryness occurred between about 8000 and 4000 yr B.P., peaking at 7200 yr B.P. (Wright 1976). In the northwestern United States most sites register greatest drought in the early Holocene, although at some sites it was delayed until the middle Holocene, concurrent with the Midwest (Barnosky et al. 1987). In the Southern High Plains, widespread eolian activity began in some areas by 9000 yr B.P. and culminated 6000-4500 yr B.P., probably because of warmer, drier conditions that reduced vegetation cover (Holliday 1989).

Stable Carbon Isotopes

A gradual shift to drier and warmer conditions occurred during the late Pleistocene. Using stable oxygen and carbon isotopes from lacustrine and soil carbonates collected at Fort Hood in north-central Texas, Humphrey and Ferring (1994) demonstrated that mesic conditions continued until 7500 yr B.P., except for a brief drying period between about 12,000 and 11,000 yr B.P. The slow replacement of cool-season plants by warm-season plants at Fort Hood agrees with an extended warming and drying climatic transition during the early Holocene.

By the middle Holocene, drying had reached a maximum according to most studies. Northwestern Texas was experiencing conditions of maximum temperatures, minimum precipitation, and eolian activity between 6000 and 4500 yr B.P. (Holliday 1985, 1989; Pierce 1987). $\delta^{13}C$ values derived from paleosols in this region revealed a shift from -23% in the early Holocene to -15% in the middle Holocene (Haas et al. 1986), i.e., a shift in dominance from cool-season C_3 grasses to warm-season C_4 grasses. Based on enriched $\delta^{13}C$ values in soil carbonate from their Texas study, Humphrey and Ferring (1994) identified a middle-Holocene xeric episode, although the $\delta^{18}O$ values from these same carbonates did not indicate a significant temperature change.

Despite an aberrant value, limited $\delta^{13}C$ data from the Sargent site, an upland loess exposure in southwestern Nebraska, suggest a gradual increase in dryness through the Holocene (Figure 21); this is interpreted as a shift in the abundance of C_4 species from slightly under 50% during the late Pleistocene to 80-90% in the middle Holocene. $\delta^{13}C$ data derived from the correction of radiocarbon ages obtained from soils buried in alluvial fill of the Central Plains (Johnson et al. 1996) also indicate a gradual increase in C_4 plants from about 12,000 yr B.P. through the Holocene, but these data are relatively noisy, however, due to the edaphic conditions encountered on bottomlands.

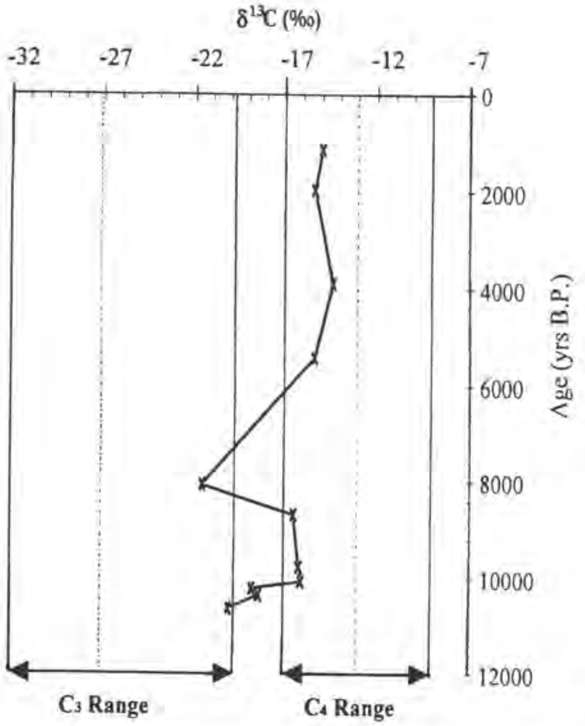


Figure 21. Composite stable carbon isotope values from the Sargent site, southwestern Nebraska for the past 11,000 years. Values are by-product of correcting radiocarbon ages for effects of fractionation (Dort 1996).

Rock Magnetism

An extended period of loess deposition is indicated by decreased weathering, i.e., decreased magnetic susceptibility. Magnetic susceptibility intensities measured at the Eustis ash pit-Bignell Hill section, Nebraska, and the Beisel-Steinle and Barton County landfill sites in Kansas (Figure 18) indicate high values in the Bignell loess (averaging 70-100 x 10-8 m^3/kg), when compared to the Peoria loess, and are only slightly lower than those of the Brady soil. Because the magnetic signal of the Bignell loess is only slightly diminished from that of the Brady soil and far greater than that of the Peoria loess (Figure 18), the former likely has as part of its source preweathered sediment from the adjacent, exposed Brady soil surface. Weaker intensities from mid-Bignell loess indicate, however, that either the depositional rate was faster than the rest of Holocene or pedogenic and/or biologic activity was weaker in Altithermal time, presumably the latter.

Magnetic data from the Sumner Hill and Manhattan Airport sites in east-central Kansas also display reduced magnetic intensities in the Holocene Bignell loess. Frequency dependence data from Sumner Hill suggest that pronounced surface instability (rapid loess input or throughput) existed at this bluff-top position during much of the Holocene (Figure 15). The Manhattan Airport site, consisting of Pleistocene and Holocene alluvial fill, displays a steady upward decline that likely reflects an increase in alluviation (Figure 16). The Holocene fill may have originated from an unnamed tributary entering from the west, rather than from the Kansas River proper; contributions of Bignell loess may also be present.

The DB site, located on the loess-mantled bluff overlooking the Missouri River valley in northeastern Kansas, yielded cultural material dating from the early Holocene (Johnson 1996a). A buried soil, believed to be the Brady, is truncated down to its Bt horizon, and the surface soil, developed in overlying loess, is welded to the soil below. The frequency dependence curve derived from the site increases from the unaltered Peoria loess below at about 1.3 m and exhibits two bulges in the upper meter, the lowermost being the buried soil and the upper being the surface soil (Figure 22). Cultural Material is associated with the buried Bt horizon as well as with the surface soil.

Tree Rings

Variations in tree-ring widths from one year to the next have long been recognized as an important source of chronological and climatic information. The mean width of a ring in any one tree is a function of many variables, including the tree species, tree age, availability of stored food within the tree and of important nutrients in the soil, and a whole complex of climatic factors, including sunshine, precipitation, temperature, wind speed, humidity, and their distribution through the year (Bradley 1985). The tree is essentially a filter or transducer which, through various physiological processes, converts a given climatic input signal into certain ring-width output which is stored and can be studied in detail, even thousands of years later (e.g., Yapp and Epstein 1977; Fritts 1983).

Unfortunately, the tree-ring record extracted from the Central Plains covers only the last few hundred years, but does provide us with an impression of the recent variability in climate. Information on latest Holocene drought episodes comes from the ring sequences in logs buried at the Ash Hollow site in western Nebraska (Weakley 1962). According to that record, droughts longer than 15 years occurred in A.D. 1276-1313, 1438-1455, 1512-1529, 1539-1564, 1587-1605 and 1688-1707.

In the North Platte area of western Nebraska, Weakley (1943), in a study of red cedar and ponderosa pine, found 13 more or less severe droughts lasting five years or more during the past 400 years. Drought appeared to recur at ill-defined intervals of 15 to 25 years.

Climatic Modeling

Using a modified version of the Blytt-Sernander scheme of climatic episodes, Bryson et al. (1968) produced a model that subdivided the Holocene into the pre-boreal, Boreal, Atlantic, sub-Boreal, sub-Atlantic, Scandic, neo-Atlantic, and Pacific episodes. For example, during the Atlantic episode (8450-4680 yr B.P.), the wedge of modified Pacific air that characterizes the grassland climate was expanded northeastward into central Minnesota and eastward towards the Atlantic seaboard (Bryson et al. 1970).

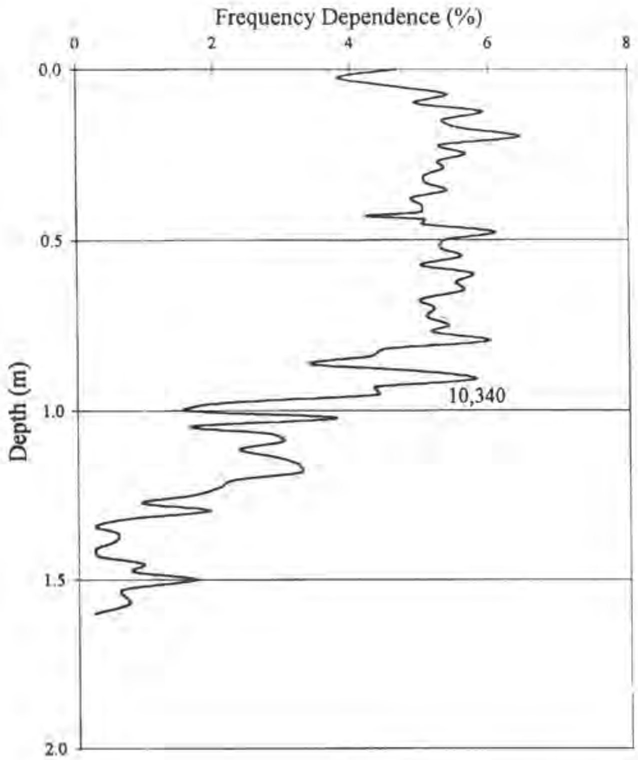


Figure 22. Magnetic frequency dependence from the DB site at Fort Leavenworth, northeastern Kansas (Johnson 1996a).

According to recent model simulations, by around 9 ka summer insolation had increased but was still secondary in influence to the shrinking Laurentide ice sheet (COHMAP Members 1988). The glacial anticyclone persisted in eastern North America, but was much smaller than at 12 ka. With the Pacific subtropical high gaining strength adjacent to the west coast of North America, northwesterly winds replaced westerly winds along the coast in the Northwest. The Midcontinent was still cooler and more moist than at present in July. By the early Holocene (9 ka), the ice had wasted appreciably, the jet stream was no longer split, orbital parameters were favoring increased temperatures, and zonal flow was dominating (Kutzbach 1987).

For the Altithermal, i.e., 6 ka, model results produced mean summer temperatures 2° to 4°C higher than present (COHMAP Members 1988) and annual precipitation up to 25 % less than at present in the region (Kutzbach 1987). Surface westerly winds in the midcontinent were stronger than today, with warmer and drier conditions prevailing. Since 6 ka, simulation indicates that westerly flow has weakened and summer temperatures have decreased.

Nature of the Record

A substantial body of knowledge exists concerning the paleoenvironmental history of the Central Plains. This body of knowledge is, however, somewhat awkward to synthesize because of its uneven distribution both geographically and chronologically, and its derivation from many different types of proxy data using many different types of methods. Nonetheless, when making a comparison with the level of knowledge two to three decades ago, we certainly have a much better impression of late Quaternary environments today.

To extract the paleoclimatic signal from proxy data, the record must first be calibrated, which involves using modern climatic records and proxy materials to understand how, and to what extent, proxy materials are climate-dependent (Bradley 1985). It is assumed that the modern relationships observed have operated, unchanged, throughout the period of interest. All paleoclimatic research, therefore, must build on studies of climate dependency in modern-day natural systems, but not all environmental conditions in the past are represented in the modern times. Obviously, situations existed during glacial and early postglacial times which defy characterization by modern analogs (Martin and Martin 1987). Accordingly, one must be aware of the possibility that erroneous paleoclimatic reconstructions may result from the use of modern climate-proxy data relationships when past conditions have no analog in modern world.

Although there is considerable paleoenvironmental data from the Central Plains, very little can be interpreted quantitatively, e.g., in terms of temperature or precipitation. Quantitative paleoclimatology seems to be conceptually quite difficult, with the few attempts thus far based on tree rings (e.g., Weakley 1962), pollen (e.g., Webb et al. 1993), phytolith morphology (Johnson et al. 1993), and stable carbon isotopes (e.g., Nordt et al. 1994; Fredlund 1993; Johnson et al. 1993). However, the application of mathematical techniques such as transfer functions to proxy data sets of the region holds the promise of allowing quantitative reconstruction of climate by relating quantitative data on modern environments to past environmental data. The use of such transfer functions requires systematic modern baseline data for both the proxies and modern climate.

A major problem in environmental reconstruction is that studies tend to produce paleoenvironmental data which lack the necessary chronological control. Such control for paleoenvironmental information must exist, or it is almost impossible to make spatial correlations; the data cannot, therefore, contribute to regional understanding. Until recent years this had been a serious problem for the Central Plains, but chronostratigraphies are rapidly developing for the alluvial and eolian deposits. The late Pleistocene vegetation cover of the region has provided only scattered wood and charcoal in loess, eolian sands, and alluvium; the grass cover of the Holocene has furnished even fewer datable materials. For radiocarbon control in this region, researchers have frequently used humates preserved in buried soils. Despite general acceptance of radiocarbon dating by Quaternary scientists, some debate still exists regarding the accuracy of humate-derived ages. Thermoluminescence dating has been employed in several studies (e.g., Oviatt et al. 1988; Feng et al. 1994; Maat and Johnson 1996). Together, radiocarbon and thermoluminescence dating are, however, producing consistent ages, resulting in an ever-increasing resolution of the chronology for late Quaternary deposits of the Central Plains.

3 A History of Archeological Research on the Central Plains, by

Matthew E. Hill, Jr., Jack L. Hofman, and Karolyn Kinsey

In comparison to the numerous histories of North American archeology (e.g., Meltzer et al. 1986; Trigger 1989; Willey and Sabloff 1993; Wilmsen 1965; Wissler 1942) there are only a few detailed summaries of the development of archeology on the Great Plains (Wedel 1961a, 1961b, 1982; Strong 1935, 1942; Frison 1973). The present study attempts to add information to these histories with special attention given to the Central Plains. Archeology on the Central Plains did not occur in a vacuum; political, social, economic, and intellectual influences from other regions of North America and Europe both stimulated and helped frame archeological activity there. One cannot fully understand Plains archeology without examining it from a national context. The development of Central Plains archeology did not simply mirror that of other regions, but rather Central Plains archeologists were influenced by national trends in archeology and vice-versa. In fact, some unique features of Central Plains archeology are best examined in contrast to the archeology taking place in other areas of North America.

Willey and Sabloff's (1993:7-10) work is the baseline for the present study. For convenience, their seven historical periods are adapted to fit the history of research in the Great Plains. Although, as Schuyler (1971) demonstrates, the specific chronological-explanatory framework used in national histories of archeology often do not accurately represent the evolution of regional research. As a result we modify the chronology of Willey and Sabloff's system to fit this region's archeological research history. Four periods have been identified for the Central Plains.

Exploration and Speculation (1492-1840s)

Immediately following the voyages of Columbus, several Europeans began to speculate on the origin and age of the inhabitants of the Americas (Haven 1856; McGee and Thomas 1905; Trigger 1989). Despite their interest, few Europeans had direct observations of the inhabitants or antiquities of the New World. The only people to collect information about the inhabitants of the New World were explorers, colonial administrators, or priests. This information was used to support a myriad of conclusions on the origin and age of aboriginal inhabitation of the Americas (Wauchope 1972; Willey and Sabloff 1993). Most accounts record information on the distribution and activities of native groups, while only a few discussed the native antiquities, such as mounds and earthworks.

In the Great Plains region, early Spanish and French and later American explorers were the first to observe and document the cultures of native Plains groups. Expeditions of Coronado, Onate, Ulibarri, LaHarpe, Du Tisne, Villazur, and others between 1541 and 1800 provide initial information on some Southern and Central Plains groups (Gunnerson 1984; Hammond and Rey 1940; John 1975; Schlesier 1994; Wedel 1959:19-47, 1986; Wedel and DeMallie 1980; Winship 1896). The Lewis and Clark and later Pike expeditions in the early 1800s provided further insights into the native Plains culture groups.

Following the War of Independence, westward expansion increased and the European settlers encountered the great earthen mounds of the Ohio and Mississippi valleys. Questions about these earthen works were the impetus for a direct study of Native American antiquities. The work of Thomas Jefferson (1944) and Benjamin Smith Barton (1797) at earthen mounds in the eastern United States were the earliest systematic investigations into North American archeology (Trigger 1989; Wilmsen 1965; Willey and Sabloff 1993). However, most archeology done before the 1800s was performed by explorers and travelers.

Antiquarian interests were the basis for most early archeological research. These centered mainly on questions of who built the earthen mounds and their relationship to the Native Americans who inhabited the country during historic times. It was commonly believed that the Moundbuilders were a separate and more advanced race than the historic Native American groups. Native Americans were thought to be culturally static and "savages" by many Europeans (Trigger 1986), and they were considered responsible for the destruction of the Moundbuilder culture (see Trigger 1989; Silverberg 1968; Willey and Sabloff 1993; Wilmsen 1965). These negative views of Native Americans and the belief of a separate Moundbuilder culture had a major influence on the interpretations of the archeological record.

By the early 1800s, only a few attempts had been made to systematically investigate the earthen mounds and publish the results of their finds. In 1820, Caleb Atwater surveyed a series of mounds along the Ohio River, recognizing different functions and distributions of the mounds. Wilmsen (1965) attributed Atwater's works as being the first systematically controlled archeological observations in America. Squier and Davis' (1848) mapping and excavation of a series of mounds in the Ohio Valley marked a major change in the approach to archeological research. The major change was not Squier and Davis' interpretations, for they concluded that the Moundbuilders were an old, extinct race of stationary agriculturists and unrelated to the contemporary Indian populations (see also, Williams 1991; Willey and Sabloff 1993). The difference was that they systematically investigated a problem and replaced speculation with descriptions. As Willey and Sabloff (1993: 41) stated:

> Squier and Davis used rudimentary functional classification for the mounds and asked some questions about the probable use or purposes of such archeological structures. These questions were formulated as quite explicit hypotheses, and they went further in suggesting lines of investigation that might be pursued to verify or disprove their

> supposition. In so doing, they anticipated, in a degree, the modern method of formulating hypotheses and testing expectations.

After this it became increasingly evident that excavation and description of archeological material were critical steps in answering most archeological questions.

Central Plains

During this period numerous explorers and traders made observations on the activities of aboriginal Plains groups (see summaries in Gunnerson 1984; Schlesier 1994; Strong 1935; Wedel 1959). Most of these observations were about location, customs, environments, and daily activities. These observations continue to be used by archeologists to help interpret the late archeological record. The antiquities of the Plains groups were generally ignored by these explorers, with the exception of the Lewis and Clark expedition.

No actual "archeological" research occurred during this period. Blakeslee (1987) claimed that the first investigation into the archeology of the Central Plains is contained in a late eighteenth century narrative. This narrative, of dubious historical reliability, describes John Peyton's alleged 1774 excavation of a mound in Kansas.

Classificatory-Descriptive (1850s-1930s)

This period represents the development of systematic archeology. At the beginning of this period there was limited professional involvement in archeology. By 1930, however, the field was dominated by professional archeologists, numerous artifact typologies and chronologies had been developed, and field techniques became more sophisticated.

Developments in the mid-1800s in Europe eventually had a strong influence on the development of American archeology (Wilmsen 1965). In 1833, Lyell published *Principles of Geology* which established several key things: a long antiquity for the earth, the value of index fossils, and the principle of uniformitarianism. A quarter century later, the work of Darwin on evolution and the discoveries of Boucher de Perthe along the Somme near Abbeville demonstrated the long chronology of human history and a biological mechanism for change over time (Grayson 1984). These changes, especially the European Paleolithic finds, made researchers in North America aware that the antiquity of human occupation in North America may have considerable depth. Not all researchers agreed; some were opposed to ideas of evolution and a long human occupation in the Americas. However, by the end of this period, both evolution and a long human antiquity were generally accepted by all North American geologists and archeologists.

Following the Civil War, there were two major research interests in American archeology: (1) the identity and antiquity of the Moundbuilders, and (2) the origins and antiquity of Native Americans.

Moundbuilders

Despite the quality of work by Squier and Davis, some researchers during this period favored an opposite view of the relationship between the Moundbuilders and contemporary Native Americans (Willey and Sabloff 1993). Scholars, such as Samuel Haven (1856) and H. R. Schoolcraft (1854), accepted that the Moundbuilders were simply the ancestors of the modern Native American population. However, the Moundbuilder debate continued until the early 1890s. What finally put an end to debate over the origins of the Moundbuilders was the work of Cyrus Thomas for the Bureau of American Ethnology (BAE). The involvement of the BAE started in 1882 when the U.S. Congress ordered them to spend $5,000 a year on mound research. Thomas directed the excavation and mapping of numerous mounds in the Mississippi and Ohio valleys which resulted in the monumental publication of *Report of the Mound Exploration of the Bureau of Ethnology* (1894). Thomas concluded that there was a direct historical link between the Moundbuilders and contemporary Native Americans.

Antiquity of Native Americans

Discoveries in France in the midnineteenth century, established that people lived with extinct animal species during the Pleistocene (Grayson 1983; Lubbock 1865). These finds stimulated researchers in America to look for similar deposits (Nelson 1933; Meltzer 1983; Wilmsen 1965). Some of the initial finds that attributed human presence during the Pleistocene times included the Natchez finds (Lyell 1863), Koch's mastodons (Koch 1857), and the Calaveras Skull (Whitney 1880). As summarized by Meltzer (1983), these American finds were very different from the European Paleolithic finds. The skeletal remains and artifacts found in these American deposits were not analogous to those found in Europe. For example, in America fully modern human remains were found in potential Pleistocene deposits, whereas in Europe similar deposits contained more "primitive" human forms.

As a result of these problems, researchers used artifact morphology as an important component in arguments that artifacts were of Paleolithic age (artifacts that were "crude" in form). The first major American claim for discovery of "Paleolithic" artifacts was by Charles Abbott on his farm in Trenton, New Jersey (Abbott 1876; Claypoole 1896; Holmes 1919). By 1888 Abbott had recovered approximately 60 artifacts along with human and elephant bones. This find stimulated workers to report similar finds all over the United States in the 1880s and 1890s (see summaries in Hrdlicka 1907; McGee and Thomas 1905; Holmes 1919). By the 1890s, Jenness (1933:93) stated that over 8,500 "Paleolithic" artifacts had been reported in approximately 35 states and Canada. The major "Paleolithic" finds in the Central Plains were Winchell's (1913) finds in northeast Kansas and discoveries of artifacts and fossils in the loess of Iowa and Nebraska (Schultz 1943).

Many critics argued against the numerous claims of Paleolithic artifacts. The most vocal group were scientists at the BAE—especially William Henry Holmes and Ales Hrdlicka. They had two main objections. First, the American Paleolithic artifacts were not analogous to the artifacts from Europe. Based on his work at the Piney Branch Quarry, Holmes (1892) claimed that all lithic artifacts go through a standardized reduction sequence. Therefore, he believed that the American Paleolithic artifacts were actually early stage rejects of recent artifact production. Another objection was that many of these Paleolithic sites had evidence of potential contamination, inconclusive stratigraphic evidence, or else questions concerning the ability of the collector (Chamberlin 1919). The proponents of the American Paleolithic artifacts responded to these criticisms by stating that Holmes' "rejects" would not be confused with Paleolithic artifacts (e.g., Haynes 1893). Their other response was to criticize the opponents (especially Holmes) who assumed that contamination was a problem at these sites rather than demonstrating that it was.

By 1900, the debate over the antiquity of human occupation in the New World changed in orientation. The cause of this change was the discovery of skeletal remains in apparent Pleistocene contexts. Meltzer (1991:13) reports that between 1900 and 1926 some three dozen skeletons from apparently ancient deposits were discovered throughout North and South America. The most significant include Vero and Melbourne, Florida (Loomis 1924, 1925; Sellards 1916a, 1916b), Lansing, Kansas (Chamberlin 1902; Upham 1902; Shimek 1903, 1908; Williston 1902; Winchell 1902, 1903), and Gilder Mound, Nebraska (Barbour 1907; Barbour and Ward 1906a, 1906b; Gilder 1911).

As with the Paleolithic sites, the antiquity of these skeletons was quickly attacked by several critics. These critiques took two forms. The first was the position that many of these skeletons, such as found at Lansing and Gilder Mound, were not actually in Pleistocene-age deposits. Hrdlicka (1907, 1912, 1918, 1928) argued that none of these skeletons represented Archaic or premodern humans. Hrdlicka believed that an ancient skeleton of Pleistocene age would show "primitive" anatomical features similar to those of Neanderthal specimens from Europe. Proponents of these finds countered that these sites were in primary Pleistocene deposits and that Hrdlicka's theory of primitive features was unrealistic. The debate between these two camps continued for about two decades with neither side conceding defeat.

The debate over possible Pleistocene-age human occupation of the Americas finally reached a resolution with the discoveries at the Folsom type site in New Mexico (Figgins 1927; Cook 1927; Meltzer 1983). At Folsom several fluted projectile points were found associated with an extinct form of bison in undisturbed Pleistocene-age deposits. The Folsom site was not the first to associate extinct bison and human artifacts. Sites such as 12 Mile Creek (Williston 1902; Rogers and Martin 1985), Lone Wolf Creek (Figgins 1927), and Meserve site (Meserve and Schultz 1932) were similar to the Folsom site in both setting and composition but did not have the same historical impact. Several researchers (Haynes 1968; Stanford 1969) have suggested that the reason the Folsom site was accepted as a Pleistocene-aged site was that it met three important "requirements." These include: (1) presence of human skeleton or distinctive artifacts, (2) the evidence is within undisturbed geological deposit, and (3) the age of the site must be demonstrated by association with fossils of known age or suitable radiocarbon dates.

According to Meltzer (1983, 1991), another key reason for the acceptance of the Folsom site was that the investigators notified outside observers and requested visits to help validate the in situ finds while the excavation was in progress.

Central Plains Archeology

By the end of the nineteenth century, several local researchers began systematic investigations into a series of prehistoric and historic sites (Strong 1935; Wedel 1959). In 1888 James E. Todd investigated a series of flint quarries in Cass County, Nebraska, and argued for their human origins (see Strong 1935; Wedel 1982). Between 1881-1890, J. A. Udden, a professor at Bethany College, worked at the Paint Creek Village site south of the Smoky Hill River in Kansas (Udden 1900; see summary in Wedel 1959). As was later claimed about Udden's work, "his report stands as one of the few bright spots in Kansas archeology to date" (Wedel 1959:86). Wedel's praise is based on the clarity of Udden's artifact description and careful conclusions that the inhabitants of the Paint Creek Village were probably related to the modern Wichita Indians. In retrospect, it is clear that linking archeological remains with specific ethnic groups has been a major concern of Plains archeology for its entire history.

Beginning in 1895, J. V. Brower, with some local help, searched for sites in central Kansas to relocate the route of Coronado and to find traces of the Quivira (land of Wichita) and Harahey (land of Pawnee) (O'Brien 1984; Roper 1994b; Wedel 1959). Wedel (1959:88) noted that some of his interpretations may be in error, but his two-volume report (Brower 1898, 1899) is an important record for the early archeology of the Plains.

Just before the end of the nineteenth century, S. W. Williston and H. T. Martin excavated a seven-room pueblo in Scott County, Kansas (Williston 1899; Williston and Martin 1900; Martin 1909). While initial interpretations viewed it as a Spanish settlement, Hodge (1900) correctly noted that the site was probably the pueblo of El Quartelejo occupied in the late seventeenth and early eighteenth century by Pueblo Indians who had fled Spanish domination in the upper Rio Grande region of New Mexico.

From the end of the nineteenth century through the first decade of the present century, a series of sites were excavated which played important roles in the debate over the antiquity of humans in North America.

In 1895 paleontologists with the University of Kansas Museum of Natural History recovered a fluted lanceolate projectile point under the right scapula of a complete skeleton of *Bison bison occidentalis* (Williston 1902a). The site, 12 Mile Creek, was located on the bank of a small tributary of the Smoky Hill River in Logan County, Kansas. The bison bonebed contained the remains of 12 bison and was covered with approximately 5.5 m of sediment. As noted, this site was similar to the Folsom site but it did not impact the embryonic anthropological community at the time the way Folsom did 30 years later (Rogers and Martin 1984). However, other scientists, especially paleontologists, viewed 12 Mile Creek as an important Pleistocene deposit with an indisputable human component (Figgins 1927; McClung 1908; Osborn 1910). Meltzer (1991, 1994) and Romer (1933) have separately argued that only in retrospect was 12 Mile Creek recognized as being of great antiquity, and moreover, at the time of the excavations the Pleistocene age of the deposits was equivocal. However, these conclusions are not supported by the available information. Williston (1897, 1902a) clearly recognized that 12 Mile Creek dated to the Pleistocene and explicitly stated the importance of the association of the point with an extinct form of bison. Recent archeological research has demonstrated that 12 Mile Creek was a Paleoindian-age bison bonebed, which had been ^{14}C dated to ca. 10,350 B.P (Rogers and Martin 1984). Later interest in the site centered on projectile point typologies (Howard 1935; Brown and Logan 1987; Rogers and Martin 1984; Wedel 1959); the historical importance of the site (Hill 1994; Jackson and Thacker 1992; Meltzer 1991; Rogers and Martin 1984); and analysis of the faunal remains and site formation processes (Hill et al. 1993; Rogers and Martin 1984).

In February, 1902, skeletal remains of two humans—an adult male and a 6- or 7-year-old child—were accidentally discovered beneath 20 feet of sediment along the Missouri River near Lansing, Kansas (Williston 1902b). The skeletons had modern cranial characteristics and were similar to historic Plains Indian groups (Holmes 1902; Hrdlicka 1907; Wedel 1959). The antiquity of the remains was based on the age of the 20 feet of loess covered the deposit. Williston, Upham, Winchell, and Haworth all argued that the overburden was an undisturbed loess deposit contemporary with the Iowan interglacial (Winchell 1903). The opposition, including Chamberlin, Salisbury, and Holmes, supported the theory that the overburden was redeposited sediment which dated to the Holocene period (Chamberlin 1902). Unfortunately, the debate over the Lansing site—like other American Paleolithic sites—became quickly stalemated with neither side changing its position. Wedel (1959: 93) concluded that the Lansing site represented an early ceramic or late preceramic burial, but a series of radiocarbon dates on the bones indicate a middle Holocene age (O'Brien 1984).

Four years after the discoveries at the Lansing site, Robert F. Gilder, of Omaha, Nebraska, excavated human remains from an artificial mound at the Long's Hill site (Strong 1935). The site contained a large number of human bones located above and below a burned clay layer which was 4 feet below the surface. The bones from the lower level were thought to be of a "primitive" form (Barbour 1907; Gilder 1907). Hrdlicka (1907) examined the skeletal material from Long's Hill and stated that the human remains were a modern form, and rodent activity in the mound has caused a high degree of disturbance. Even though the argument against the great antiquity of the Long's Hill remains was very convincing (Strong 1935:46), the debate continued for decades and finally ended in a stalemate.

Intensive archeological research in Kansas dwindled following the work at Lansing and was not resumed until the appearance of Waldo Wedel in the 1930s. An exception to this was the notable work of Gerard Fowke who conducted a surface survey of the Missouri Valley from Doniphan County, Kansas, to Omaha, Nebraska (Fowke 1922; Wedel 1959).

The beginning of the twentieth century witnessed the inception of professional archeology in Nebraska. Elmer E. Blackman was selected as the first state archeologist of Nebraska in 1901. His early work consisted of trying to dispel the myth that human occupation of the Plains was limited to the historic period (Paul 1986). To this end he excavated several historic and protohistoric Pawnee villages (Blackman 1903, 1905, 1906). Frederick Sterns of Harvard University also was very active in the southeastern portion of Nebraska and northeastern Kansas during this period. He carried out extensive excavation of numerous village sites of the Nebraska culture, throughout this area (Hill and Cooper 1938; Strong 1935). Unfortunately, except for Sterns' work at the Walker-Gilmore site in Cass County (Sterns 1914, 1915a) and Strong's *An Introduction to Nebraska Archeology* (1935) most of his data is unpublished (Sterns 1914, 1915a,1915b). From 1926 to 1929 Asa T. Hill excavated numerous historic Pawnee houses at the Hill site (25WT1).

Professional Archeology and Federal Involvement (1930-1965)

During this period, archeology became dominated by university-trained archeologists. Associated with increased professionalism, archeologists began to organize into professional and avocational societies, such as the Society of American Archaeology (1934), Plains Anthropological Conference (1931), and the Colorado Archeological Society (1935).

Federal Involvement in Archeology

This period witnessed a tremendous increase in the amount of fieldwork in archeology, which was a direct result of federal support. In 1928 Congress authorized the Smithsonian Institution to cooperate in anthropological research with any qualified state, educational, or scientific institution (Wedel 1982). This law (Public Law 248) supplied $2,000 a year for archeological research in any state for the next five years. Wedel (1982:95) reported that 20% of this money went towards work in the Plains and supported several early surveys in Central Plains states (Hill and Cooper 1938; Hill and Wedel 1936; Renaud 1930, 1931; Strong 1935; Wedel 1959). During the Great Depression, one aspect of the Works Progress Administration (WPA) was to support archeological fieldwork. Despite the monetary support and large numbers of fieldworkers devoted to archeological fieldwork the WPA's main purpose was for work relief and not scientific research (Grosser 1981).

Following World War II, federal support of archeological research greatly increased with the River Basin Survey Project. In the 1920s and 1930s the U.S. Army Corps of Engineers and

Bureau of Reclamation planned to construct hundreds of dams. The actual construction of these dams was held up until after the war. In June, 1945, the Committee for the Recovery of Archeological Remains (CRAR) was created to develop a salvage plan for the archeological sites which would be inundated by the construction of the dams. On October 9, 1945, the Inter-Agency Archeological Salvage Program was established.

Because of the massive size of the projects, almost the entire archeological profession was mobilized. While four regional headquarters (Lincoln, NE; Austin, TX; Eugene, OR; and Berkeley CA) were established to oversee work, it was local universities, museums, and historical societies who performed much of the work (Jennings 1985). Stephenson (1967:4) reported that by 1965 the River Basin Survey crews had worked in 273 reservoirs in 29 states. A total of 5,250 sites were identified with 576 sites in 58 reservoirs being tested or excavated. Table 5 lists reservoir archeological projects in Central Plains.

There were both positive and negative results of the 20-year River Basin Survey program. While there were over 700 publications resulting from the River Basin Survey (Petsche 1968; Stephenson 1967), Jennings (1985: 285) estimated that this represents only 25% of the data collected. Other problems included erratic funding and difficulties in finding qualified personnel (Jennings 1985; Grosser 1981). Some of the more positive accomplishments resulting from the River Basin Survey include the following (Grosser 1981; Jennings 1985; Lehmer 1971; Stephenson 1967; Wedel 1967):

1. advances and standardization in field techniques, such as application of dendrochronology and interdisciplinary studies, use of power equipment in excavations, and the acceptance of the Smithsonian trinomial site designation system;

2. increase in archeology education, such as field training for ca. 1000 students, and the establishment of graduate programs and laboratories of archeology;

3. large increase in amount of cultural data recovered which resulted in the establishment of a 10,000-year cultural sequence in North America.

Following the end of the River Basin Surveys, the federal government continued to support archeology through numerous research grants (e.g., National Science Foundation), federally supported salvage operations, and legislation which would protect threatened archeological sites. Some of the more important federal regulations pertaining to archeology are listed in Table 6. The 1966 National Historic Preservation Act insured that any federal undertaking that affected sites on, or eligible for, the National Register would have to consider the impact of the project on those properties. The 1971 Executive Order 11593 provided for an inventory of cultural resources on federal lands for nomination to the National Register. The 1974 Moss-Bennett Bill (Public Law 93-291) authorized all federal agencies to expend funds on preservation of historical/archeological data. This body of legislation, especially the Moss-Bennett Bill, has finally secured funding for federal construction projects and established the basis for Cultural Resource Management programs.

Theoretical Changes

During this period, museums across the country were filling with artifacts which had been collected during the previous decades. In addition, many excavations, especially in the Southwest and East, were uncovering stratified sites. As a result, archeologists recognized the need to organize and arrange these collections into geographically and temporally meaningful categories (Willey and Sabloff 1993).

This organization required definition of diagnostic artifacts through use of distinctive attributes. Variation in artifacts types and attributes could be used to observe spatial and temporal variation in the archeological record. In areas of the country where stratified sites were prevalent, artifact types in the stratigraphic levels were used as the basis for developing cultural chronologies (e.g., Ford and Willey 1941; Kidder 1924; Strong 1935; Webb and DeJarnette 1942). However, during the 1930s and 1940s, very few stratified sites were known in the Midwest and Plains. As a result, the Midwestern Taxonomic System was developed as an organizational framework for archeological assemblages (McKern 1939). This classification system began with the component as its basic unit. The component was composed of artifact types and features—e.g., ceramics, houses, burials—from an archeological site. Similar components were then organized into larger spatial units of foci, aspects, phases, and patterns. In McKern's system the scale of cultural similarity was documented by trait lists summarizing the presence or absence of specific traits (Spaulding 1985). McKern's system by definition was ahistorical, but with the addition of chronological information this approach became a useful technique for organizing the regional archeological records (Bell and Baerreis 1951; Griffin 1952; Wedel 1959). With the advent of dendrochronology and radiocarbon dating (Libby 1955), regional culture chronologies became increasingly precise and less dependent upon stratified sites.

By the early 1950s explicit concern for chronological ordering and integration of archeological assemblages and complexes was widely evident. Philip Phillips, Gordon Willey and others (Phillips and Willey 1953; Phillips et al. 1951; Willey and Phillips 1958) developed what has remained the primary framework of archeological unit concepts for the Plains region and eastern North America (Willey and Phillips 1958:11-57). Additions to and modifications of this system of components, phases, traditions, and horizons attest to the resilience, utility, and flexibility of this formulation (Blakeslee 1978; Lehmer 1971; Krause 1969, 1982, 1989).

In the last two decades of this period archeology expanded its concern beyond chronology with increasing interest in cultural behavior (Taylor 1948; Willey and Sabloff 1993). Human behavior was approached by examining the context and function of artifacts. Willey and Sabloff (1993: 156-157) define these terms as follows:

> By context, we mean here the full associational setting of any archeological object or feature: its position on or in the ground and its positional relationship to other objects and features. With

Table 5. Archeological Research in Selected Reservoirs and Watershed Projects in the Central Great Plains.

Reservoir	County	Funding	Reference
Colorado			
Big Muddy Reservoir		NPS	Breternitz et al. 1970
Blue Reservoir		COE	Anonymous n.d.; Hylton et al. 1973; Withers 1949a
Blue Mesa Reservoir	Gunnison	RBS	Lister 1962
Bonny Reservoir	Yuma	RBS	Bliss n.d.
Boxelder Creek Reservoir		USSCS	Gordan and Kranzush 1977
		NPS	Morris, Metcalf, Davidson 1974; Morris et al. 1979; Ohr, Kvamme, and Morris 1979
Cabin Creek			Morris and Marcotte 1975
Carter Lake Reservoir	Larimer	NCWCS	Kranzush 1982
Chatfield Reservoir	Jefferson	HCRS	Nelson 1979; Withers 1972
Cherry Creek Reservoir	Arapahoe	RBS	Anonymous 1983
		COE	Kivett 1947f; Wormington 1948
Colorado-Big Thompson Reservoir		RBS	Burgh 1947
Cottonwood Dam		RBS	Hurst n.d.
EL Dorado Canyon		NJMRP	Hand 1981
Gateview Dam		RBS	Hurst n.d.
Granby Reservoir	Grand	RBS	Burgh n.d.
Gunnison-Arkansas Project		RBS	Withers 1949a
Loveland Reservoir		USFS	Weber and Anderson 1977
McPhee Reservoir	Larimer	RBS	Sias n.d.
Milton Reservoir	Weld	USFS	Tate 1985
Missouri River		RBS	Fenenga 1953 Wedel 1947; Wheeler and Smith 1953
Narrows Reservoir	Morgan	RBS	Fenenga 1951b
Navajo Reservoir	Archuleta	RBS	Kivett 1947b
Platoro Reservoir	Conejos	RBS	Meyers 1950
Poudre Canyon Watershed		USFS	Grant 1978a,b
Republic River		RBS	Bauxar 1948; White 1947
Ruedi Reservoir	Pitkin	RBS	Withers 1949b
Senac Reservoir	Arapahoe	City of Aurora	O'Neil et al. 1986; Tate and Friedman 1986
Smoky Hill River		RBS	White 1947
Trinidad Reservoir	Las Animas	RBS	Baker n.d.; Dick n.d.
Two Forks Reservoir		BUREC	Windmiller 1974, 1975
Wildcat Creek	Morgan	City of Fort	Lutz, Farmer, Muceus 1978
Wray Reservoir	Yuma	RBS	Kivett 1947g
Kansas			
Big Hill Reservoir	Labbette	COE	Marshall 1966a, 1966d; Rowlison 1977, 1978, 1980; Thies 1982
Big Sugar Creek		NPS	Brown, Evans, and Rucker 1974; Logan 1983
Cedar Point Reservoir	Chase	COE	Barr 1968
Cedar Bluff Reservoir	Trego	RBS	Kivett 1947a
Cheney Reservoir	Reno	NPS	Witty 1963a
Clinton Reservoir	Douglas	COE	Chambers 1977
		RBS	Chism 1966
		NPS	Johnson 1968; Logan 1987; Nathan 1980; Sturdevant 1983
Copan Reservoir	Chautaugua	COE	Rohn and Smith 1986
		NPS	Vaughan 1975, 1976; Vehik and Pailes 1979
Council Grove Reservoir	Morris	NPS	O'Brien 1983
		COE	Witty 1961a, 1962b, 1963c, 1965b, Witty 1982
Cross Creek Watershed		USSCS	Timberlake 1982, 1986a, b
Delaware Watershed		USSCS	Timberlake 1982
Diamond Creek Watershed		USSCS	Ashworth 1981a,1982a,b
El Dorado Reservoir	Butler	NPS	Bastian 1979
		COE	Brockington et al. 1982; Eoff and Johnson 1968d
			Fuller 1976, 1977; Johnson 1983; Leaf 1976, 1978; Root 1978
Fall River Reservoir	Greenwood	NPS	Eoff and Johnson 1968a
Elk City Reservoir	Montgomery	COE	Brogan 1980
		NPS	Frantz 1964; Marshall 1965, 1966b, 1966c,
			Marshall 1967b, 1972; Marshall, Turner, and Bass 1972
			Weakly 1965; Witty 1962 c, n.d.
Fall River Lake	Greenwood	COE	Elock and O'Brien 1979
Fort Scott Lake	Bourbon	NPS	Bradley 1969; Bradley and Harder 1969
Frog Creek Reservoir	Osage/Coffey	NPS	Eoff and Johnson 1968b; Marshall 1965
Glen Elders Reservoir	Mitchell	RBS	Carlson 1967, 1971; Kiehl 1953; Marshall n.d. c; Riley 1967; Solecki 1952a
Grove Reservoir	Shawnee	NPS	Marshall 1969
Hillsdale Reservoir	Miami	NPS	Artz et al. 1976
		COE	Blakeslee and Rohn 1982; Carrillo 1969a,b; Rohn and Daniel 1979; Rohn and Williams 1977;
			Rohn and Woodman 1976; Sturdevant and Carrel 1983
John Redmond Reservoir	Coffey	NPS	Rogers 1979
		COE	Schmits, Jones, Witty 1980; Thies and Witty 1981; Witty 1961b, 1963d, 1964b
Kansas River		COE	Sturdevant 1980
Kanopolis Reservoir	Ellsworth	RBS	Anonymous 1947
		COE	Grand River Institute 1980
		NPS	Hayden 1978; Kivett 1947b; Leaf 1977; Lees 1986; Mattes 1947b
Kaw Lake		COE	Rohn et al. 1981
Kirwin Reservoir	Phillips	RBS	Kivett 1947c
	Cowley	NPS	Mattes 1947a; Solecki 1952b;Witty 1966b; Witty, Bass, and Grubb 1964
Little Delaware-Mission Creek		NPS	Eoff and Johnson 1968c
Lovewell Reservoir	Jewell	RBS	Fenenga 1951a; Fenenga and Cooper 1951; Neuman et al. 1962
Lyon Creek Watershed		COE	Jones 1975
Marion Reservoir	Marion	COE	Malone and Rohn 1980; Witty 1963b
Melvern Reservoir	Osage	COE	Aldenerfer 1980
		RBS	Bradley 1968

Table 5, concluded.

Reservoir	County	Funding	Reference
		NPS	Moore and Birkby n.d.; Moore et al. 1962; Reynolds 1984; Schmits 1983, 1984; Smith and Birkby 1962, 1963; Traub 1975; Witty 1975; Wilmeth 1952
Middle Creek Watershed		USSCS	Ashworth 1981, 1982
Milford Reservoir	Geary/Clay	COE	Marshall and Witty 1967; Muller and Schock 1964; O'Brien 1976, 1977; Schmits 1983, 1984; Schwiekhard and O'Brien 1982; Witty 1961d,1962c, 1963b
Mud Creek		COE	Heffner 1973; Logan 1983
Neosho River Watershed		COE	Schmits 1973
Norton Reservoir	Norton	NPS	Blasingham 1963
Onaga Reservoir	Pottawatomie		Reynolds 1971,1975,1979
Perry Reservoir	Jefferson	RBS	Jones 1968
		NPS	Logan and Fosha 1991
		COE	Marshall 1967a; Nickel 1973; Schmits 1986; Witty 1964a, 1966a, 1982, 1983
Pomona Reservoir	Osage	COE	Schmits 1983, 1984; Traub 1977; Wilmeth 1952, 1960, 1970
Pony Creek Watershed			Lees 1986
Roy's Creek Watershed		USSCS	Timberlake 1986b
Smoky Hill River		RBS	Strurdevant 1980
		COE	White 1957
Stranger Creek			Logan 1983
Strawn Res. (John Redmond)	Coffey	RBS	Moorman 1953
Toronto Reservoir	Woodson	RBS	Howard 1964; Johnson 1957; Johnson et al. 1957; Moorman 1953; Rohn, Cacioppo, King 1980
Turkey Creek	Riley/	NPS	Quade 1969b
Tuttle Creek Reservoir	Pottowatomie	RBS	Cumming 1958
		NPS	Johnson 1970
		COE	Johnson et al. 1980; Klinger, Ayres, and Imhoff 1987; Miller 1982; Schmits et al. 1987; Solecki 1953; Ziegler 1976
Upper Black Vermillion Watershed		NPS	Calabrese 1966c, 1967a; Quade 1969c
Verdigris Watershed		NPS	Calabrese 1965, 1966a, 1967b; Rohn, Daniel, King1972; Unrau and Wood 1972; Witty 1965a
Wakarusa Reservoir		NPS	Jones 1976a,b, Quade 1969a
Walnut Creek Reservoir	Brown	NPS	Calabrese 1966b, 1967b
Webster Reservoir	Rook	NPS	Solecki 1952c
Wilson Reservoir	Russell	NPS	Rowlinson 1983;
		COE	Rowlinson and Witty 1982; Solecki 1952d; Ungar 1977; Witty 1961c, 1962a
Wolf Creek Watershed		USSCS	Ashworth 1980a,b, 1982
Nebraska			
Box Butte Reservoir	Dawes	RBS	Bauxar 1947
Briscoe Dam		USSCS	Pepperl and Haas 1978
Davis Creek Reservoir		NPS	Grange 1963b; Howard and Gant 1966; Kivett and Metcalf 1949
Enders Reservoir	Chase	RBS	Kivett 1947d
Gavin's Point Reservoir		COE	Blakeslee and O'Shea 1983
		RBS	Fenenga 1953
		NPS	Gant 1963; Howard and Gant 1965; Mattison 1953, 1956
Harlan County Reservoir	Harlan	COE	Adair and Brown 1987
		NPS	Champe 1950
		RBS	Kivett 1947a, n.d.; Kivett and Shippee 1947; Pepperl 1978b; Pepperl, Falk, Dunlay 1978; Roetzel et al. 1982
Irish Creek		NPS	Quade 1969e
		RBS	
Loup River Watershed			Holen 1983
Lower Platte River		RBS	Cumming 1953
		BUREC	Gunnerson and Gunnerson 1952
		COE	Rickey 1968; Wedel 1947
Medicine Creek	Frontier	RBS	Davis 1953a,b, 1950, 1951, 1952
		BUREC	Davis and Schultz 1952; Kivett 1947e, 1949; Kivett and Wedel 1947; Holder and Wike 1950; Wood 1967 Davis 1962; Schultz and Frankforter 1948,1949; Wedel and White 1947
Mission Creek		NPS	Quade 1969d
Nemaha River		NPS	Hunt 1973; Neuman et al. 1964
Niobrara River Basin		RBS	Pepperl 1983; Wheeler and Smith 1953; White 1951
Red Willow Reservoir	Frontier	COE	Bauxar and White 1986
		NPS	Grange 1962, 1963a, b, 1980; Kivett 1961
Swanson Lake	Hitchcock	NPS	Kivett 1951
South Branch Drainage			Osborne 1982
Tekamah-Med Creek	Burt	USSCS	Pepperl 1978a
Weeping Water Drainage			Osborne 1982

Abbreviations
BUREC: Bureau of Reclamation
COE: US Army Corps of Engineers
HCSRS: USDI, Heritage Conservation and Recreation Service
NCWCS: Northern Colorado Water Conservation Service
NJMRP: North Jeffco Metropolitan Recreation and Parks District
NPS: National Parks Service
RBS: Smithsonian Institution, River Basin Survey
USFS: US Forest Service
USSCS: US Soil Conservation Service

Table 6. Selected Federal Legislation That Supports Archeological Research or Preservation.

Date	Legislation	Definition
1928	Public Law 248	Provided matching funds (up to $2000/year) to qualified insititutions for archeological research.
1935	Historic Sites Act	Established the broad mandate for the Department of Interior to identify and preserve sites and structures that are historically important.
1960	Reservoir Salvage Act	Authorized the National Park Service to seek appropriations for salvage behind dam-building agencies to cooperate in such salvage.
1966	National Historic Preservation Act	Requires that archeological resources deemed eligible for the National Register be given consideration in planning
1969	National Environmental Policy Act	Requires archeological remains be considered in making environmetal impact statements
1970	Executive Order 11593	Requires all federal lands to be inventoried for archeological remains.
1974	Arch. and Hist. Preservation Act	Established a mechanism for salvaging archeological remains threatened by federally supported projects by mandating up to 1% of the total project budget for the preservation of archeological/historic remains.

> these data, archeologists order their material, relating them to assemblages or complexes, which ostensibly have cultural significance, and they may relate these material to natural environmental settings.....[By function] we mean both use and function, as these terms are defined by cultural anthropologists.

Functional analysis of artifacts was not a new innovation; how prehistoric groups used projectile points, axes, or scrapers has always been of interest in archeology. The emphasis now was on how artifacts were used in human "lifeways." Artifact function was generally inferred from artifact form and context. Aspects of form and context were continually argued within archeology for the next several decades (Willey and Sabloff 1993).

Also in this period archeologists began to consider the interrelationship of environment and human culture (Hurt 1966; Weakley 1943, 1946; Wedel 1943, 1963). This whole area of interest can be discussed under the rubric of cultural ecology. It was believed that environmental factors influenced or even determined cultural development and change. Julian Steward (1955) was a principal figure in ecological anthropology, building on earlier work of Wissler, Kroeber, and others. He argued that the culture core was articulated with specific environments through technology and that the technological adaptations (core elements) of a culture would in turn influence other aspects of that culture.

Central Plains

This period was the true beginning of professional archeology on the Plains. The history of Central Plains archeology generally followed the same pattern as that of the larger American archeology. However, the works of Duncan Strong and Waldo Wedel impacted archeology on a national level, especially on the way non-Plains archeologists thought of the prehistoric occupation of the Plains.

Early work on the Central Plains during this period mainly consisted of archeological surveys of Kansas, Nebraska, and Colorado. As previously stated, this work in Kansas and Nebraska was financed largely through grants from the Smithsonian Institution Cooperative Fund. A. T. Hill (Nebraska State Historical Society) and Duncan Strong (University of Nebraska) began in 1929 a multiyear project to survey Nebraska (Hill and Cooper 1938; Hill and Wedel 1936; Strong 1935; Wedel 1934). The purpose of these surveys was twofold. The first purpose was to record sites and collect representative artifacts—mainly pottery. The second purpose was to investigate historic-age sites visited or recorded by Euro-American explorers.

> It was believed that by isolating and clearly defining the archeological characteristics of the historic peoples a whole series of sites could soon be removed from the category of unknowns; and furthermore, that a comparison of materials so identified with earlier remains in the region might open lines of attack which would permit the establishment of a time sequence extending 'from the known historic into the unknown prehistoric' [Wedel 1938:1].

This research approach formed the basis of the Direct-Historical approach (Strong 1933; Wedel 1938). This approach attempted to work back through time from documented historical period sites and assemblages into prehistoric times in the same geographic area. The approach was both simple and elegant. It was based on identifying cultural traits found at documented historic sites and comparing them to traits found at prehistoric sites. When the prehistoric sites exhibit many of the same traits found at known historic sites, it was assumed they shared a similar cultural heritage.

These early surveys consisted of surface surveys and limited excavations. Since time, funding, and personnel were limited, subsurface testing was also limited to areas of human habitation—commonly village house structures (Wedel 1934, 1961).

Other researchers from the Nebraska State Museum concentrated on the late Pleistocene-aged finds in western Nebraska (Barbour and Schultz 1932a, 1932b; Meserve and Barbour 1932; Schultz and Eiseley 1935; Schultz 1932, 1943). These sites generally supported the association of human artifacts with extinct animals as previously identified at the Folsom type site.

The surveys of Colorado (Renaud 1931a, 1932a, 1932b, 1933, 1935) and Kansas (Wedel 1959) followed the same lines as that of Nebraska. However, the early survey of Colorado was limited to a surface survey of the eastern portion of the state.

Excavations were not part of this survey and therefore chronological organization of the data was less feasible. Instead emphasis was placed on typological analyses, specifically for lithic tools and to a lesser extent ceramics (Renaud 1931a). Sites were not organized in reference to age but rather pseudo "functional" classifications, such as camp sites, work shops, petroglyphs, and tipi-rings, and locational designations, such as blowouts, rock shelters, and lookouts. Unlike the surveys of Kansas and Nebraska, the investigations into Colorado elicited more information on the Paleoindian period than the late prehistoric and protohistoric periods (Renaud 1931b, 1932b). This is partly explained by the research interests of E. B. Renaud and the exceptional finds of Paleoindian artifacts in the Yuma County area of Colorado.

Research at stratified sites such as Signal Butte and documentation of late prehistoric villages finally overturned the widespread assumption that the Plains region was uninhabitable before the introduction of the horse (Kroeber 1939; Wissler 1922; Johnson and Wood 1980; Wedel 1961a, 1982). The final blows to this theory came with Strong's 1933 article "The Plains Culture Area in the Light of Archaeology" and his 1935 *Introduction to Nebraska Archeology*. Strong stressed that the nomadic horse tribes which have dominated ethnographic interests (Kroeber 1948; Wissler 1914) were only a recent development on the Plains and were preceded by semihorticultural and pedestrian hunting groups.

With the introduction of the River Basin Survey Program, much archeological research in the Central Plains focused on reservoir salvage programs. The largest unit of this program was the Missouri Basin Project, headquartered in Lincoln, Nebraska. This program was to deal with five major dam constructions along the Missouri River and 100 lesser projects along its tributaries (Wedel 1967). The massive number of sites that were excavated during the Missouri Basin Project has helped to establish an impressive cultural chronology for the Plains region, especially for the past 2,000 years (Lehmer 1971; Wood 1977; Schlesier 1994). An important phase of the Missouri Basin Project was the chronology program, which produced approximately 100 radiocarbon dates from various time periods (Wedel 1967), and the development of dendrochronological research (Weakley 1943, 1946). While dozens of reservoirs in the Central Plains were investigated by the Missouri Basin Project, the most intensively investigated projects occurred at Harlan County, Medicine Creek, Davis Creek and Gavins Point in Nebraska, and Glen Elder in Kansas (Wedel 1967) (Figure 23; Table 5).

Behavioral, CRM, and Interpretative Archeology 1965-1995

This period includes the last three decades of American archeology. The changes that have occurred during this period have had a profound affect on present-day archeology. Because some important changes have occurred in the very recent past, historians lack the necessary time perspective to evaluate some trends during this period. Another problem in providing a history of this period is that the volume of archeological research has been huge. It is, therefore, impossible to discuss the numerous specific projects; only general trends will be reviewed.

Theoretical Archeology

Writings on systems theory and culture process laid the foundation for the changes in archeological method and theory associated with the appearance of processual archeology in the 1960s. Processual or "new" archeology was a product of anthropologically trained archeologists who were dissatisfied with the cultural-historical approach common in the archeology of the 1950s. These archeologists, led by Lewis Binford, believed that archeology could explore how cultures work and change, i.e., cultural processes, rather than simply organizing cultural histories and reconstructing past lifeways (Binford 1962). Processual archeologists were also disappointed with the lack of testing of traditional archeological interpretations. Previously, the archeological inferences had been evaluated by two criteria: (1) the degree to which present knowledge of modern groups could be projected into the past, and (2) the confidence in the ability and honesty of the archeologist advancing the hypothesis (Binford 1968). Binford, and others, wanted archeology to become a more rigorous scientific profession in which interpretations could be objectively and independently evaluated.

> We assert that our knowledge of the past is more than a projection of our ethnographic understanding. The accuracy of our knowledge of the past can be measured: it is this assertion which most sharply differentiates the new perspective from more traditional approaches. The yardstick of measurement is the degree to which propositions about the past can be confirmed or refuted through hypothesis testing....once a proposition has been advanced—no matter by what means it was reached—the next task is to deduce a series of testable hypotheses which, if verified against independent empirical data, would tend to verify the proposition [Binford 1968:17].

There are four basic tenets of processual archeology. First, cultural change can be understood through an evolutionary approach. Second, cultures are systems with interrelated components, and changes in any one aspect will necessarily influence other aspects of the system. Third, the link between human cultures and the environment is not a linear relationship—one in which environment influences culture or vice-versa—but rather humans are one part of the ecosystem. Finally, researchers need to take a generally scientific (positivist) approach to archeology. This approach should stress explicit assumptions, hypothesis testing (hypothetical deductive approach) (Binford 1967, 1968; Watson et al. 1971), and a positivist philosophical position (Salmon 1982). This scientific approach emphasized statistical control of data through sampling techniques which permit generalization about variability (Thomas 1986; Mueller 1975). Through this

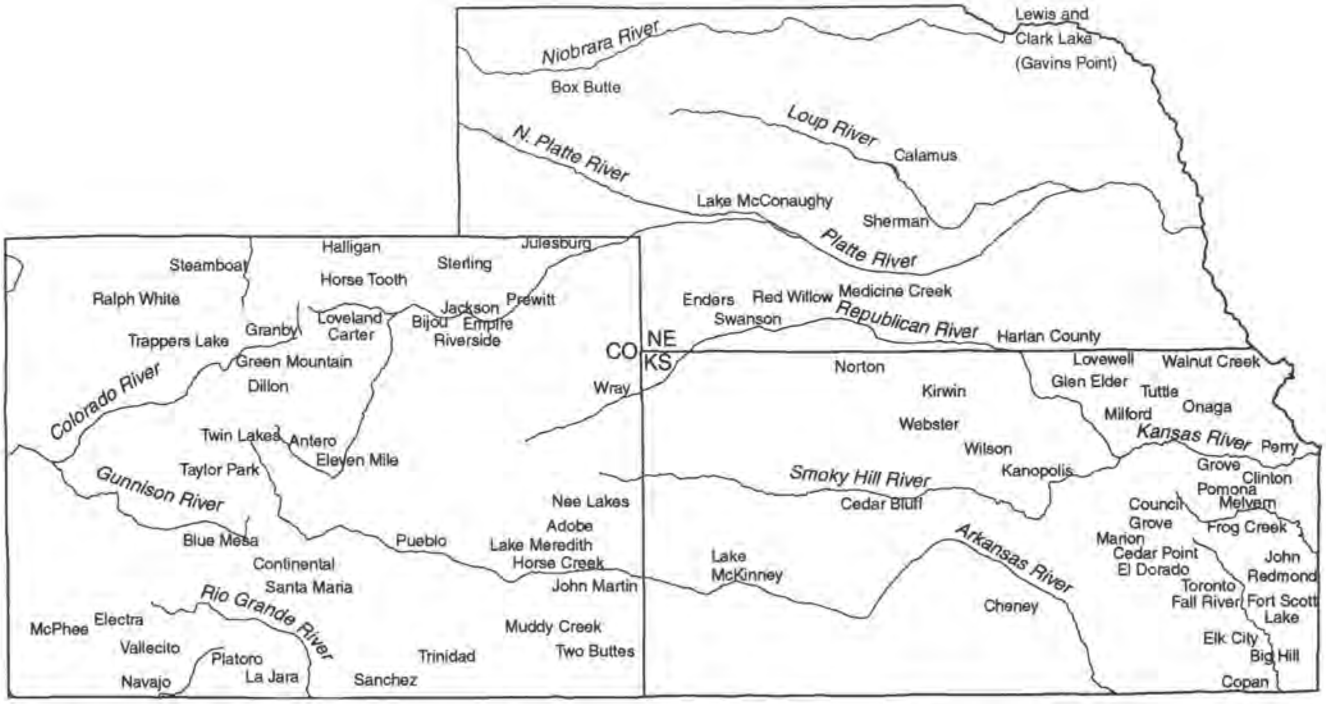


Figure 23. General location of selected artificial reservoirs and watershed projects in the Central Plains.

approach it was hoped that archeologists could develop "laws" of cultural dynamics which would be relevant to the general field of anthropology (Schiffer 1976).

By the late 1970s processual archeology was criticized for not fulfilling its goal of identifying "laws of cultural change" (Willey and Sabloff 1993). This criticism was probably premature and definitely overlooked the positive contributions processual archeology made to the general field of archeology. In response to critics, processual archeologists realized that it was necessary to change the approach to studies of the archeological record. These responses included a reexamination of what the archeological record was and how archeologists can best study it.

Many archeologists initiated ethnoarcheological studies of modern groups attempting to associate the dynamic nature of human behavior and the static nature of the material record (see Binford 1978; Gould 1980; Gould and Watson 1982; Lee and DeVore 1968; Yellen 1977; Kramer 1979). Binford (1981) suggested bridging arguments, called middle-range theory, can be built by studying the links between the statics (material record) and dynamics (human behavior) in ethnographic situations and then drawing analogies between the static archeological record and the dynamics of the prehistoric past. Binford claimed that it was not enough to draw simple analogies between the present and the past, instead archeologists must try to explain the nature of the relationship between dynamic systems and the resultant archeological records.

However, it was also realized that the archeological record was not analogous to the material culture of ethnographic groups. The primary difference is that the cultural materials result only from behavior, while the archeological record is the result of cultural and noncultural processes. Taphonomy, in its most general usage, is the study of processes which influence the formation of the archeological record. Faunal studies have led the way in taphonomic research (Behrensmeyer and Hill 1980; Binford 1981; Bonnichsen and Sorg 1989; Gifford-Gonzalez 1991; Todd 1987; Voorhies 1969), although key studies have appeared in analyses of many other materials (Schiffer 1987).

An increasingly important development since about 1980 has been an explicit concern for the study of culture change through a selectionist or Darwinian evolutionary perspective (Boyd and Richerson 1985; Dunnell 1980, 1982, 1988, 1995; O'Brien and Holland 1991; Leonard and Jones 1987). The basic argument is that adaptationist or functional explanations do not facilitate and can actually inhibit the study of culture change. Variability, not normative patterns or behaviors, is key to understanding change from an evolutionary perspective. There is currently no viable alternative explanatory framework for the study and explanation of long-term changes in culture, behavior, and technology as reflected in the archeological record.

By the end of the 1970s, a group of archeologists in both Britain and America had grown highly critical of processual archeology. These critics have been grouped together under the single heading: postprocessual archeology (Patterson 1986; Shanks and Tilley 1994). While these researchers may differ with one another in their specific approaches, they generally agree on their criticism of processual archeology. These analysts were dissatisfied with processual archeology's continued commitment to what they see as narrow ecological and evolutionary archeology, approaches which the critics feel is out of touch with present concerns of anthropology (e.g., gender, power, ideology, structure, history). Irrespective of their approach—gender, Marxist, critical, contextual—postprocessualists contend that processualists have overlooked the importance of ideology to direct and determine cultural change and the impact of contemporary culture on the structuring and execution of scientific research.

Processualists have responded that postprocessualists are unscientific and rely heavily on what is essentially a direct historical approach, wherein all interpretations of the past are limited by the present. The debate between these two camps has been intensive and often personal but has generally not swayed either side. The importance of the debate is not that the participants change each other's opinions, but rather that the strengths and weaknesses of each set of arguments are explored (Preucel 1991; Duke and Wilson 1995).

CRM Archeology

Although the past 30 years are known for many theoretical changes in archeology, these approaches have only partially influenced the majority of archeological fieldwork during this time. Most of the field archeology since the late 1960s has been conducted in direct response to federally supported Cultural Resource Management (CRM). This applied archeology has specific requirements to fulfill and these are largely based on procedures, methodologies, and theoretical perspectives which were widespread in the Americas during the early 1970s when much cultural resource preservation legislation was put into practice. These CRM goals include (1) determining the existence of archeological remains in proposed project areas, (2) determining the impact of the project on the cultural resources, (3) assessing the significance of the affected resources according to the criteria of the National Register of Historical places, and (4) providing recommendations regarding the disposition of archeological remains on the basis of the assembled facts (Raab et al. 1980). Such work is generally focused on the identification of archeological "sites" and some unrealistic assumptions about sampling, site significance, and the formation of the archeological record (Ebert 1991; Dunnell and Dancy 1983; Foley 1981; Smith and Wandsnider 1993; Schiffer 1987).

Federally funded contract archeology has become a dominant force in the archeology of North America. If measured by total financial expenditures and number of field projects, the vast majority of fieldwork has been performed through CRM projects. Hassler (1989:121) estimates that in 1975 total expenditures on federally supported CRM projects in North America totaled approximately $20.8 million, while five years later those expenditures reached almost $100 million. Clearly, CRM work has been a major driving force in the archeology of the last several decades.

This regulated archeology often differs with the approaches of research-oriented or academic archeology. Many critics have stated that CRM archeology does not contribute proportionately to the advancement of knowledge of the archeological record (Flannery 1982; Goodyear et al. 1978; Schiffer and Gumerman 1977). The numerous reasons for this disparity include the fact that the legal requirements of contract archeology can be fulfilled without undertaking a study aimed at significant archeological research questions. Others argue that the idea of significance in the archeological record is problematic because the knowledge that can gained from an archeological site has more to do with the approach brought to the site by the researcher than any intrinsic nature of the site itself (Raab and Goodyear 1984; Binford 1989).

Another problem arises from the fact that many contract archeological firms are private firms organized to make a monetary profit and often operate outside of academic circles where they may be isolated from ideas and developments in archeology. The profit motive has a powerful influence on the type and extent of work done by these companies and on the follow-through time allocated to research following fieldwork. This can motivate CRM companies to perform the least amount of work to fulfill its obligations, thus resulting in minimal information about the archeological resources being studied (Raab et al. 1980). Follow-through in research and publishing, long-term research in specific regions, familiarity with sites and research questions, and knowledge of the regional archeological data base are often hampered by "hit-and-run" CRM projects. Such problems, however, are certainly not limited to CRM archeology.

Central Plains Archeology

The work on the Great Plains has been dominated by federal CRM contracts. Grosser (1981:59) stated that 95% of all research is funded by federal government contracts. Cultural Resource Management programs began to appear on the Plains in the early 1960s, but at that time the number of projects was small. Between 1975 and 1979 the amount of work in CRM on the Great Plains increased substantially, but by 1980 economic recession caused a dramatic reduction of the available monies for CRM projects. However, the energy boom during this time continued to finance some work on the Great Plains, especially in Montana, Wyoming, North Dakota, and Colorado. While these energy projects commonly supported archeological work, this work was commonly small scale surveys and small mitigation projects such as those associated with drilling pads. Thus while more work was supported by energy projects, these projects often concerned only small areas and were generally not directed toward general research questions.

While contract work on the Central Plains has many problems, it also has contributed positively to archeology. As Hassler (1989) stated, contract archeology has financially supported many graduate and undergraduate students, as well as providing research topics for numerous student projects. Based on the volume of work, CRM archeology has contributed vast amounts of data on the human occupation of the Plains. Much of the specific fieldwork in CRM archeology occurred in reservoir and river basin studies (Table 5; Figure 23), energy projects (e.g. drilling wells, pipelines), and highway construction.

Unfortunately, much of this data contributed through contract work never reaches the larger archeological audience. The general impression of many research archeologists is that most CRM reports are unpublished and therefore "notoriously difficult to obtain" (Roper 1987:342). However, as Roper's (1987) analysis of archeological publications in the Plains has concluded, the trend of contract archeologists' poor publication record is improving. Roper stated that CRM archeologist publications in academic journals has substantially increased since the early 1980s. Nevertheless, academic researchers still contribute approximately 70-80% of all journal articles. One explanation of this pattern is that CRM archeologists have no research latitude on the work they perform, even though the work they do often warrants publication in archeological journals (Roper 1987).

This period has also witnessed a tremendous increase in the amount and quality of archeological research on the Plains. Several researchers (Eighmy 1983; Johnson and Wood 1980) have noted the tremendous methodological advances in Plains archeology, such as computer analysis, bioarcheology, dating methods, remote sensing, settlement studies, lithic technology, ceramic studies, and faunal analyses. Methodological advances in these research areas were also associated with conceptual advances. These advances have been in archeological taxonomy, culture history and area syntheses, paleoenvironmental studies, the relationships between environment and cultural change, and fundamental changes in the perception of what the archeological record represents and how it is studied. Many of these interests are long-standing ones in Plains archeology, but new tools and ideas are now contributing to this research.

4 Early Hunter-Gatherers of the Central Great Plains: Paleoindian and Mesoindian (Archaic) Cultures, by Jack L. Hofman

Hunting and gathering peoples have occupied the Americas for more than 12,500 years if we accept the well-documented evidence from the Monte Verde site in southern Chile (Dillehay 1989). Further evidence, considered inconclusive by many researchers, has also been reported for the even earlier presence of people in the New World (e.g., Adovasio 1993; Dillehay and Collins 1988; Ericson et al. 1982; Ochsenius and Gruhn 1979; Guidon 1986; Bryan 1986a; Meltzer et al. 1994).

When prehistoric people first came to the Central Plains region of North America remains one of many unresolved problems which can only be evaluated through study of the region's archeological record. However, consideration of the earliest archeological record in the Americas as a whole is of considerable relevance to establishing the history and patterns in the first settlement(s). Understanding the timing and avenues for entry into the New World has important implications for study of the earliest portion of the archeological record on the Central Plains.

The concern of this chapter is to provide a critical synopsis of the early and extended portion of the archeological record in the Central Plains from the time of the first human arrivals until the appearance of a constellation of traits which mark the "end" of, or a major change in or addition to, the traditional hunting and gathering way of life.

These marker traits include the artifacts associated with an increasingly sedentary and horticultural way of life: ceramics, structural remains, storage technology, and plant food processing equipment. There are problems with this distinction, usually referred to by archeologists as Archaic vs. Woodland cultures, because each of the above listed traits which we generally recognize as typical of Plains Woodland and later cultures have earlier expressions in the Archaic complexes of the Plains region. Permanent structures, storage, use of ceramic objects, and plant processing equipment all appear thousands of years before the spread of Woodland traits and horticultural economies on the Central Plains. Also, there is no evidence that the "Archaic" or hunting and gathering lifeway ended or became extinct with the onset of Plains Woodland a little more than 2,000 years ago. Instead it is likely that there were always hunters and gatherers (though representing a variety of different traditions) in the Central Plains region between the Rocky Mountains and the Missouri River trench until the aboriginal people were displaced by Euro-American encroachment and finally by the near extermination of bison.

The focus of this review, however, is on the archeological record of hunting and gathering peoples who occupied the Central Plains region prior to the appearance of ceramic vessel technology. This is simply a convenient boundary marker and is not intended to imply that the use of ceramic vessels, in and of itself, is necessarily of fundamental socioeconomic importance. Early ceramic technology on the Plains probably reflects the increasing need for effective storage and processing technology associated with intensified use of seedy plants. It may, however, signal a general change or increasing variability in aspects of some Plains cultures (such as mobility or redundancy of site use) which develops during the following centuries into the Plains Village tradition (Wedel 1986; Lehmer 1971; Schlesier 1994).

The economy of the late prehistoric Plains Village groups also exhibited a significant component of hunting and gathering (Holder 1970; Osborn 1987), as did that of protohistoric groups and historic Euro-American settlers. The significance of or relative economic contributions of hunting and gathering vs. farming are commonly discussed but remain poorly understood. Studies of bone chemistry hold the potential to inform us about the relative importance of bison and other meat in the diet as compared to garden produce and wild plants (e.g., Tuross and Fogel 1994; Habicht-Mauche et al. 1994; Tieszen 1994).

Archeological sites and studies outside the Central Plains will be referred to as is appropriate for comparative purposes. For the most part, however, the maps, tables, and discussion will focus on this specific region. The archeological summary is presented in chronological order beginning with pre-11,500 B.P. sites followed by recognized Paleoindian complexes including Clovis, Goshen, Folsom, Midland, Agate Basin, Hell Gap, Cody, Angostura, Allen/Frederick, Meserve, and other less well-established complexes.

The Archaic complexes discussed include Frontier, Logan Creek, Oxbow, McKean, Munkers Creek, Pelican Lake, Besant, Eldorado, and Nebo Hill. The technological characteristics, economic evidence, natural resource use, and social organization evidence for these complexes are presented as well as some basic information about the frequency and distribution of key sites and reported finds. Basic information on the scale of excavations, available radiocarbon dates, and major problems or perceived "data gaps" are also provided.

This review is based primarily on a wide variety of previous publications pertaining to the prehistoric archeology of the Central Plains region. Some relatively new or previously unpublished information is also included as appropriate. By way of historical background and to acknowledge the primary sources used here, selected key publications are listed in Table 7 in chronological order. This is not a comprehensive listing, but simply a means to recognize important sources which might otherwise be missing from the cited references, and to provide some sense of the nature and cadence of publications concerning the preceramic archeology of the Central Plains.

Pre-11,500 Archeology

Consensus on the time of arrival of the "founding populations" in western and central North America has not been reached. We do not know when people first arrived in North America and we do not know how many migrations occurred.

Table 7. Chronological Presentation of Selected Key Central Plains Preceramic Archeological Sources.

Author/s	Date	Title
Williston	1902	An Arrow-Head Found with the Bones of Bison Occidentalis, Lucas, in Western Kansas.
Figgins	1927	The Antiquity of Man in America.
Figgins	1931	An Additional Discovery of the Association of a "Folsom" Artifact and Fossil Mammal Remains.
Renaud	1931-1935	Archaeological Survey of Eastern Colorado
Meserve/Barbour	1932	Association of an Arrow Point with Bison Occidentalis in Nebraska.
Renaud	1932	Folsom and Yuma Artifacts, New Material.
Schultz	1932	Association of Artifacts and Extinct Mammals in Nebraska.
Figgins	1933	A Further Contribution to the Antiquity of Man in America.
Renaud	1934	The First Thousand Yuma-Folsom Artifacts.
Renaud	1934	Archaeological Survey of Western Nebraska.
Figgins	1934-1935	Folsom and Yuma Artifacts
Strong	1935	An Introduction to Nebraska Archaeology.
Roberts	1935	A Folsom Complex: Preliminary Report on Investigations at the Lindenmeier Site in Northern Colorado.
Schultz/Eisley	1935	Paleontological Evidence of the Antiquity of the Scottsbluff Bison Quarry and Its Associated Artifacts.
Barbour/Schultz	1936	Palaeontologic and Geologic Consideration of Early Man in Nebraska.
Eiseley	1939	Evidence of a Preceramic Cultural Horizon in Smith County Kansas.
Champe	1946	Ash Hollow Cave: A Study of Stratigraphic Sequence in the Central Great Plains.
Holder/Wike	1949	The Frontier Culture Complex, A Preliminary Report on a Prehistoric Hunter's Camp in Southwestern Nebraska
Bliss	1950	Early and Late Lithic Horizons on the Plains.
Davis	1953	Recent Data from Two Paleo-Indian Sites on Medicine Creek, Nebraska.
Wormington	1957	Ancient Man in North America.
Mulloy	1958	A Preliminary Historical Outline for the Northwestern Plains.
Irwin/Irwin	1959	Excavations at the LoDaisKa Site.
Wedel	1959	An Introduction to Kansas Archaeology.
Dick/Mountain	1960	The Claypool Site: A Cody Complex Site in Northeastern Colorado.
Wedel	1961	Prehistoric Man on the Great Plains.
Davis	1962	Archaeology of the Lime Creek Site in Southwestern Nebraska.
Krieger	1964	Early Man in the New World.
Hurt	1966	The Altithermal and the Prehistory of the Northern Plains.
Irwin	1968	The Itama: Early Late-Pleistocene Inhabitants of the Plains of the United States,Canada, American Southwest.
Voorhies	1969	Taphonomy and Population Dynamics of an Early Pliocene Vertebrate Fauna, Knox County, Nebraska.
Breternitz	1971	Archaeological Investigations at the Wilbur Thomas Shelter, Carr, Colorado.
Wheat	1972	The Olsen-Chubbuck Site: A Paleoindian Bison Kill.
Irwin-Williams et al.	1973	Hell Gap: Paleoindian Occupation on the High Plains.
Reeves	1973	The Concept of an Altithermal Cultural Hiatus in Northern Plains Prehistory.
Stanford	1974	Preliminary Report of the Excavation of the Jones-Miller Hell Gap Site, Yuma County, Colorado.
Agenbroad	1978	The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains.
Benedict/Olsen	1978	The Mount Albion Complex: A Study of Prehistoric Man and the Altithermal.
Frison	1978	Prehistoric Man on the High Plains.
Schmits	1978	The Coffey Site: Environment and Cultural Adaptation at a Prairie-Plains Archaic Site.
Wilmsen/Roberts	1978	Lindenmeier, 1934-1974: Concluding Report of Investigations.
Wheat	1979	The Jurgens Site.
Stanford	1979	The Selby and Dutton Sites: Evidence for a Possible Pre-Clovis Occupation of the High Plains.
Grange	1980	Excavations in the Red Willow Reservoir, Nebraska
Johnson	1980	Archaic Prehistory on the Prairie-Plains Border.
Shields	1980	Investigations at the McEndree Ranch Site, 5BA30.
Frison/Stanford	1982	The Agate Basin Site: A Record of Paleoindian Occupation on the Northwestern High Plains.
Cassells	1983	The Archaeology of Colorado.
Eighmy	1984	Colorado Plains Prehistoric Context.
O'Brien	1984	Archaeology in Kansas.
Reid	1984	Nebo Hill and Late Archaic Prehistory of the Southern Prairie Peninsula.
Greiser	1985	Predictive Models of Hunter-Gatherer Subsistence and Settlement Strategies on the Central High Plains.
Kornfeld/Todd	1985	McKean/Middle Plains Archaic: Current Research.
Wedel	1986	Central Plains Prehistory, Holocene Environments and Culture Change in the Republican River Basin.
Gunnerson	1987	Archaeology of the High Plains.
Brown/Simmons	1987	Kansas Prehistoric Archaeological Preservation Plan.
Bamforth	1988	Ecology and Human Organization on the Great Plains.
Lintz/Anderson	1989	Temporal Assessment of Diagnostic Materials from the Pinon Canyon Maneuver Site.
Frison	1991	Prehistoric Hunters of the High Plains (2nd).
Metcalf/Black	1991	The Yarmony Site.
Black	1991	Archaic Continuity in the Colorado Rockies: The Mountain Tradition.
Forbis	1992	The Mesoindian (Archaic) Period in the Northern Plains.
Theis/ Witty	1992	The Archaic of the Central Plains.

Neither do we know from which direction the earliest settlers came when people first entered the Central Plains. The related questions are:

1) when did people first arrive in North America,

2) what was the general level and specific nature of their technology,

3) what was the nature and variety of their subsistence,

4) how many successful migrations by genetically distinctive populations were there,

5) did people utilize the coastal route during some periods or only the interior periodically open ice-free corridor,

6) and, how much time was required for these people to disperse throughout the continent?

These questions have stimulated archeological thought and efforts for decades, but we are not appreciably closer to resolution or consensus than were our colleagues of half a century ago (Bryan 1986; Bonnichsen and Steele 1994; Bonnichsen and Turnmire 1991; Carlisle 1988; Dincauze 1984;

Haynes 1987; Meltzer 1989a; Owen 1984; Shutler 1983). By 1945 we knew that people had been in the Americas since at least the late Pleistocene, and there was some understanding of their technology and economy. This is not to imply that progress has not been made. Rather, most of these issues remain as vital as they were decades ago, but they are generally much more fine-tuned and based on a much greater body of evidence. Clarity has come in terms of refined questions, reassessment of assumptions, and improved techniques to aid the evaluation of interpretations.

In simplest form, a key issue (or perhaps THE issue) concerning founding populations in western North America centers on whether Clovis people were actually the First Americans in the region. It is also possible that Clovis people were derived from an existing population representing an earlier migration or migrations, or that Clovis represents a later migration unrelated to preexisting peoples (Meltzer 1989a, 1993).

A closely related question is where did Clovis originate. At present, our best documented and evaluated evidence for pre-Clovis or pre-11,500 year old occupation in North America does not come from the West. Rather, the most well-documented sites having strong evidence are in the East, Meadowcroft Rockshelter in Pennsylvania (Adovasio et al.1978) and in South America at the site of Monte Verde, Chile (Dillehay 1986, 1989). Pre-Clovis-age sites in western North America are fairly common, but only a few of these have withstood critical reappraisal during the past decade (Dincauze 1984; Stanford 1982, 1983; Waters 1985). Reappraisals armed with new controlled experimental knowledge of taphonomic (Behrensmeyer and Hill 1980; Bonnichsen and Sorg 1989) and geologic processes which influence the geologic, paleontologic, and archeological records have so seriously questioned most arguments for pre-11,500 sites in western North America that there are none which are currently accepted by most scholars as probable pre-Clovis-age sites. There is some evidence for non-Clovis, stemmed point tradition, materials which are of the same approximate age as Clovis (Bryan 1986, 1991).

Evidence from nonarcheological avenues has also been brought to bear on the issue, but ultimately the estimates for timing of the peopling of North America or for the number of migrations cannot be fully resolved without supportive archeological evidence. Important discussions of linguistic (Greenburg et al. 1986; Gruhn 1988; Nichols 1990; Rogers et al. 1990, 1992), genetics (Andrews 1994; Crawford 1992, O'Rourke and Lichty 1989; Schanfield et al. 1990; Szathmary 1994; Ward et al. 1991; Zegura 1985), and the minimal human skeletal evidence (Steele and Powell 1993, 1994; Turner 1985, 1992) are of relevance, but as noted by Meltzer (1989a) they cannot be used to resolve the issues which exist at present.

In a very real sense, the current state of affairs is that some believe strongly in pre-11,500 year old occupations in the West and throughout the Americas (Bryan 1986; Alsoszatai-Petheo 1986), whereas others, regardless of personal belief, simply see no conclusive evidence for pre-Clovis in the heartland of the Clovis culture (Haynes 1987; Lynch 1990). There is no argument that Clovis is the earliest widespread identified cultural complex in western North America south of the Pleistocene ice sheets, but this is not the same as arguing that Clovis is the absolute earliest evidence for occupation.

The basic position of this presentation is that Clovis as traditionally recognized and discussed stands as a monolithic, normative construct having a singular adaptive pose and which "appears" to be (is usually suggested to be) quite homogeneous and widespread in a very short time frame. When we dissect Clovis, however, and take into account the variability in site types, differences in archeological recovery, technological diversity, bone technology, assemblage diversity, variation in projectile point form, and diverse economic evidence, then Clovis has a less homogeneous and less normative form (see also Simms 1988; Meltzer 1993b). This great variety may provide us with clues as to Clovis origins as well as to the ultimate transition from Clovis to later cultural units identified in the archeological record. It has been stated that, "the Clovis people flourished on the Great Plains for about 500 years and then, around 11,000 years ago, they abruptly vanished, to be replaced by a multitude of different hunting-gathering cultures in the millennia that followed" (Fagan 1987:189).

There is no real justification for this position, beyond the fact that archeologists sometimes assume that the names we assign to the archeological record, such as "Clovis," reflect a past reality where cultural groups were discrete, normative in their behavior, and unchanging. Not a very realistic view of cultures.

Pre-Clovis Evidence in Western North America

To understand the founding populations of western North America, I believe that it is first important to focus attention on the Clovis cultural complex and to gain as clear an understanding of it as possible. The reason being that the archeological record of Clovis holds our primary source of important clues as to what preceded Clovis. As indicated by Meltzer (1989a), however, we can not assume that any and all pre-11,500 evidence is necessarily related to Clovis. As Bryan (1986) has argued, Clovis was perhaps only one of multiple technological traditions which existed in the Americas during the end of the Pleistocene. Therefore, the investigation of pre-11,500 evidence in the New World can properly consist of two related and hopefully integrated tactics.

First we need a detailed understanding of Clovis technology, settlement, and economy as a key source for modeling Clovis origins. Assuming that Clovis did not spontaneously generate, it will eventually be possible to identify Clovis progenitors wherever they may occur. The Nenana complex of central Alaska holds some promise in this regard (Powers and Hoffecker 1989; Goebel et al. 1991). Secondly, investigation of terminal Pleistocene (ca. 20,000-11,000 B.P.) deposits and landscapes is critical in order to learn what kind of archeological record is or might be represented during that time period, independent of our expectations about Clovis.

The archeological record cannot be understood simply by direct observation. The material record of past events has no inherent meaning (Binford 1989). Meaning must be assigned or attributed to the record by archeologists or "prehistorians" through inference, comparisons, and through study of the material correlates of behavior and contemporary processes. Fundamental archeological concepts such as artifact and context are often not self-evident "things" which can simply be observed in the field by trained specialists. Rather, artifact and context are concepts in the analytical realm. They are meanings ascribed by archeologists to things and places, rather than natural inherent truths passively observed and recorded. Herein lies the primary difficulty with pre-11,500 sites in western North America and elsewhere in the New World.

Much of the controversy and discussion about the pre-11,500 record consists of arguments about whether such and such is an "artifact" and how the radiometric dates or stratigraphy, in terms of age and disturbances, should be "read." The archeological record is not a documentary text simply to be read by anyone who is "archeologically literate." It is instead a noncommittal material expression lacking agendas, inherent truth, or intention, and must therefore be interpreted through use of archeological reasoning, comparison, analogical arguments, and assumption. The lack of embedded or obvious meaning in the archeological record has resulted in the creative reconstruction of the prehistoric past by archeologists and other specialists of various backgrounds and interests. It is not surprising that interpretations of the same material items, the same localities, the same radiocarbon dates, and the same stratigraphic profiles have sometimes varied radically (cf. Simpson 1982; Haynes 1973; Adovasio 1993; Lynch 1990; MacNeish 1976; Morlan 1988; Payen 1982; Fagan 1987).

Sites in western North America which are relevant to the study and interpretation of the peopling of the New World reflect as much about the growth and development of a discipline as they do about our knowledge of the past. Selected sites which have played important roles in the development of ideas, models, and methods for the investigation of the peopling of the New World are listed in Table 8. Previous reviews of the evidence are available in numerous sources (Adovasio 1993; Morlan 1988, Stanford 1982, 1983, 1991a, Meltzer 1989, Dincauze 1984, Grayson 1988; Haynes 1987; Johnson and Logan 1990; Owen 1984; Waters 1985).

Investigations at sites such as these listed in Table 9 have served to focus archeological attention on critical issues, not just concerning the peopling of the New World, but on fundamental aspects of archeological inquiry as well. At issue and of central concern at all these sites and numerous others are questions of context, stratigraphic mixing, disturbance processes, artifact recognition, chronometric and stratigraphic dating, and artifact typology. The location of selected pre-11,500 sites in the Central Plains is provided in Figure 24.

Table 8. Reported Pre-11,500 B.P. Central Plains Sites with Potential Evidence of Human Action (Modified Bone).

Site	Location	Evidence	Dates	Source
LaSena	Frontier Co.,NE	Mammoth	17,000	a
Red Willow	Frontier Co.,NE	Mammoth		e
North Cove	NE	Lithics		
Selby	Yuma Co., CO	Mammoth	13-16,000	b
Dutton	Yuma Co., CO	Mammoth	13-16,000	b
Lamb Spring	Arapahoe Co., CO	Mammoth	11,735 ± 95 13,140 ± 1000	c
Bonner Springs	Wyandotte Co., KS	fauna		d
Reagan Site	MO	lithic		

Sources: a, Holen et al. 1990; Holen and May 1994; b, Stanford 1979a; Stanford and Graham 1985; c, Rancier et al. 1982, Fisher 1992; d, L. Martin et al. 1979; e, Myers et al. 1980.

Dated sites of pre-Clovis age were reviewed by Waters (1985) with critical consideration given to the dating and stratigraphy. None of the sites were then (early 1980s) or are now considered as having reliable evidence for pre-11,500 occupations. Numerous sites have been found or studied more recently, such as Burnham, Oklahoma (Wyckoff 1989, Wyckoff and Carter 1994), La Sena, Nebraska (Holen et al. 1990), Lamb Spring, Colorado (Fisher 1992), and Pindejo Cave, New Mexico (MacNeish 1992) and are undergoing investigation and close scrutiny. The rules for accepting pre-Clovis sites are changing, and this is as it should be as we learn more about the archeological record and the processes that act on it. Middle range, experimental or actualistic research is enabling us to double check and reevaluate interpretations and observations. We continually ask more of researchers and must address an ever-expanding suite of evaluative tests and cross checks on interpretations of these earliest sites from which we wish to learn about the first Americans. The role of "blue ribbon panels" and on-site visits has been discussed by Meltzer (1994:16-18), but the methods that worked in 1926 may no longer be sufficient.

We have recently witnessed a dramatic increase in our understanding and critical use of applications of radiocarbon dating (e.g., Stafford et al. 1991; Stafford 1994; Taylor 1991, 1994). Studies of bone modification by human, biological, and physical processes and resulted in the development of analytical and comparative frameworks within which to study bones recovered from all archeological sites (Binford 1981; Bonnichsen and Sorg 1989). Traditional archeological research, using (abusing) the standard anthropological axiom that cultural behavior is patterned, has sometimes unfortunately transformed this to suggest that patterns encountered in the archeological record are necessarily cultural. This has changed dramatically in the past decade or so. Bones described as fleshing tools 20 years ago (Frison 1970, 1974) are in some cases now recognized as representing the actions of carnivore gnawing (Binford 1981). Bones assumed to be artifacts or flaking debris are scrutinized while acknowledging the great variety of forms and patterned remains which can result from natural processes (G. Haynes 1991; E. Johnson 1985). This is a long-standing problem in archaeological interpretation (Grayson 1986), and includes stone as well as bone objects.

Table 9. Selected Western North American Sites of Relevance to the Issue of Pre-11,500 B.P. Occupation.

Site	Location	Estimated Age	Problems	References
Tule Springs	Nevada	<15,000	C	Wormington and Ellis 1967; Shutler 1965
Calico Hills	California	200,000	D,A	Simpson 1982
Manis	Washington	<15,000	A,R	Gustafson et al. 1979
Union Pacific	Wyoming	<15,000	C,S,D	Irwin-Williams 1979
Frisenhahn	Texas	<15,000	A,S	Graham 1975
Lewisville	Texas	<40,000	D	Crook and Harris 1957, 1958; Stanford 1983
Levi Shelter	Texas	<15,000	D,C,S	Alexander 1963,1976
Lamb Springs	Colorado	<15,000	A	Stanford and Fisher 1992
Dutton	Colorado	<20,000	A	Stanford 1979; Stanford and Graham 1985
Selby	Colorado	<20,000	A	Stanford 1979
La Sena	Nebraska	<20,000	A	Holen 1994; May and Holen 1993
Gilder Mound	Nebraska		S,D	Barbour 1906b
North Cove	Nebraska	<20,000	S	Adair 1989
Lansing	Kansas		S,D	Wedel 1986
Cooperton	Oklahoma	<25,000	A,D	Anderson 1975
Burnham	Oklahoma	<30,000	C,S,D	Wyckoff et al. 199; Wyckoff and Carter 1994
Wilson Butte Cv	Idaho	<15,000	C,S	Gruhn 1961
Smith Creek Cv	Nevada	<15,000		Thompson 1985, Bryan 1986
Sandia Cave	New Mexico	<14,000	C,S,D	Hibben 1941; Haynes and Agogino 1986
Pendejo Cave	New Mexico	<30,000	S,C,R	MacNeish 1992
Hermits Cave	New Mexico	<20,000	R,D	Howard 1935
Burnet Cave	New Mexico	<20,000	R,D	Howard 1935

A=artifacts considered spurious or intrusive, D=dating or dated material or correlation of dates questioned, C=correlation of artifacts and dates or stratigraphy, S=stratigraphy complex, unclear or inconsistent, R=minimal reporting or type of reports hamper critical evaluation.

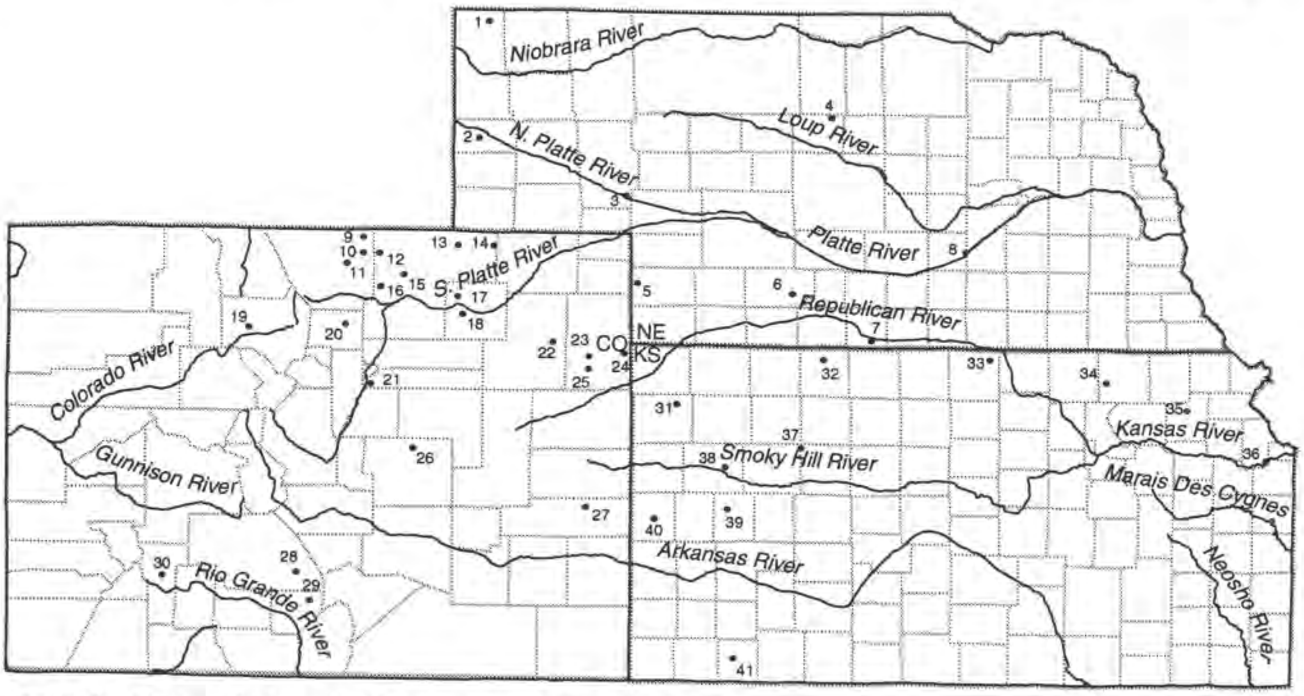


Figure 24. Location of selected Paleoindian sites in the Central Plains.
Key: Nebraska: 1. Hudson-Meng; 2. Scottsbluff; 3. Clary Ranch; 4. Elfgren; 5. Nolan; 6. Lime Creek, Allen, Red Smoke; 7. North Cove; 8. Meserve. Colorado: 9. Lindenmeier; 10. Johnson; 11. Gordon Creek; 12. Wilber Thomas; 13. Drake; 14. Dreier-Frasca; 15. Jurgens, Frazier, Powars; 16. Dent; 17. Fowler-Parrish; 18. Bijou Creek; 19. Jim Chase, Crying Woman; 20. Caribou Lake; 21. Lamb Springs; 22. Claypool; 23. Selby; 24. Jones-Miller; 25. Dutton; 26. Hahn; 27. Olsen-Chubbuck; 28. Reddin; 29. Cattle Guard, Linger, Zapata; 30. Black Mountain. Kansas: 31. Busse, Laird; 32. Tim Adrian; 33. Eckles, Lovewell; 34. Diskau; 35. Sutter; 36. Bonner Springs; 37. Walsh; 38. 12 Mile Creek; 39. Norton; 40. Kohn-Schneider; 41. Sailor-Helton.

An "artifact" is no longer determined to be such based on simple observation of an object's characteristics, but a meaning assigned to objects by researchers based on comparison and controlled experiment. Some objects, even if found in situ cannot be unequivocally sorted into artifact vs. nonartifact status.

Also, refined understanding and awareness of stratigraphic relationships and the processes of potential mixing and turbation equip us with more realistic expectations and more critical interpretation of the geoarcheological record and site formation processes (Schiffer 1987; Johnson and Watson 1987; Stegner 1990; Wood and Johnson 1978). One hundred years ago Wright's (1892) "Man in the Glacial Age" caused a stir of controversy (Meltzer 1991). Since the Folsom discovery in 1926—when the association of artifacts and Pleistocene fauna was documented and accepted—we have managed to unequivocally extend the period of human occupation in western North America back less than 500 years to approximately 11,300 B.P. (Haynes 1991a). Although not all researchers agree with this position, it is an interesting statement on the complexity of the issue of pre-11,500 occupation.

The Clovis Cultural Complex

It is likely we will never know who really discovered North America, and after decades of research no precise date can be fixed to the time of this "discovery" or the first movement of people into the New World by coastal or interior routes. By 11,300 years ago, sites belonging to the Clovis cultural complex were represented throughout much of western North America. The Clovis cultural complex or Llano complex as defined by Sellards (1952:17-46) has been characterized by several distinctive traits or recurrent features. The association of distinctive usually large fluted projectile points found with mammoth remains is central to most discussions of Clovis culture. Other megafauna and smaller species are also well represented in Clovis-age sites (Ferring 1994; Graham et al. 1981; E. Johnson 1987, L. Johnson 1989). Other technological features such as blades, beveled-based bone or ivory points or foreshafts, other ivory objects (Saunders et al. 1990a, 1991), and lithic tools similar to other Paleoindian industries including endscrapers, unifacial cutting and scraping tools made from large blades or biface thinning flakes also appear in Clovis assemblages. (Frison 1991b; Jennings 1974; Sellards 1952; Wedel 1978; Willey 1966; Wormington 1957).

Key sites in the early definition of the Clovis complex include Dent, Colorado where Clovis points were first found in geologic association with mammoth remains, but where the age could not be directly determined in relation to the previously defined Folsom type (Cassells 1983). The Blackwater Draw site is on the Southern High Plains in eastern New Mexico, where Clovis material was found in association with mammoth and bison stratigraphically below Folsom material (Howard 1935, 1936; Cotter 1937). Blackwater Draw is the type site for the Clovis complex, located between the towns of Clovis and Portales. The Miami site in the Texas Panhandle produced further evidence of the association between Clovis points, as they came to be designated, and mammoth remains with strong evidence that the points were actually used in the killing or processing of the animals (Holliday et al. 1994). Although it is generally assumed that Clovis people had a much broader spectrum diet than just mammoth and bison, these are the species most conspicuous and most numerous in most Clovis sites (Frison 1991b; Frison and Todd 1986; Grayson 1988; Hofman 1989; Leonhardy 1966; Meltzer and Smith 1986; Meltzer 1993a, 1993b). Additionally, evidence of mastodon, horse, ground sloth, camel, deer, wolf, fox, rabbit, and giant turtle has been documented (Graham et al. 1981; Graham and Hofman n.d.; Ferring 1994; Lundelius 1972; Walker and Frison 1986).

Recently, Clovis evidence has been well summarized (Bonnichsen and Turnmire 1991; Frison 1991b; Haynes 1987) with important discoveries in bone technology (Dunbar 1991; Frison 1991b; Haynes and Hemmings 1968; Saunders et al. 1990a, 1991), and in art work in the form of engraved stones of Clovis age in central Texas (Collins et al. 1991, 1992). The Sunrise Mine or Powars II site has evidence of red ochre quarrying by Clovis people (Frison 1991b; Stafford 1990). Also, the use of amber as part of the mastic in attaching projectile points to forshafts has been demonstrated (Tankersley 1994).

A development which has added substantially to our understanding of Clovis technological characteristics and variation has been the discovery and documentation of a number of caches of Clovis artifacts (Frison 1991a; Mehringer 1988, 1989; Mehringer and Foit 1990; Gramly 1993; Lahren and Bonnichsen 1974; Stanford and Jodry 1988; Wilke et al. 1991; Woods and Titmus 1985; Titmus and Woods 1991). Distinctive technological aspects of Clovis reduction have become much better documented and recognized as a result (Bradley 1991, 1993). Characteristics of Clovis technology include broad bifacial flaking with common *outre' passe* terminations. This attribute was first explicitly summarized by Frison and Bradley (1982) based on evidence from the Sheaman site in Wyoming in comparison with evidence from the Simon site cache from Idaho and the Anzick cache material from Montana. Unfortunately, these distinctive technological characteristics are often not recognizable on recycled and broken Clovis pieces, and may not be limited solely to Clovis assemblages.

The extent of the typological problems with Clovis is hinted at by the recently documented material from the Mill Iron site in Montana (Frison 1991b; 1996). The Goshen points from the Mill Iron site and a few other localities share some characteristics with Clovis and with Folsom assemblages but are especially notable due to the absence of fluting. Dating of the Goshen assemblage at the Mill Iron site is problematical as two sets or clusters of dates are available, one indicating that Goshen is as old as the oldest well-dated Clovis material and the second set indicating that Goshen is the age of terminal Clovis or very early Folsom. The material from the Mill Iron site, however, has enabled a technological and typological reassessment of some previous artifacts, and at least some specimens which have previously been referred to as Clovis are now thought to represent Goshen (Frison 1984; cf. Frison 1991b).

Typology is also an issue in consideration of Clovis finds at Colby, Wyoming (Frison and Todd 1986, Frison 1991a) and Domebo, Oklahoma (Leonhardy and Anderson 1966). The deeply concave-based points from the Colby site are unusual for western Clovis, but recently documented specimens from the Fenn Cache, found near the Wyoming-Idaho-Utah border, includes several specimens with bases comparable to the Colby points (Frison 1991a, 1991c). At Domebo, a minimally fluted and relatively gracile specimen is comparable to some Plainview points (Leonhardy and Anderson 1966). This, like the Goshen evidence from the Mill Iron site, indicates that not all projectile points in the Plains region which are of Clovis age are directly comparable to the "classic" specimens from the Blackwater Draw, Dent, and Miami sites.

Another important development concerns information about site structure. The major contribution to this work has been Haynes' investigation at the Murray Springs site in Arizona (Haynes 1982, 1991a, 1993) and Ferring's research at the Aubrey site in north Texas (Ferring 1994). Evidence from these two sites suggests that extensive campsite and processing areas will occur near Clovis-age bonebeds or kill sites and these may cover many hundred square meters. Research at the Colby site in Wyoming also indicates an extensive kill and processing area, probably representing multiple events. Similarly, evidence from ethnoarcheological research with the Efe and Hadza indicate that the activities associated with processing elephant-sized carcasses are spatially extensive (Fisher 1992; O'Connell et al. 1992). The implications of these studies concerns the scale at which archeological investigations need to be conducted in order to recognize site structural information. These developments are just being realized by most investigators. Also, the deeply buried nature of many Pleistocene deposits in alluvial and eolian settings has been demonstrated repeatedly (Ferring 1994; Leonhardy 1966; Hannus 1990a, 1990b; Hester 1972; Johnson and Logan 1990).

Environmental information derived from study of the Murray Springs (Haynes 1991a) and Aubrey (Ferring 1990, 1994) Clovis sites demonstrates convincingly the critical importance of interdisciplinary studies at Paleoindian sites, and the wealth of information which can occur in alluvial and spring-associated settings. Although climatic change or differences are marked when comparing later Holocene evidence with that from Clovis times, there is no consensus as to the nature of the Plains environment at that time. It has been argued to be a brief period of relative drought conditions by comparison with the preceding and following centuries (Haynes 1991a). It has also been interpreted as a period with a highly productive environment lacking evidence of drought (Holliday 1995). There is significant local variability, but the dynamic nature of the terminal Pleistocene environment remains an important topic of study (see Chapter 2). A variety of new kinds of evidence is being brought to focus on this subject. In addition to pollen, phytoliths, snails, sediments, and diatoms, new studies are incorporating evidence of hair (Bonnichsen et al. 1994), insect remains (Elias 1990, 1994), stable isotopes (Humphrey and Ferring 1994; Tieszen 1994), ancient DNA (Chambers and Purdue 1994), and other lines of research.

Also notable is the investigation of Clovis quarry sites. The Sunrise Mine site in Wyoming is an important red ochre source which was apparently used intensively during Clovis times and later in the prehistoric record (Frison 1988, 1991b; Stafford 1990). Red ochre is a recurrent element in most of the known caches of Clovis artifacts which have been recovered. Study of lithic quarry sites is also of importance and includes recent work in Wyoming and Texas (Frison 1991b; Mallouf 1989), as well as outside the Plains (Dragoo 1973; Gardner 1983; Sanders 1990)

The Changing Face of Clovis Culture

As research continues and we learn more about Clovis technology, site types, site structure, contemporary industries, and material culture variability it has become evident that we still have much to learn (Frison 1993). In the past few years substantial additions to our information about Clovis have been made by discovery and study of a few dispersed sites. Definition of what is and is not Clovis and the basis for assignment of sites to the Clovis or Llano complex has not been consistent or standardized. Strict definition or standardization may not be feasible or practical given the diverse range of Clovis assemblages. That much remains to be learned about Clovis lifeways, technology, organization, and land use is evident in recent discoveries many of which are mentioned above, which have dramatically expanded and enlightened our understanding and impression of Clovis culture.

An Evolutionary Perspective on Clovis Variability

As long as we perceive Clovis as a successful and uniform adaptation of highly distinctive and homogeneous character, then we have very little potential to learn about the social, economic, and technological transitions which took place during the development or decline of Clovis (Meltzer 1993b; Simms 1988). If we address Clovis variation, as witnessed by the technological and economic evidence of the archeological record, we can greatly improve our potential to learn about Clovis origins and what it developed into (Dunnell 1980, 1988, 1992a; O'Brien and Holland 1990; Simms 1988).

Clovis represents a range of technological and economic variability expressed at a variety of archeological site types. Does it indeed represent a homogeneous cultural entity which appeared, developed, and spread rapidly, and just as rapidly disappeared as has sometimes been suggested? I think the evidence is at best equivocal. Can a change in economic focus necessarily be equated with cultural change (or extinction of a lifeway)? Do differences in projectile point styles and technology reflect cultural differences in any direct way (e.g., Wiessner 1982)? These questions are at the heart of archeological research and of Paleoindian studies. There are no easy answers.

The study of variability in technology, economy, land use, and overall patterning in the material record for earliest Americans will provide us with an opportunity to identify, study, and evaluate the processes and gradients of culture change during the late Pleistocene and since. Reaffirmation of Clovis as a discrete monolithic short-lived cultural adaptation will not enhance our understanding of the past. Clovis should not float untethered in prehistory and be considered totally different and discrete from what came before and after. This building block approach to archeological study of spatial-temporal variation has long been recognized as very limiting (Clarke 1968). Addressing the significance of variability in this portion of the archeological record should provide new insights into Clovis culture and to those prehistoric societies who were Clovis progenitors and descendants.

Were there non-Clovis cultures contemporary with Clovis in the Great Plains and elsewhere? The answer to this question bears directly upon the interpretation of the number of migration events, where the immediate progenitors of Clovis lived, what was the nature of contemporary non-Clovis industries and cultures in the New World, and when, by whom, and from whence were the Central Great Plains first inhabited by humans.

Clovis Environment, Economy, Technology, and Ideology

Information for this discussion is derived primarily from Haynes (1982, 1987, 1991a), Frison (1991b), and Hofman (1989).

Available radiocarbon dates indicate that the Clovis activities in the Great Plains region occurred primarily between 11,400 and 10,900 years ago (Haynes 1993:Figure 1), at the close of the Wisconsin glaciation and the Pleistocene (Kutzbach and Webb 1991; Porter 1988; Wendland 1978; Wright 1991). The retreat of glacial ice from the Northern Plains and the changing climatic conditions during Clovis times reflect a trend that began by 14,000 years ago as a result of the Milankovitch radiation curves (Wright 1991). The Des Moines and James River lobes of the Laurentide ice sheet, and the associated glacial Lake Agassiz, directly impacted the habitable regions of the Plains in terms of potential human activity and prey species. For the western Great Lakes and Northern Plains region the height of the Wisconsin Glaciation occurred about 18,000 years ago. The accelerated climate and vegetational changes between 12,000 and 10,000 years ago probably reflect the maximum summer radiation of the Milankovitch cycle (Jacobson et al. 1987; Wright 1991:124). Distribution of fluted points in North and South Dakota and Saskatchewan (Buchner and Pettipus 1990; Gregg 1985; Schneider 1982) are complementary to the presence of glacial ice and Lake Agassiz during the terminal Pleistocene.

In the Plains region the late Pleistocene climate was notably different than that of modern time. A variety of paleontological and paleobotanical evidence supports the model that summer temperatures were lower than at present, at least during the early part of the deglaciation (Wright 1991:119). Equally important is that winter temperatures were apparently not significantly cooler than today and may have lacked the frequent bitterly cold snaps or extremes. This reduced seasonality offered a setting in which diverse species, which are no longer sympatric, inhabited the same environment (Graham 1987; Graham and Lundelius 1984; Graham and Mead 1987; Lundelius et al. 1983; Lundelius 1989). These "disharmonious" faunas were characteristic of the late Pleistocene in North America and continued until at least 11,000 years ago and for some species and regions as late as 9,000 years ago.

Overall, annual precipitation in the Plains region may have been less than today, but the effective moisture was almost certainly greater. Playa lakes were common on the Central High Plains during the late Wisconsin but apparently diminished significantly in number and size by 11,000 B.P. (Haynes 1991a). Winds were also an important factor and may actually have provided significant advantage to human hunters in stalking and pursuing prey animals. Extensive dunes in Nebraska were formed or modified by prevailing north and northwest winds (Kutzbach and Wright 1985). Extensive Peorian loess deposits in the Central Plains, often several meters in thickness, are well dated to the last 21,000 years (Johnson and Logan 1990; Johnson and Martin 1987; Martin 1993; May and Holen 1993). These late Pleistocene loess deposits usually overlay a stable surface formed in the Gilman Canyon Formation which dates between about 31,000 and 21,000 years ago. Winds during the late Pleistocene may have prevailed from the north and northwest on a year-round basis rather than seasonally as is now the case (Wright 1991). The climatic transition from the last glacial maximum of about 18,000 until the close of the Pleistocene by 10,000 years ago, was not, however, a smooth and steady directional change. There is some evidence of relatively severe droughtlike conditions during Clovis times (Haynes 1991a), and a final ameliorating cooler period, the Younger Dryas, during Folsom times from 11,000 to 10,000 years ago. Stable land surfaces and soil formation on Peorian Loess occurred in the Central Plains between 12,000 and 9,000 years ago, with the Brady soil representing an important marker generally correlated with the Younger Dryas period (Johnson and Logan 1990; Martin 1993). Holocene loess (Bignell loess) occurs overlying the Brady soil in many localities.

Most species which became extinct in the Plains region of North America were gone by or soon after 11,000 B.P. (Martin and Klein 1984; Graham et al. 1987; Grayson 1991). The reorganization of habitats and faunal associations was a complex series of events which cannot simply be modelled on contemporary ecosystems (Lundelius et al. 1983).

Vegetation on the Plains also varied dramatically through the late Pleistocene and particularly between 12,000 and 8,000 years ago. The retreat of the glacial ice and the northern shift of the jetstream had a dramatic effect on the climate and vegetation of the region. The resurgence of grasses as dominant resulted from the changing seasonality and precipitation patterns as ultimately affected by the Milankovitch solar radiation cycle.

The economy of Clovis people is most well known from a series of bonebed sites which, in the Central Plains, consistently contain mammoth remains. At the Kimmswick site, just south of St. Louis, Missouri, Clovis artifacts were found in association with mastodon and ground sloth remains. At Blackwater Draw, New Mexico, both mammoth and bison were common in the Clovis deposits, and the Aubrey, Texas, Clovis assemblage occurs with bison, turtles, and other species (Ferring 1990, 1994). The problem of background fauna in Clovis strata at various sites, including Blackwater Draw, Lubbock Lake, Domebo, and others, remains an important issue. Were these lesser species of economic importance or simply remains which accumulated independent of human action? In the Plains region, mammoth is unquestionably the key prey species associated with buried Clovis sites (e.g., Frison and Todd 1986; Hannus 1990a, 1990b; Cassells 1983; Hester 1972; Holliday et al. 1994; Leonhardy 1966). The question of if and how Clovis hunters actually dispatched mammoth remains a topic of debate (e.g., Gorman 1972; Saunders 1977, 1980, 1990; Frison 1987, 1989; Haynes 1966, 1980; Jelinek 1967; Hester 1966; D. L. Johnson et al. 1980; P. S. Martin 1990; Meltzer 1993a, 1993b; Sellards 1952). That they would have scavenged usable mammoth carcasses whenever possible is highly likely because of the quantity and wide variety of usable products to be gained from the bodies of these large animals. It is also very likely, if their technology and hunting skills were adequate (which they very likely were, Frison 1989; Stiner 1991), that mammoth were purposefully and intentionally hunted whenever feasible. The return for the investment would have been tremendous if the risk element could be reduced by careful training, practice, and critical knowledge of mammoth behavior and technology.

That Clovis people were also opportunistic in their economic pursuits and did not live by megafauna alone is indicated at locations such as Shawnee-Minisink in Delaware where a variety of species were recovered in an early Paleoindian context (McNett 1985). Evidence of fish and fruit utilization were discovered at the site. There is at present no firm evidence of intensive plant food processing or utilization by Clovis people, though this may largely be the result of preservation and recovery factors. The only evidence of food storage may be that at the Colby site in Wyoming where bone piles have been interpreted as cold weather meat caches (Frison and Todd 1986).

Clovis technological variability and distinctiveness has become better documented in recent years. Large blades and bifaces are long-established elements in Clovis culture (Green 1963; Butler 1963), and recent evidence, particularly from caches, has provided even more examples of Clovis blade and biface technology (Frison 1991a, 1991c; Lahren and Bonnichsen 1974; Mehringer 1988; Wilke et al. 1991; Stanford and Jodry 1988; Goode and Mallouf 1991; Young and Collins 1989). The distinctive nature of Clovis biface reduction technology has served as a diagnostic aid to further illustrate the similarity of assemblages as far removed as Washington State, Idaho, Wyoming, Colorado, Montana, New Mexico, and Texas (Bradley 1991, 1993).

The distinctive Clovis fluted points were apparently a multipurpose implement, judging by numerous reworked blades, evidence of wear on blade edges, and impact-damaged tips (Gramly 1993; Meltzer 1987; Haynes 1982; Hannus 1990a; Hofman and Wyckoff 1991). Stone tool forms include unifacial tools, endscrapers, and other types. Bone artifacts include the widespread occurrence of beveled-based bone or ivory cylindrical points or foreshafts (Lahren and Bonnichsen 1974; Frison 1982a; Sellards 1952; Wilmeth 1968). Other cylindrical objects found at the Richey-Roberts site in Washington are more problematic as to function (Gramly 1993). A shaft wrench from Murray Springs, Arizona (Haynes and Hemmings 1968) is a highly distinctive artifact which has close analogs in Upper Paleolithic assemblages in Europe and Eurasia (Soffer 1985; McBurney 1976). Production of mammoth ivory artifacts is also seen in the Blackwater Draw collection (Saunders et al. 1990a, 1991). The study of pits and markings on Clovis-age bone and ivory pieces has suggested to Saunders (Saunders et al. 1990b) that these people or some individuals employed a standard "Clovis unit of measure" which was used in production of tools and weapons. In central Texas, recent research has documented the occurrence of engraved limestone tablets in Clovis and early Paleoindian contexts (Collins et al. 1992). These artifacts illustrate an artistic or ideological element in Clovis culture which has not previously been found outside the realm of technofunctional artifacts.

Clovis Sites in the Central Plains.

In the central Great Plains region there have been numerous finds of Clovis projectile points in both upland surface and streambed contexts (e.g., Brown and Logan 1987; Hofman and Hesse 1996; O'Brien 1972; Myers 1987; Rogers and Martin 1982, 1983; Schmits 1987a; Wetherill 1995; Yaple 1968). A number of sites remain minimally investigated and much needed research remains to be done concerning both the distribution of finds and follow-up studies at specific sites. The known distribution of Clovis points in the Central Plains is provided in Figure 25, showing the occurrence of Clovis finds per county in Colorado, Nebraska, and Kansas. This distribution is certainly to be seen as a minimal record. Some finds are recorded by state or local rather than by county designation and so are not included on these maps. Much of the variation in the county distribution shown here is due to historical accidents of discovery and reporting. To gain an overall impression of the occurrence of Clovis material across the Central Plains region, Figure 25 simply show the counties which are known to have produced one or more Clovis points. Although Clovis artifacts are fairly widespread in the region, there are many areas which lack records and some find spots which merit considerably more detailed attention than they have received to the present.

A number of sites, however, have received more detailed study or are now under investigation. Nine of these, which provide an indication of the range of Clovis sites in the region, are discussed in more detail below. Limited information on additional Clovis sites is provided in Table 10. Examples of Clovis projectile points from the Central Plains are provided in Figure 26. A listing of Central Plains Clovis site records is provided in Table 11 and lithic cache sites in Table 12.

Dent Site, Colorado. Dent is located on the valley margin of the South Platte River near the railroad depot at Dent and was the first Clovis point and mammoth association documented in the New World. The site was discovered and first investigated late in 1932 by Regis College professor Conrad Bilgery, who in 1933 was joined by Figgins from the Denver Museum (Figgins 1933; Cassells 1983:44-49). The most detailed recent discussion of the site is found in Cassells (1983) and Haynes (1974), but the site is currently being reinvestigated. Spring flooding in 1932 revealed gravels and large bones at the site. Excavation and recovery apparently did not include mapping of the bonebed or screening of the matrix. The full

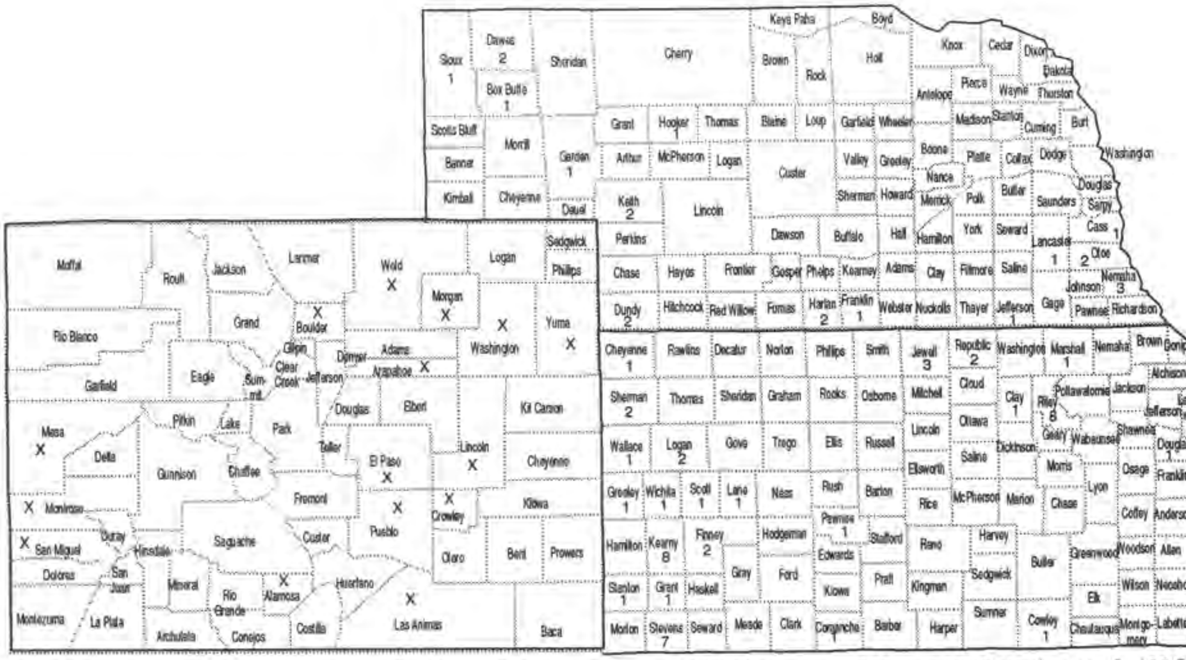


Figure 25. Occurrence of Clovis points in the Central Plains (Meyers 1987; Hofman and Hesse 1996; Holen et al. 1996; Brown and Logan 1987; Stein 1984; Wetherill 1995; Pitblado 1994; Nelson 1969; Nelson and Breterantz 1970; Greiser 1985).

Table 10. Comparison of Excavations and Assemblages from Selected Clovis Sites.

Site/Location	Excavated area (m²)	Recovery	Number of Artifacts Pts.	Tools	Flks.	Mammoth
Miami,TX	80±	no screen	3	2	2	5
Domebo,OK	31	no screen	3	*2	3	1
Lange-Ferguson,SD	32	fine screen	@3	@4	1	2
Naco, AZ	31	no screen	8	0	0	1
Lehner,AZ	60	no screen	13	8	8	9
Escapule,AZ	124	1/4" screen	2	0	0	1
Murray Spgs.,AZ	950	1/4"screen	20	25	>12,000	$4
Blackwater #1,NM	378#*	no screen	11	98	99	6
Colby,WY	756	fine screen	4	9	#32	7
Kimmswick,MO	48	fine screen	4	4	>1,000+	** 2
McLean,TX	?	no screen	1	0	0	1
Dent,CO	?	no screen	3	0	0	12
Lubbock Lake,TX	177	fine screen	1	7	0	3

* The two tools from Domebo and a fourth projectile point were found in the stream channel near the bonebed.
@ The three points from Lange-Ferguson (two complete and one impact broken base fragment) were found in Butte B about 8 m from the bonebed (Hannus 1989, 1990). The four tools from the site are all mammoth bone tools.
# The tools from Colby include two stone choppers, one abrader, one flake tool, one biface fragment, and four possible bone tools (Frison and Todd 1986). The Colby flakes include one channel flake.
+ There were thousands of very small retouch flakes at Kimmswick in both Clovis levels. Artifact counts are combined for both Clovis levels C1 and C3 (Graham and Kay 1988).
** At least two mastodons, plus deer, turtles, and ground sloth ossicles were recovered at Kimmswick in the two Clovis levels.
$ At Murray Springs the excavation area included the mammoth kill Area 3, the bison kill Area 4, and the camp Area 6. Bison (a total of 11 animals) were represented in both areas 3 and 4. The total number of retouch flakes from the site is more than 12,000 (Haynes 1982:393).
#* For Blackwater Draw Locality #1, the area of excavation includes Cotter's excavations and the El Llano Dig #1. Artifact counts are from Hester (1972) and primarily represent these areas.

Table 11. Clovis Archeological Sites Recorded in the Central Plains.

Site Name	Number	County	Type	Ref.
Colorado				
Dent	5WL268	Weld	Mammoth kill	a
Dutton	5YM36	Yuma	Camp?	b
Claypool	5WN18	Washington	Mammoth kill/camp?	c
Hahn	5EP1	El Paso	Camp	d
Bijou Creek	5MR2		Camp	d
—	5MR338		Camp	d
Klein	5WL1368	Weld	?	g
Nebraska				
Cumro/Pielstick	25CU2	Custer		NSHS files
Gothenburg	25DS32	Dawson		NSHS files
—	25LC76	Lancaster		
NSHS files				
Dawson	25WN15	Washington		NSHS files
Hiscock	25FR	Frontier		e
Kansas				
Diskau	14RYx	Riley	camp	b
Eckles	14JW4	Jewell	camp	c
Busse	14SH1	Sherman	cache	d
Lovewell	14JW	Jewell	mammoth kill	e
Koehn-Schneider	14GL496	Greeley	mammoth	f

References: a. Cassells 1983; b. Stanford 1979; c. Dick and Mountain 1960; Bradley and Stanford 1987; d. Greiser 1985; e. Holen 1994; f. W. C. Johnson et al. 1990; g. Zier et al. 1993.

Table 12. Paleoindian Lithic Caches in the Central Great Plains.

Site	County/State	Age	Contents*
Drake	Larimer,CO	Clovis	points; exotic+ varied
Hiscock	Frontier,NE	Clovis?	blades; WRG; cores; tools
Walsh	Trego, KS	Hell Gap?	bifaces; local jasper
Busse	Sherman,KS	Clovis?	bifaces local?; blades; jasper; flakes
Sailor-Helton	Seward,KS	Clovis?	blades; exotic; cores; Alibates; flakes

*Sources: Drake (Stanford and Jodry 1988); Hiscock, Medicine Creek (S. Holen, 1994); Walsh (Stanford 1984); Busse (Hofman 1995a); Sailor-Helton (R. Mallouf 1994).

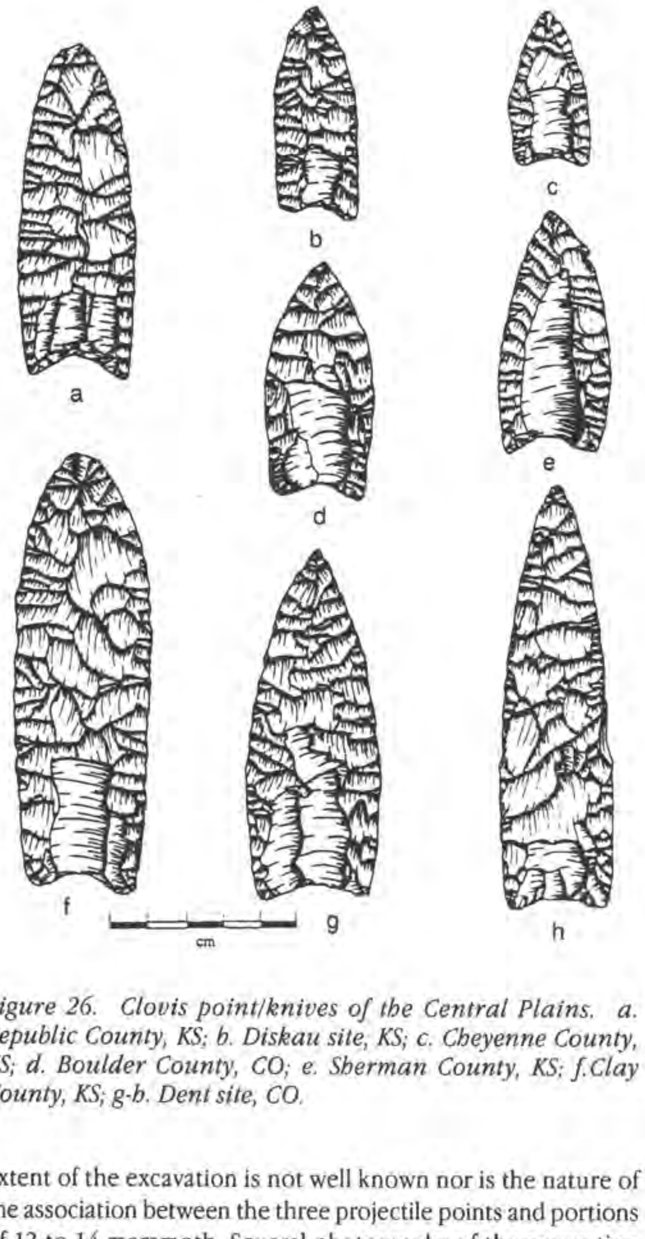


Figure 26. Clovis point/knives of the Central Plains. a. Republic County, KS; b. Diskau site, KS; c. Cheyenne County, KS; d. Boulder County, CO; e. Sherman County, KS; f. Clay County, KS; g-h. Dent site, CO.

extent of the excavation is not well known nor is the nature of the association between the three projectile points and portions of 12 to 14 mammoth. Several photographs of the excavation do exist (Cassells 1983:Figure 5-5). The sediments containing the bone included sandy alluvium with coarse cobble and bolder inclusions. Reinvestigation of the site by Frank Frazier indicated that the bones had probably been water transported and that the large cobbles were derived from older terrace deposits. Because the deposits have been reworked, the relationship between the Clovis points and mammoth bones remains unclear. Radiocarbon dates on the mammoth bone, however, indicate that the mammoth were of Clovis age (Stafford 1990; Stafford et al. 1991). It is quite possible that the Clovis points reflect the actions of Clovis hunters who wounded, or killed, or scavenged one or more of the mammoth represented at Dent.

Claypool Site, Colorado. Claypool is primarily known as a Cody complex and late Paleoindian site (Dick and Mountain 1960), although finds from the locality include Clovis points and Folsom evidence as well as mammoth remains (Bradley and Stanford 1987; Stanford and Albanese 1975).

Drake Site, Colorado. The Drake site is a Clovis cache from Weld County, northeastern Colorado, which consists of 13 complete new or newly resharpened projectile points, a hammerstone, and a fragment of ivory (Stanford and Jodry 1988). Lithic material is primarily Alibates flint, with one probable Edwards chert point, and an unidentified material. The points range from about 9 to 16.5 cm in length and 3 to almost 4 cm in width. The points are mostly in pristine condition, although six appear to have been resharpened. The cache was discovered partially buried in a wheatfield near the top of a low ridge. The location is in the Colorado Piedmont near Pawnee Buttes, but there is currently no particularly remarkable feature to mark this place on the landscape.

Dutton Site, Colorado. The Dutton site and the nearby Selby site are primarily known for their late Pleistocene, pre-11,500 year old faunal assemblages (Stanford 1979a, 1982; Graham 1981, 1987). Both sites are located in playa lake basins on the high plains of eastern Colorado. During heavy machinery stripping of overburden above the Pleistocene fauna level, later dated to ca. 16,000 B.P., evidence of Clovis-age activity was encountered at the Dutton site. One Clovis point was found.

Busse Cache, Kansas. The Busse cache is an example of a possible Clovis-age "cache" which highlights the problems of cultural assignment and use of the concept of caching. The term "cache" in Paleoindian literature refers to several different kinds of collections. The Busse site near Bird City in northwestern Kansas is believed, on the basis of artifact typology and technology, to represent a Clovis-age tool cache and occupation or activity site. The Busse site cache was discovered in June 1968 by Dan Busse, was minimally investigated by the Busse family at that time, and has since witnessed no further significant disturbance. The cache consists of some 90 lithic artifacts (several of which are refitted from prehistoric breaks) which were found 20-50 cm below the surface. The pieces were all lying flat and appeared to have been laid down on an old surface. Excavation around the initial find of a large biface extended for only a few feet until the primary concentration of cached pieces was exposed.

The excavation of this area yielded one large cobble of jasper, one flat chalk (cortex) covered cobble with evidence of intensive use as an abrader, 13 large bifaces from 29.6 cm to 10 cm long (six of these bifaces are refit from large fragments), 25 large blades and fragments including numerous scraping tools (four are refit from broken pieces), two flake tools of exotic flints possibly from southeastern Wyoming, and 48 flakes and fragments representing the reduction of large bifaces and tool making or maintenance. Some of the artifacts, notably the large bifaces and some tools, have streaks of red ochre which usually occurs on one surface only. All specimens except three are made from high quality yellow to brown Niobrara jasper with the closest quality sources located at least 100 km to the east of the site. The broad flat flaking on the large bifaces is similar to that expressed on some pieces from other Clovis-age stone tool caches including the Anzick site in Montana (Wilke et al. 1991) and the Fenn cache from the Wyoming/Utah/Idaho border (Frison 1991c). The unifacial blades include some with cortex or which are irregular in form as well as more standard pieces. The platform technology and overall form, however, are comparable to Clovis blades from the Blackwater Draw site and elsewhere (Young and Collins 1989; Green 1963; Montgomery and Dickinson 1992). A spurred end-scraper and a graver are also distinctive Paleoindian tool forms. The large biface thinning flakes, some of which refit to the large bifaces, are quite similar to specimens from the Sheaman Clovis or Goshen site in eastern Wyoming (Frison 1982a; Frison and Bradley 1982).

The site is situated on a west slope in a field which was under cultivation until the early 1960s when it was seeded back to grass. A small drainage just west of the site might have held a live spring during the late Pleistocene when the cache was deposited. There is nothing noteworthy about the specific location of the cache find spot as it appears today, and discovery of the cache occurred when Mr. Busse, checking a fence line, walked down a cattle path which had been eroded by recent rains. A small piece of jasper in the bottom of the path caught his eye and on trying to pick it up, he discovered it was just a small exposed portion of a very large biface. On removing this large biface, it hit against another one laying next to it and the discovery of the cache was made.

The likelihood of additional material still being present in the immediate vicinity of the cache find is quite good as there has been no subsequent disturbance, and a buried surface is apparently represented. If it is possible to identify and trace this late Pleistocene surface over an extended area, it should be possible to learn a considerable amount about the nature of the group who occupied the site and the organization of activities which they performed. Preliminary investigation of the site began in 1995 (Hofman 1995a).

The Busse Cache is distinctive and of particular significance for a number of reasons. It is different from any recorded Paleoindian caches in that it contains many heavily used tools, it lacks final stage preforms or finished projectile points, and many of the artifacts appear to represent the worn, damaged, or irregular pieces which we would expect to be the first to be abandoned if transport decisions were being made. The Busse Cache is arguably of Clovis or Paleoindian age because of some key diagnostic attributes of other Clovis finds. These include the large flat bifaces, the use of red ochre, the prepared core and blade technology, distinctive spurred tools on flakes and scrapers, radial break tools, and distinctive scraper forms.

Functional clues as to how the Busse Cache artifacts were used include high polish and steep-edged tools which might serve in hide processing, thick-edged tools with heavy edge damage as can occur in wood or bone working, thin-edged tools with polish and light fracture patterns indicative of butchering, and thick bifacial edges with heavy damage such as can occur in initial butchering or dismembering activities. Also, tool maintenance and recycling is evident by the flakes and refit pieces. This range of activities is what we would expect to occur in the context of butchering and processing carcasses and in repairing damaged tools. Butchering a mammoth or numerous bison carcasses would result in new products such as hides, meat, fat, marrow, bone, and others which the hunters might wish to take with them and so necessitate the reevaluation of what was to be transported when the group moved on. This could result in the caching of excess, damaged, or second quality lithic pieces with the possibility of future use. More than 16 lbs of stone are represented in the Busse Cache, and this durable material could be cached with confidence that it would remain useful should someone in the group need to return and claim it for future use. Examples of artifacts from the Busse Cache are shown in Figure 27.

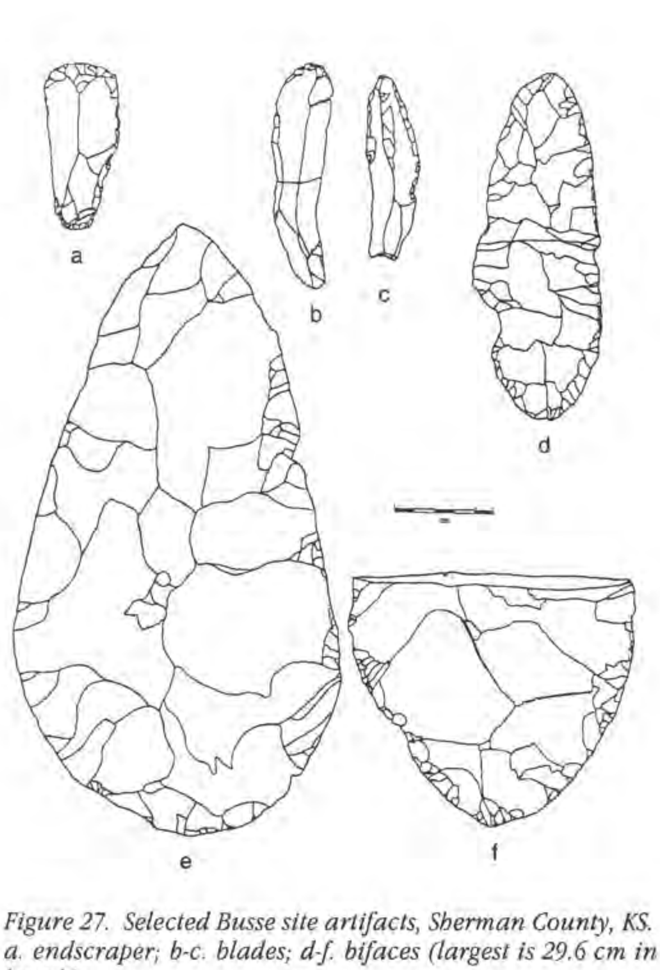


Figure 27. Selected Busse site artifacts, Sherman County, KS. a. endscraper; b-c. blades; d-f. bifaces (largest is 29.6 cm in length).

Eckles, Kansas. Bank erosion at Lovewell Reservoir in Jewell County, Kansas has yielded a collection of Clovis artifacts made predominantly from Flattop (White River Group) chalcedony (Hoard et al. 1992, 1993; Holen et al. 1990). This collection includes projectile points, scrapers, unifacial tools, and debitage.

Lovewell, Kansas. The discovery of mammoth bones attracted archeological attention to this location in the early 1960s (Witty 1970). Initial geological and stratigraphic assessment indicated that the mammoth remains were in deposits substantially older than Clovis and the site was essentially discounted. Following discovery of the Eckles site, however, reinvestigation of the Lovewell Mammoth site was initiated (Holen 1993). Reevaluation of the geological and stratigraphic position of the bonebed stratum indicated that it may indeed be terminal Pleistocene in age. Analysis of the bone material from the original excavation revealed a modified bone which may represent a section of a beveled-base point or foreshaft (Holen 1993).

Koehn-Schneider Site. This mammoth site, 14GL496, is located in Greeley County, Kansas near Tribune (W. C. Johnson et al. 1990). Erosion in 1987 exposed the mammoth bone about 8 m below the modern surface. In addition to the historic soil, three paleosols overlie the bone deposit and have a consistent series of radiocarbon dates on soil humates. The lowest soil, about 2 m above the mammoth, dates to 11,170 ± 170 (TX-6371), and a date on the apatite fraction of the mammoth bone of 11,050 ± 170 (Tx-6405) is assumed to be slightly young. The estimated age is ca. 11,400. No Clovis artifacts were found with the mammoth bone, but Clovis points have been found within a few kilometers of the site. Possible butchery marks are present on the skull.

Diskau Site, Kansas. This site is a lithic scatter in an upland setting overlooking the Big Blue River in Marshall County, northeast Kansas (Schmits 1987). Surface collecting since the 1940s has produced 123 formal lithic tools including "8 projectile points, 26 knives, 62 scrapers, 15 gravers, 2 spokeshaves, 2 preforms, 1 drill, 1 piece d'esquille, 3 discoidals and 4 biface fragments" (Schmits 1987:69). Many of the scrapers are small, spurred endscrapers. Many tools exhibit evidence of multiple functional units and multiple wear types. A campsite with a variety of activities probably including retooling, work on hard substances such as wood and bone, and possibly hideworking is indicated. Lithic materials include much nonlocal stone, and only a small proportion of local Permian Flint Hill cherts. Niobrara (Smoky Hill) jasper is the most common lithic material. Flattop chalcedony from northeast Colorado and Knife River flint from western North Dakota are represented in lesser amounts as are chalcedony and other unidentified materials which may be derived from western sources in Colorado or Wyoming.

Hiscock Cache, Nebraska. This large collection of cores, flakes, blades, scrapers, and unifacial tools is composed Flattop or White River Group chalcedony (Holen, personal communication 1994). The technology of many pieces suggest Paleoindian affiliation and a number of blades are comparable to Clovis specimens. The cache was found on Medicine Creek in Frontier County, southwest Nebraska. More recent study suggests to Holen that the site may be late prehistoric in age.

Sailor-Helton Cache, Kansas. This large cache of blades, flakes, and cores was found near the Cimarron River in Seward County, southwestern Kansas (Mallouf 1994). The cache is of Alibates agatized dolomite from the Canadian River in the Texas Panhandle about 200 km south of the find. This cache includes some very large Alibates cores and blades, some of which can be refit.

Lange-Ferguson Site, South Dakota. Although slightly north of the Central Plains study region, the Lange-Ferguson site in southwestern South Dakota holds some important clues about Clovis in the Plains region (Hannus 1985, 1990a, 1990b). Excavation at this mammoth bonebed and campsite revealed portions of two mammoth; a variety of mammoth bone expediency butchery tools; good climatological information from phytoliths, fauna, snails, and stratigraphy; and a small but important assemblage of stone tools. The site was buried beneath about 8 m of overburden in the White River Badlands. Remains of two mammoth represent an adult female and a young calf. Taphonomic study determined that the bones had been rapidly buried in a low-energy pond environment without impacts of severe weathering by exposure, carnivore modification, or alluvial sorting or transport. The flaked and modified bone tools represent an important addition to the Clovis technological complex, and one that might be expected to be present, especially when lithic resources are limited or depleted.

Only one chipped stone artifact was found in the mammoth bonebed, a utilized flake which would have been a very serviceable tool in butchering or dismembering the carcasses. The remaining few lithic artifacts were found in a camp and processing area about 15 m away from the bonebed. These artifacts include three Clovis points, two of which are heavily reworked and the third which is a basal fragment exhibiting an impact fracture and which was subsequently burned, probably from exposure to a hearth. Only a small group of people and a relatively short-term occupation are indicated, but whether the mammoth were killed or simply scavenged remains unresolved. The impact-damaged Clovis point suggests that some hunting was going on. It is important to note that if excavation had been limited only to the bonebed, most of the lithic assemblage and the diagnostic Clovis points would not have been recovered.

The mammoth bone expediency tools recovered at Lange-Ferguson hold important implications for Clovis technological organization and are an important reference series for other sites which lack the associated lithic assemblage. The bone use pattern seen at Lange-Ferguson suggests that we must leave open the possibility that other late Pleistocene sites or samples of Clovis and pre-11,500 age may have bone artifacts but lack substantial lithic assemblages. Therefore, Central Plains sites such as La Sena, Nebraska and Dutton, Selby, and Lamb Spring, Colorado must be evaluated with the knowledge that mammoth bone expediency tools were part of the early Paleoindian Clovis complex and may well have been part of any earlier complexes which may have existed in the region.

Angus Site, Nebraska. The Angus site in Nuckolls County, Nebraska was reported in 1931 (Figgins 1931), but the nature of the artifact/mammoth association at the site was considered questionable by several researchers at the time. Wedel (1961a:58) offered only one sentence concerning the Angus site, "The Angus, Nebraska, find remains inadmissible as evidence of association because the circumstances of discovery of the point have never been cleared up." Sellards (1952:36) was also skeptical and noted, "Some doubt may exist as to the certainty of the contemporaneity of the Angus point and the elephant remains." More recent reinvestigation (Holen 1986), producing at least one thermoluminescence date, has shown the deposit to be much older than Clovis age and has served to confirm the early suspicions. The projectile point from the site (Figgins 1931; Sellards 1952:Figure 20a) is in the Denver Museum and exhibits unusual characteristics for Clovis (full length fluting and too thick for Folsom). For the present, the Angus site is not considered to represent an artifact/mammoth association.

Summary of Central Plains Clovis Sites.

The documented Clovis sites in the Central Plains region have provided disappointingly little detail about Clovis culture. In terms of current literature, the Dent and Drake sites are perhaps the two most significant published Clovis sites in the region. Dent is historically significant despite the early date of the fieldwork and poor understanding of the site's formational history. Drake is an important example of a Clovis cache, but unfortunately the details of context were lost on discovery. These sites exemplify a common pattern and problem in Clovis archeology. Considering Clovis literature in the Plains area as a whole, we gain a better understanding of Clovis technology, economy, and lifeways. However, for the Central Plains, knowledge of Clovis is largely borrowed from other areas. Despite more than 60 years of research on Clovis sites in the region we have no direct evidence about site structure, arrangement of features, evidence for dwellings or hearths, key economic species other than mammoth, correlated radiocarbon dates, ideology, group size, burial practices, or numerous other interests. For all these things we must look to research outside the Central Plains.

There is, however, substantial progress in terms of paleoecology and terminal Pleistocene land surface studies (e.g., Johnson and Logan 1990; see also Chapter 2) and concerning lithic resource use and procurement (Hoard et al. 1992, 1993; Stanford and Jodry 1988). It should be evident that Clovis sites are still minimally reported and poorly understood in the Central Plains region and should therefore be considered of highest significance. An understanding of Clovis technology has increased and includes more information on both lithic and bone tools. It is evident in comparisons between sites such as Drake and Lange-Furgeson, for example, that the Clovis assemblages will vary widely and can look radically different from one context to another. A list of radiocarbon dates from Central Plains early Paleoindian sites is provided in Table 13.

The Goshen Complex

The Goshen complex was first identified by Irwin (1968), based on research at the Hell Gap site near Goshen Hole in Goshen County, Wyoming. Confusion surrounding this complex has had several sources. The stratigraphy at the Hell Gap site is relatively complex and the definition of the Goshen complex in Area 1 at Hell Gap was confounded by issues of stratigraphy, radiocarbon dates, and typology. At Hell Gap, Goshen was interpreted to be stratigraphically older than Folsom and to be a Clovis variant (Irwin 1968). It was also recognized as typologically very similar to Plainview on the Southern Plains. It was later interpreted to represent a complex intermediate between Clovis and Folsom (Irwin-Williams et al. 1973). Southern Plains Plainview evidence, however, suggested that

Table 13. Radiocarbon Dates from Central Plains Early Paleoindian Sites.

Site	Complex	Date	δ	Lab No.	Material	Reference
Lamb Springs	pre-Clovis	13,140	1000	M-1464	bone	Fisher 1992
	pre-Clovis	11,735	95	SI-4850	bone	Fisher 1992
	pre-Clovis	12,750	150	SI-6487	organic material	Fisher 1992
Selby	pre-Clovis	16,630	320	SI-5185		Stanford 1979
Dutton	pre-Clovis	13,600	485	SI-5186		Stanford 1979
Dutton	below Clovis	11,710	150	SI-2877		Stanford 1979
Dent	Clovis	11,200	500	I-622	bone, organics	Haynes et al. 1984
		10,690	50	AA-2942—2947	(average of 5, bone)	Haynes 1993
		10,660	170	AA-2942		Stafford et al. 1991
		10,800	110	AA-2943		
		10,600	90	AA-2945		
		10,710	90	AA-2946		
		10,670	120	AA-2947		
La Sena	pre-Clovis	18,870	360	TX-7006	soil humates	May and Holen 1993
		16,660	490	TX-6708		
Koehn-Schneider	Clovis?	11,050	180	TX-6405	bone apitite	Johnson et al. 1990
		11,170	170	TX-6371	soil	
		9800	120	TX-6372	soil	
		7460	130	TX-6373	soil	
Lindenmeier	Folsom	11,200	400	GX-1282	charcoal	Wilmsen/Roberts 1978
		10,780	135	I-141	all charcoal	Haynes 1993
		10,560	100	TO-337		
		10,500	80	TO-342		
		10,660	60		avg. of 3	Haynes 1993
12 Mile Creek	Folsom?	10,435	260	GX-5812a	bone apatite	Rogers/Martin 1984
		10,245	335	GX-5812b	bone gelatin	
		10,520	70	CAMS-16072	bone, KOH-ext. collagen	unpubl.
Linger	Folsom	8480	85	SI-3540	bone	Cassells 1983
Linger	Folsom	9885	140	SI-3537	bone	Cassells 1983

this complex postdated Folsom, a position held by most researchers (e.g., Holliday et al. 1985; Hofman 1989), but recently questioned on the bases of typology and radiocarbon dating (Haynes 1991b). Recent investigations at Hell Gap and with the existing collections (Sellet and Frison 1994) indicate that the stratigraphy and projectile point sequence at the site is more complex than previously assumed.

Currently then, interpretation of the place of the Goshen complex in Paleoindian culture-history is unresolved. Evidence at Hell Gap initially suggested that it was pre-Folsom in age, technological comparison suggests that Goshen and Plainview are very similar (more similar than many Cody complex point types for example), but Plainview is generally interpreted as being post-Folsom. I believe it is in the realm of possibility that each view is correct and that the problems in interpretation may derive from a faulty assumption. That is, we have generally assumed that the chronological and technological variation in Plains Paleoindian projectile points was a single unilinear development. If this was not the case, if there were multiple projectile point types in concurrent use by Paleoindian groups (and recognizing that our definition of types may not correlate in any direct way to past ethnic or cultural differences), then it is possible that Plainview and Goshen projectile points are the same technological type, and that they are both older and younger than (and also contemporary with) some Folsom assemblages. Available radiocarbon dates for Folsom, Cody complex, Agate Basin, and other late Paleoindian complexes indicate that there may indeed be considerable overlap in the temporal use of these styles (cf. Frison 1993).

Research at the Mill Iron site in southeastern Montana near the intersection of the North and South Dakota borders (Frison 1988, 1991a, 1991b, 1993, 1996) has documented the first sizeable and unmixed Goshen assemblage. The site is in the Little Missouri drainage in the Humbolt Hills of Carter County, the northernmost edge of the Black Hills. This site represents a bison kill and camp preserved on a butte or erosional remnant which is about 20 m high and 35 m in diameter. The Goshen component is buried up to 2 m below the surface and extensive Holocene erosion has resulted in the isolation of this butte by about 65 m from the landform to which it was originally attached. The implications of the Mill Iron geomorphic setting for archeological site preservation and discovery in the region are substantial.

The bonebed area at Mill Iron has evidence of about 30 animals killed in the late fall or early winter (Todd et al. 1996). Projectile points found in the kill and camp/processing area are distinctive by their lack of fluting and usually precise parallel flaking. In terms of morphology and technology, the Goshen points from the Mill Iron site are very similar to (unfluted) Folsom and generally distinct from Clovis. A variety of lithic artifacts with diagnostic Paleoindian characteristics, including endscrapers, gravers, wedges, burins, and unifacial tools is represented. Interestingly, modified pieces of mammoth bone were found with the assemblage which may be evidence of contemporaneity of Mill Iron people with mammoths or it could indicate scavenging of old bone.

The extent of the typological problems in Paleoindian studies is exemplified by the Goshen problem (Frison 1991a, 1991b). The Goshen points from the Mill Iron site and a few other localities share some characteristics with Clovis and with Folsom assemblages but are unusual among early Paleoindian point types due to the absence of fluting.

Dating of the Goshen assemblage at the Mill Iron site is problematic as two sets or clusters of dates are available, one indicating that Goshen is as old as the oldest well-dated Clovis material and the second set indicating that Goshen is slightly later. The early series of radiocarbon dates (all on charcoal) include samples from both the camp area and bonebed. The mean ages of these early dates (N=5) range from 11,570 to 11,320 B.P. (Frison 1991b:Table 1). The late series of dates from Mill Iron (N=4), again from both the camp and bonebed range from 10,760 to 11,010 B.P. This difference remains unresolved. The material from the Mill Iron site, however, has enabled a technological and typological reassessment of some previous artifacts and at least some specimens that had previously been referred to as Clovis are now thought to represent Goshen (compare Frison 1984 and Frison 1991b).

Although projectile points which may be classified as Goshen have been recovered in the Central Plains, there are few excavated components. The Upper Twin Mountain site, 5GR1513, near Kremmling, Colorado (Kornfeld 1992; Todd et al. 1996) is the only excavated site currently reported from the Central Plains. This site is discussed with the Folsom sites below. Also, the Jim Pitts site in extreme western South Dakota (39CU1142) had a Goshen component in a stratified campsite (Donohue 1995, 1996; Donahue and Hannenberger 1993). Jim Pitts is located in the western Black Hills near the Wyoming border about 265 km southeast of Mill Iron, and about 180 km northeast of the Hell Gap site. Radiocarbon dates from Jim Pitts compare with the older series of dates from Mill Iron.

The Folsom Complex

The Folsom technological complex represents one of the more famous, distinctive, and widespread early prehistoric cultures in the Plains, Rocky Mountains, and Southwest areas of the United States. Folsom technology is well known through detailed studies of collections from sites such as Lindenmeier, Colorado; Blackwater Draw, New Mexico; and Agate Basin and Hanson in Wyoming. Isolated artifact finds, bison kill sites, campsites with ephemeral surface hearths, small assemblages of tools from hunting overlooks, and lithic workshop sites are known from Montana and North Dakota to southern Texas and New Mexico. Table 14 provides a summary listing of selected key Folsom sites outside of the Central Plains region. Some of these are listed simply because information is available in the literature, not because the sites are necessarily unique or inherently significant. Folsom sites are more numerous and better studied on average than Clovis sites. This is especially true in the Central Plains region where extensive and detailed research at the Lindenmeier site during the 1930s by Roberts has placed this site assemblage at center stage in Folsom

Table 14. Selected Folsom Sites Outside the Central Plains.

Site, Location	Site Type	Sources
Folsom, NM	Kill	Figgins 1927, Cook 1927, Haynes 1993
BWD#1, NM	Camp/Kill	Hester 1972
Mitchell, NM	Camp	Boldurian 1990, Stanford & Broilo
Elida, NM	Camp	Hester 1962, Warnica 1961
Lone Butte, NM	Camp	Amick et al. 1992
Adair-Steadman, TX	Camp/wksh	Tunnell 1977, 1991
Lipscomb, TX	Kill	Hofman et al. 90,91; Todd et al. 92; Schultz 1943
Lubbock Lk, TX	Kill	Sellards 1952, E. Johnson 1987
Lake Theo, TX	Kill/Camp	Harrison & Smith 1975, Harrison & Killen 1978; Johnson et al. 1982
Shifting Sands, TX	Kill/Camp	Hofman et al. 1990
Scharbauer, TX	Camp	Wendorf et al. 1955; Holliday et al 1993
Kincaid Shelter, TX	Kill?	Sellards 1952, Collins 1990
Horn Shelter, TX	Camp	Redder 1985
Waugh, OK	Kill	Hofman et al. 1992, Hofman 1995
Cooper, OK	Kill	Bement 1994a, 1994b
Cedar Crk, OK	Camp/Kill	Hofman 1990
Winters, OK	Camp	Hofman and Wyckoff 1987
Howard Gully, OK	Kill/camp	Hofman et al. 1991
Cattle Guard, CO	Camp/Kill	Jodry 1987, 1992, Jodry & Stanford 1992
Montgomery, UT	Camp	W. Davis 1985
Hanson, WY	Camp	Frison & Bradley 1980; Ingbar 92
CKM, WY	Camp	Frison 1984
Agate Basin, WY	Kill/Camp	Frison 1982, M.G.Hill 1994
Hell Gap, WY	Camp	Irwin 1968, Irwin-Williams et al. 73
Adobe, WY	Overlook	Hofman & Ingbar 1988
Powars II, WY	Ochre Qrry	Frison 1991; Stafford 1990
MacHaffie, MT	Camp	Forbis and Sperry 1952
Indian Crk, MT	Camp	Davis and Greiser 1992
Moe, ND	Camp	Schneider 1982
Lake Ilo, ND	Camp/Wksh	Ahler & Root 1993; Root 1993;

technological and campsite studies for more than half a century (Wilmsen and Roberts 1978).

Campsites often occur in close association with kills or lithic sources such as at Hanson and Agate Basin, Wyoming; Lake Ilo, North Dakota; Cattle Guard, Colorado; and Adair-Steadman, Texas. High quality lithic materials were generally used in artifact manufacture, and quarry activity may be indicated at the Knife River source area in North Dakota (Root 1993). Quarrying for red ochre is indicated at Sunrise Mine and the Powars II site in eastern Wyoming (Frison 1991b; Stafford 1990). Characteristic Folsom artifacts include delicately made, thin, fluted and unfluted lanceolate projectile points, distinctive projectile point preforms and channel flakes from fluting, bifacial cores, thin bifacial knives, endscrapers which often exhibit spurred corners, delicate pointed gravers, and a variety of mostly unifacial tool and composite tool forms. In addition, a variety of bone tools including projectile points, eyed needles, notched pieces, grooved bones, and occasional beads are known to occur. The use of red ochre in domestic and bison kill settings is also documented (Roper 1991).

The Folsom complex was first recognized and gained historical significance when discoveries between 1926 and 1928 at the Folsom site in northeastern New Mexico established the contemporaneity of projectile points and a Pleistocene form of bison (Figgins 1927; Cook 1927; Meltzer 1983, 1993a; Wormington 1957). Stratigraphic evidence indicated that the deposit was a minimum of 10,000 years old (Bryan 1937) which bolstered the paleontological information. This has subsequently been supported by a series of radiocarbon dates

Table 15. Selected Folsom Radiocarbon Dates from the Great Plains.

Site	Location	Radiocarbon Date	δ	Lab#	Material	Ref.
Lindenmeier	Colorado	11,200	400	GX-1282	ch	a
		10,780	135	I-141	ch	b
		10,560	100	TO-337	ch	b
		10,500	80	TO-342	ch	b
Hanson	Wyoming	10,700	670	RL-374	ch	c
		10,080	330	RL-558	ch	c
		10,300	150	Beta-22514	ch	c
		9970	340	Beta-22513	ch	c
Carter/K-M	Wyoming	10,400	600	RL-917	ch	b
Agate Basin	Wyoming	10,780	120	SI-3733	ch	b
		10,665	85	SI-3732	ch	b
		10,375	700	I-472	ch	b
Hell Gap	Wyoming	10,930	200	A-503	org	b
		10,690	500	A-504	org	b
		10,290	500	A-502	org	b
Indian Creek	Montana	10,980	150	Beta-4619	ch	b
		10,630	280	Beta-13666	ch	b
Folsom	New Mexico	10,780	100	AA-1213	ch	b
		11,060	100	AA-1708	ch	b
		10,760	140	AA-1709	ch	b
		10,890	150	AA-1710	ch	b
		10,850	190	AA-1711	ch	b
		10,910	100	AA-1712	ch	b
		10,260	110	SMU-179	bn	d
Blackwater Draw	New Mexico	10,250	320	A-380-379	ca-pl	b
		10,490	900	A-386	ca-pl	b
		10,170	250	A-488	ca-pl	b
		10,490	200	A-492	ca-pl	b
Lipscomb	Texas	10,820	150	NZA-1092	ch	e
Waugh	Oklahoma	10,379	85	NZA-3602	ch	e
		10,404	87	NZA-3603	ch	e
Lubbock Lake substratum 2a	Texas	10,880	90	SMU-292	hu	f
		10,530	90	SMU-285	hu	f
		10,780	80	SI-3202	hu	f
		10,369	80	SI-3200	hu	f
		10,060	170	SMU-251	hu	f
		9905	140	SI-4975	hu	f
		10,195	165	SI-4976	hu	f
Kincaid Shelter	Texas	10,025	185	TX-17	ch	g
		10,065	185	TX-19	ch	g
		10,365	110	TX-20	ch	g
Bonfire Shelter	Texas	10,230	160	TX-153	ch	h
		10,100	300	TX-658	ch	h
		9920	150	TX-657	ch	h
Owl Cave (Wasden)	Idaho	10,145	170	WSU-2485	ch	i
		10,470	100	WSU-2484	ch	i
		10,970	150	WSU-1786	ch	i
12 Mile Creek	Kansas	10,435	260	GX-5812a	bn apatite	j
		10,245	335	GX-5812b	bn gelatin	j
		10,520	70	CAMS-16072 KOH-ext.	bn collagen	k

Sources: a. Wilmsen and Roberts 1978; b. Haynes 1993:Table 1; c. Ingbar 1992; d. Haynes et al. 1984; e. Hofman 1995b; f. Holliday et al 1983, 1985; g. Haynes 1967; h. Dibble and Lorrain 1968; i. Miller 1983; j. Rogers and Martin 1984; k. previously unpublished.
Material: ch=charcoal, ca-pl=carbonized plants, org=organic material, hu=soil humates.

which indicate that the bison kill occurred about 10,800 years ago (Haynes 1992, 1993; Haynes et al. 1992).

The Folsom site is located about 19 km west of the town of Folsom and was first discovered in 1908 by a local cowboy, George McJunkin. Paleontologists from the Denver Museum of Natural History first excavated at the site in 1926 when the association between artifacts and Pleistocene bison was indicated. In 1927 a number of archeologists were invited to view finds of artifacts in place among the bison skeletons. In

1928 paleontologists working for Barnum Brown of the American Museum of Natural History in New York conducted more extensive excavations at the site and recovered additional bison skeletons and Folsom points (Wormington 1957).

The next substantive research on the Folsom complex occurred in the 1930s at the Lindenmeier site in northern Colorado (Roberts 1935a,1936; Wilmsen and Roberts 1978) where an extensive campsite was investigated. Also in the 1930s, research at the Blackwater Draw Locality #1 site in New Mexico yielded stratigraphic evidence that Folsom was slightly younger than Clovis in age (Howard 1935; Sellards 1952; Wormington 1957). Currently there are nearly 30 radiocarbon dates on Folsom (Table 15) which are considered reliable and these indicate a chronological period for Folsom between 10,200 and 10,800 radiocarbon years B.P. (Haynes 1993, Haynes et al. 1992). At the early end, this is only about 100 years younger than the most recent acceptable dates for Clovis, indicating that radiocarbon dating alone will not enable distinction between the latest Clovis and earliest Folsom deposits.

The distribution of Folsom sites and finds has been established based on site excavations and the study of diagnostic surface occurrences (Amick 1994; Davis and Greiser 1992; Hofman 1987, 1994b; Huckell 1982; Largent et al. 1991; Morrow and Morrow 1994; Myers 1987; Naze 1986). Evidence of Folsom technology is found from southern Canada to northern Mexico and from Illinois to Utah, Idaho, and eastern Arizona. The greatest density of sites and finds appears to be in the High Plains, dissected Plains, and Rocky Mountains foothills regions. The finds are correlated with the terminal Pleistocene records for *Bison bison antiquus* (e.g., Munson 1990).

Figure 28 shows the reported occurrences of Folsom finds and sites in the Central Plains region by county. The nature of this evidence varies widely and includes brief mention of finds (e.g., Wedel 1938c; Howard 1935, 1939; Barbour and Schultz 1936), descriptive reports (e.g., Agogino and Parrish 1971; Galloway and Agogino 1961; Hurst 1943), area surveys (Naze 1986), and detailed site studies (Wilmsen and Roberts 1978). Folsom sites recorded in the Central Plains region are listed in Table 16, and examples of Folsom artifacts from the region are shown in Figure 29.

The basic elements of the Folsom technological system were documented by Roberts' investigations at the Lindenmeier site during the 1930s (Roberts 1935a, 1936a, 1937b). The extensive and varied assemblage from this site remains the most "complete" and among the better documented of Folsom assemblages (Wilmsen and Roberts 1978). Detailed studies of other Folsom sites and assemblages have enhanced the record from Lindenmeier. Notable sites with relatively large or varied assemblages include Hanson, Wyoming (Frison and Bradley 1980; Ingbar 1992); Agate Basin, Wyoming (Frison and Stanford 1982); Hell Gap, Wyoming (Irwin 1968); Lake Ilo, North Dakota (Root 1993); Cattle Guard, Colorado (Jodry 1987, 1992; Jodry and Stanford 1992); Blackwater Draw and the Mitchell Locality, New Mexico (Hester 1972; Boldurian 1990); Elida, New Mexico (Hester 1962); Shifting Sands, Texas (Hofman et al. 1990); and Adair-Steadman, Texas (Tunnell 1977; Tunnell and Johnson 1991).

These site studies have documented much of the range of lithic and bone technology of Folsom. Characteristics of Folsom

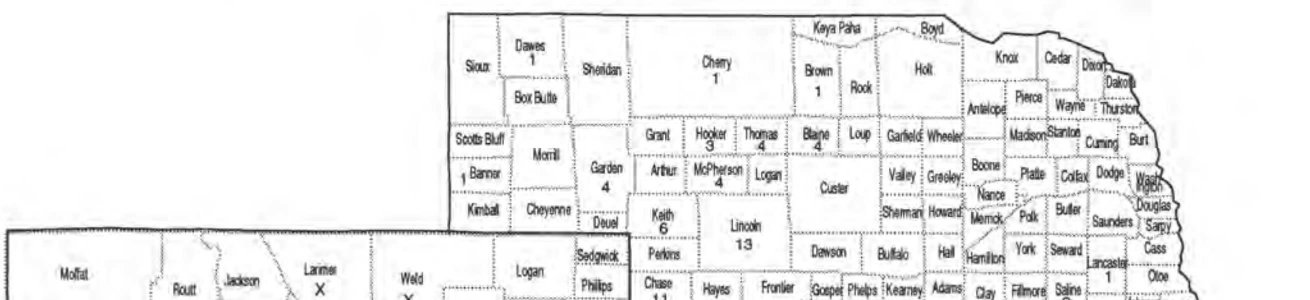


Figure 28. Occurrence of Folsom points by county in the Central Plains (Barbour and Schultz 1936; Myers 1987; Holen 1991; Holen et al. 1996; Hofman 1994; Nelson 1969; Nelson and Breternitz 1970; Greiser 1985).

Table 16. Folsom Sites Recorded in the Central Plains.

Site Name	Number	County	Site Type	Ref.
Colorado				
Lindenmeier	5LR13	Larimer	Camp/Kill	e
Powars	5	Weld	Camp	f
Johnson	5	Larimer	Camp	g
Fowler-Parrish	5	Morgan	Processing	h
—	5MR338	Morgan	Camp	d
Barger Gulch (Crying Woman)	5GA1208	Grand	Camp	i
*Upper Twin Mtn	5GA1513	Grand	Kill/Camp	j
Lower Twin Mtn	5GA186	Grand	Camp	j
Cattle Guard	5AL101	Alamosa	Kill/Camp	k
Linger	5AL91	Alamosa	Kill	l
Zapata	5AL90	Alamosa	Kill/Camp	m
Reddin	5SH77	Saquache	Kill/camp	a
Bijou Creek	5MR2	Morgan	Camp	d
Hahn	5EP1	El Paso	Camp	d
Black Mountain	5HN55	Hinsdale	Camp	n
Nebraska				
Elfgren	25BL10	Blaine	Sandhills	o
Calf Creek	25CE27	Cherry	Sandhills	NSHS files
—	25CE38	Cherry	Sandhills	NSHS files
Nolan	25CH4	Chase		p
—	25CH23	Chase		NSHS files
—	25DW65	Dawes		NSHS files
Morrison	25HO12	Hooker		NSHS files
—	25HO42	Hooker		NSHS files
—	25KH2	Keith		NSHS files
Wind Springs	25SX77	Sioux		NSHS files
Kansas				
12 Mile Creek	14LO1	Logan	Bison kill	q

References: a. Cassells 1983; b. Stanford 1979; c. Stanford and Albanese 1975; d. Greiser 1985; e. Wilmsen and Roberts 1978; f. Wormington 1957; g. Galloway and Agogino 1962; h. Agogino and Parrish 1971; i. Naze 1994; j. Kornfeld et al. 1992; k. Jodry 1992. Jodry and Stanford 1992; l-n. Jodry et al. 1993; o. Holen 1987; p. Barker and Schultz 1956; Myers 1987; q. Rogers and Martin 1984.

* This is a Goshen site with no Folsom points.

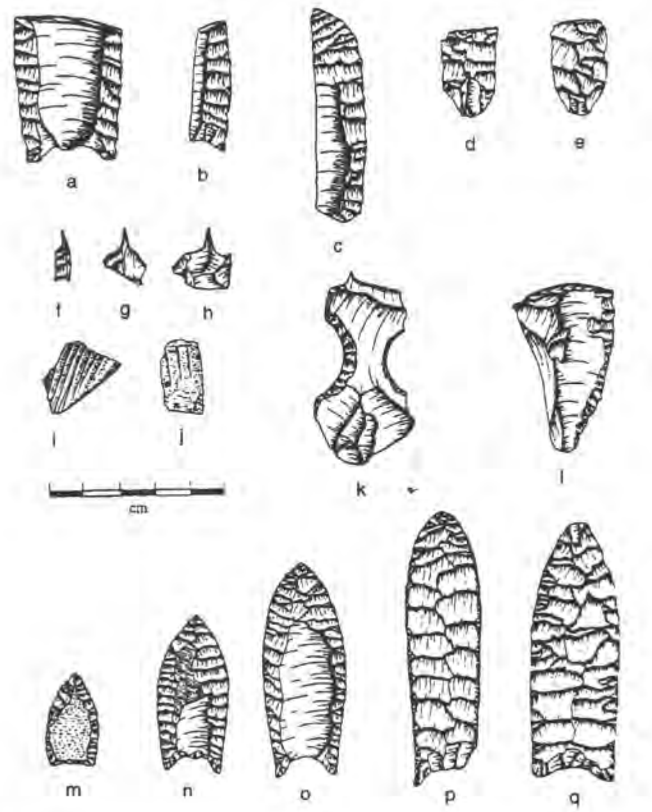


Figure 29. Folsom complex and other artifacts from the Central Plains. a-c. Folsom preform fragments; d-e. Folsom channel flakes; f-h. gravers or tips; i-j. engraved bone pieces; k. double spokeshave; l. spurred end scraper; m. pseudo-fluted Folsom point made on a flake (a-m. from Lindenmeier site); n. Folsom point, Prowers County, CO; o. Folsom point, Hitchcock County, NE; p. Midland point, Banner County, NE; q. Goshen point, Sioux County, NE.

stone technology, in addition to the classic fluted projectile points (Bell 1958; Roberts 1934), include bifacial fluted and unfluted preforms which also served as tools (Judge 1973; Boldurian and Hubinsky 1994), very thin broad bifaces which probably served in cutting and butchery (Root et al. 1994), very large bifaces which served as cores for large tools and blanks (Stanford and Broilo 1981; Boldurian 1991; Hofman 1992), delicate and thin channel flakes from fluted point production which often served as tools, fine-tipped gravers made on thin flakes, endscrapers which often exhibit graver spurs at one or both corners, sidescrapers, spokeshaves or concave scrapers, notches or very small spokeshaves, denticulates or serrated-edged tools, bifacial and unifacial drills, borers, or tips, occasional burins on flakes, combination tools which combine from two to several distinct tool forms on one piece, bend break and hinged flake tools (Frison and Bradley 1980), radial break tools (Frison and Bradley 1980), utilized and informal flake tools, choppers made on cobbles, hammerstones, abrading stones, and small grinding stones (sometimes with red pigment-stained surfaces). This relatively rich lithic tool variety is represented in widely differing proportions at different sites dependent upon numerous situational factors. These include the length of occupation, number of people, composition of the group, proximity to a quality lithic source, whether kill, butchery, or processing activities are conducted, season, ground cover (which influences artifact loss), and a variety of other conditions.

Complementing this lithic technology is a rich variety of bone tools and artifacts. These artifacts are primarily from a few excavated sites which have relatively good preservation due to dry climates and rapid burial. Collections from Lindenmeier and the Folsom components at the Agate Basin site are most notable (Wilmsen and Roberts 1978:126-134; Frison and Craig 1982). A key tool type is the eyed needle which is also documented at other Folsom-age sites including Hanson (Frison and Bradley 1980:103) and Winkler #1 (Blaine and Wendorf 1972). These needles were generally very delicate, but reached at least 8 cm in length (Frison and Craig 1982:Figure 2.111a). Needles were apparently used in sewing skins or hides with sinew or fiber. At both Lindenmeier and Agate Basin eyed needles were clustered in what were apparently domestic work areas.Other bone tools include a variety of modified long bone implements, which may have served many tasks, but include serrated fleshers and probable knapping tools. Bone projectile points are documented from Agate Basin (Frison and Zeimens 1980; Frison and Craig 1982) which adds an interesting dimension to the hunting technology. Foreshafts or tool handles may be represented by hollowed rib sections (e.g., Frison and Craig 1982; Hester 1972), and possible Folsom point fluting tools are represented by a T-shaped elk antler section and bone pieces from Agate Basin (Frison and Bradley 1981, 1982). A hollow tube bone bead made from a small animal long bone is reported from Lindenmeier, and the remnants from manufacture of such beads were found at Agate Basin. Also, manufacturing by-products from needle manufacture are probably represented by cut scapulae fragments at Agate Basin. Experimental work has shown the flat bone from scapulae to be particularly resilient and suitable for needle manufacture (Frison and Craig 1982:166). Numerous small bone objects, roughly circular or elongated, with small regular edge notches are also reported and generally referred to as decorative pieces or gaming objects. Also, sections of rib and long bone have been found which have narrowly spaced parallel grooves. Specific functional interpretations have not been offered for these, but I suspect they may represent manufacturing steps in the production of objects such as needles or beads. A very small (<2 mm diameter) bone bead was recently found at the Shifting Sands Folsom-Midland site in western Texas. Such small ornamental objects were probably made in sets, and the grooved segments of bone may represent an initial step in the manufacture of such artifacts (Hofman 1996).

In general terms, the Folsom lithic technological system was highly portable and centered upon the production of bifaces and large biface thinning flakes which could be routed through a variety of possible functional and morphological stages depending upon immediate requirements and on the long-term plans of the group. Judge's discussion of Folsom technology in the central Rio Grande valley was an early and largely successful attempt to explain this technology as a highly curated and versatile lithic reduction system of a mobile group. Judge (1973:192) argues,

> Folsom people were quite conservative in their use of lithic material and...this is manifest in the production of a preform as a primary focal unit. By-products of this process served as blanks for other tools, which then served multipurpose rather than specialized needs. It is tempting to suggest that this efficiency in utilization of raw material and the multipurpose usage of a minimum number of tool types represents an adaptation to a highly mobile way of life. This is certainly a possible explanation for this phenomenon in the central Rio Grande valley.

Continued research generally supports Judge's conclusion (Boldurian 1991; Hester 1972; Jodry 1987; Ingbar 1992, 1994; Amick 1994; Hofman 1991, 1992; Root and Ahler 1994). Even in Folsom site situations where raw material is abundant (with a nearby source), such as at the Hanson site in Wyoming (Frison and Bradley 1980; Ingbar 1992, 1994) and Lake Ilo in North Dakota (Ahler and Root 1993; Root and Ahler 1994), specialized tool forms and bifaces were at the heart of the technological system. Completed points and final stage preforms are sometimes made of exotic materials even at lithic source areas and workshop sites. Ingbar (1992:187-188) writes,

> Why are wasteful reduction techniques, especially fluting, not performed at raw-material source sites where production failures would not have been disastrous?... the answer to this must be that long-term utility of the core, whether a large biface or flake, must have been equally or more important than the number of projectile points in a hunter's gear. The wide range of tools that can be created from a flexible form like a large biface or flake may have been more advantageous given uncertainties about the location and purpose of tool needs.

Projectile points were apparently only one of several important functional end products of the staged biface technological reduction process. This sequencing of artifact forms included heavy bifacial tools (including early stage cores and preforms), and thick or thin biface reduction flakes which could be used in unmodified form or transformed into a variety of standardized or expedient tool types. Channel flakes from fluting provide a sharp and delicate cutting tool, and fluted or unsuccessful preforms could also be routed to a variety of tool types such as bend break tools, burins, radial break tools, scrapers, gravers, etc. When Folsom point production and fluting is viewed within the broader context of the overall Folsom chipped stone industry, fluting might be seen as a "no lose" strategy rather than as a highly dangerous and wasteful process.

Folsom economy has generally been characterized as specialized or focused on bison hunting (Sellards 1952; Wormington 1957; Frison 1991b; Bonnichsen et al. 1987). To date, all Folsom components which have bone preservation include bison remains, usually as the dominant species in terms of number of animals and almost always in terms of volume or mass yield. Only at the Wasden site, Owl Cave, in Idaho is there evidence for the association between Folsom points and mammoth remains (Miller 1982, 1983); otherwise, mammoth were apparently extinct by Folsom time. Lesser species are also sometimes associated with Folsom material, notably deer, antelope, elk, camel, jackrabbit, wolf, fox, marmot, turtles, and microtines (Walker 1982; Davis and Greiser 1992; Wilmsen and Roberts 1978). Blood residue studies have also shown nonbison species such as antelope were part of the Folsom economy (Hyland and Anderson 1990; Amick 1994).

Several authors have suggested that the dependence of Folsom people on bison is more apparent than real (Kornfeld 1990; Meltzer and Smith 1986), because of differential preservation, visibility, and recovery of bison remains, especially at kill sites, vs. more delicate remains of smaller species. It is generally accepted that Folsom people would have used a variety of plant and animal resources other than bison at least in some seasons and settings (Hofman 1990b, 1994a; Davis and Greiser 1992).

A variety of bison hunting techniques were employed by Folsom people and we continue to learn more about the variety of hunting strategies of these and other early Plains hunting groups (Frison 1987a, 1993). Minimally, these groups used stalking and small group encounter hunting (e.g., Bamforth 1985; E. Johnson 1987), jumps over steep canyon walls (Dibble and Lorrain 1968), arroyo head-cut traps (Frison and Stanford 1982; Bement 1994a, 1994b), and probably sand dune traps as well (cf. Frison 1974; Dawson and Stanford 1975). The number of animals taken ranged from a few individuals to almost 60 at the Lipscomb site (Hofman and Todd 1990, 1995; Todd and Hofman n.d.; Todd et al. 1992). There does not appear to be a direct correlation between the number of animals and the number of projectile points or artifacts recovered (Hofman 1994a) (Table 17). Numerous other factors such as season, number of hunters, length of occupation (opportunity for recovery of gear), number of animals, dispersion of carcasses, access to carcasses, differential preservation, ground cover, and other situational variables were probably of importance in determining the final makeup of the archeological record.

Table 17. Number of Bison and Projectile Points at Folsom Bison Bonebeds.

Site, Location	#Points	#Bison	Ratio	Season*
Agate Basin, WY	3	9	0.3:1	Late winter/Early spring
Carter/K-M, WY	0	2	0:2	n/a
Lindenmeier, CO (Bison Pit Area)	13	9	1.4:1	n/a
Folsom, NM	20	28	0.7:1	Early fall
Lipscomb, TX	30	56	0.5:1	Late summer/Early fall
Lake Theo, TX	14	12	1.2:1	Early fall
Cooper, OK	32	35?	0.9:1?	Late summer/Early fall

Only finished stone points are included here (not preforms or bone points). Three kill events are represented at the Cooper site (Bement 1994b).
* Seasonal information is from Todd and Hofman (1992: Table 8), and from Bement (1994b).

Folsom groups were highly mobile and are believed to have moved over regions of considerable size during the course of their hunting and foraging activity. Stone tool source studies suggest fairly common movement up to 200-400 km from locations where lithic materials were acquired for tool manufacture (Wilmsen and Roberts 1978; Jodry 1987; Stanford 1991b; Frison 1982; Hesse 1995; Hofman 1991a; Hofman et al. 1991; Amick 1994). Because of the probable low population density and the rarity of recurrently occupied sites, direct acquisition of lithic material for tool manufacture is believed to have been the primary means for obtaining the critically important stone, rather than relying upon uncertain or unpredictable trade.

Information on ideology and ritual is limited. Red ochre was an important element in Folsom life and is represented in some fashion at most Folsom campsites and at several kill sites. Occupation surfaces at Agate Basin, Hanson, and Lindenmeier had evidence of red ochre. Also, an important recent find at the Cooper bison kill site in Oklahoma was a skull from the lowest of three bison bonebeds which had a narrow red zigzag line and other marks (dots) painted on it (Bement 1994a). The skull, from an essentially articulated skeleton, was painted and set on top of the bonebed facing toward the mouth of the gully where two subsequent kill events occurred (Bement 1994a). This is the first such find in the New World Paleoindian record, but it brings to mind painted mammoth skulls and other elements from the Upper Paleolithic sites such as Mezhirich in the Ukraine (Soffer 1985). Also, red ochre-stained bone is reported from the Sheaman Clovis site in eastern Wyoming (Frison 1982a), and the important Powars II site represents a red ochre quarry used by Folsom and other Paleoindian people (Frison 1991b; Stafford 1990).

An interesting bone feature is also known from the Lake Theo site bison bonebed. A series of long bones and mandibles were set vertically in a small circular hole and apparently supported a bison skull in a dense bison bonebed (Harrison and Smith 1975). This may have been an offering or a feature similar in purpose to the Cooper site's painted skull.

Folsom ritual has also been suggested in relation to the production of fluted points (Frison and Bradley 1982; Frison 1991a:56; Bradley 1991:375; Hofman 1989:37). Some Folsom point preforms have been found which were fluted successfully on both sides and then discarded without being completed (Bradley 1991, 1993). This suggests that in some situations it was perhaps the fluting itself rather than the creation of a functional point which was of most significance.

Ornaments are other artifacts potentially reflecting Folsom ideology or decorative art. Beads have been found at several sites including Lindenmeier, Agate Basin, and Shifting Sands. At Shifting Sands in western Texas, a very small bone or ivory bead 1.7 mm in maximum diameter was found in Area 6. This very small bead would not have been used singly but in conjunction with other such beads probably for creating decorations or designs on clothing or other articles. Intensive use of beads is well shown at Upper Paleolithic site of Sungir in the Ukraine where thousands of beads of varying sizes were found as burial associations (Bader 1978; Shimkin 1978). In the New World, such small beads as the ones found at Shifting Sands have not been reported elsewhere in Paleoindian contexts, but this find holds important implications for recovery and recognition of small decorative elements in Folsom technology.

Selected Folsom Sites in the Central Plains

Lindenmeier Site. The Lindenmeier site is located in north-central Colorado, north of Fort Collins and less than 3 km from the Wyoming border. The site is on the Colorado Piedmont escarpment within the drainage system of the Cache la Poudre and South Platte rivers. The site's geologic setting and stratigraphy are discussed by Bryan and Ray (1940). It was discovered in 1924 by amateur archeologists who subsequently reported it, following the discoveries at Folsom, New Mexico, to the Smithsonian Institution (Coffin 1937; Cassells 1983; Renaud 1931b, 1932b). Roberts (1935a, 1935b, 1935c, 1936a, 1940, 1941) then worked at the site from 1934 through 1940 conducting extensive, well controlled, and for the most part thoroughly documented excavations. Cotter (1978) also conducted excavations at the site on behalf of the Colorado Museum of Natural History (now the Denver Museum).

As noted by Wilmsen, the Lindenmeier site stands out as exceptional in large part due to the quantity and quality of the fieldwork. More than 1800 m^2 were excavated by Roberts plus more than 20 test pits, not including the work of Cotter or the Coffins. About 580 field days were spent at the site with an average crew of eight to nine people between 1934 and 1940. Areas I and II which were the primary focus of Wilmsen's analysis included about 1,133 m^2 which yielded more than 33,000 flakes and tools (not including bone debris or bone artifacts). This is an average of about 30 artifacts per square meter, but the density was highly variable across the excavated areas and there was no fine screen recovery. Dry screening, probably with quarter-inch mesh, was done for the Folsom levels for much of the excavation. At least three distinct artifact-bearing strata of Folsom age were recognized in Area II (Wilmsen and Roberts 1978:54). The formational history and relationships of these units is not well understood but hold important implications for artifact density, site occupational history, and assemblage analyses. Because of the large and varied collections, Lindenmeier provides the standard basis for comparison and discussion of Folsom assemblages. The site has been suggested by some authors to represent an aggregation site for Folsom bands (Wilmsen 1974), a possibility which merits further investigation (Hofman 1994a).

Fowler-Parrish Site. The Fowler-Parrish site is located near Orchard, Colorado in the South Platte drainage (Agogino and Parrish 1971). At least 17 Folsom points and fragments were collected from the site in an area that apparently contained at least two bison bonebeds. Deflation of the sandy matrix and intensive artifact collecting limited the research potential of the site which apparently represented a bison kill. No information is available on associated camp or processing areas which were probably located nearby.

Powars. Site The Powars site is near Greeley and Kersey, Colorado on the South Platte River. It has been largely destroyed by wind deflation and subsequent house construction and agricultural activity. The site was a camp in a sand dune area on the south side of the river and yielded more than 2,000 artifacts including Folsom points and endscrapers. Brief mention of the site is found in Wormington (1957:39) and Roberts (1937a).

Johnson Site. This small Folsom assemblage from a site near La Porte, Colorado on the Cache la Poudre River was documented by Galloway and Agogino (1961; Wormington 1957:40). This location is about 24 km from Lindenmeier and the site yielded 10 Folsom points (most from the surface), 22 channel flakes, and endscrapers. Substantial Archaic and late prehistoric material was also represented at this severely deflated site. An area of more than 20 m^2 was excavated. A stone circle probably of post-Folsom origin is reported, as is evidence for late prehistoric occupation of nearby rockshelters. The site is significant for the reported common utilization of quartzite in the Folsom assemblage. The site has been largely destroyed by road construction.

Upper Twin Mountain (Jim Chase Site). This site, 5GA1513, is located northeast of Kremmling, Colorado and has been investigated since 1990 by Frison and Kornfeld (Kornfeld et al. 1992; Kornfeld and Frison 1995). The site consists of a bison kill at an elevation of about 2,500 m ASL and represents a Goshen or Goshen/Plainview kill. An area of about 32 m^2 has been excavated, and a single radiocarbon date on bone is 10,240 ± 70 (G.C. Frison and M. Kornfeld, personal communication, 1994). At least 15 bison are represented and were apparently killed in late fall or early winter (Todd et al. 1996). A Folsom campsite, Lower Twin Mountain (5GA186) is located a short distance away.

The Crying Woman Site, 5GA1208. This extensive site includes an area which represents a Folsom campsite along Barger Gulch in Middle Park (Naze 1994). The site is situated near a series of springs in the headwaters of the Colorado River. Controlled surface collections and testing by Naze has produced Folsom points, preforms, channel flakes, a spurred endscraper and other materials. Two preforms and three channel flakes are made from local Kremmling chert, but at least one point from the site is from possibly nonlocal red jasper.

Middle Park Survey. The upper Colorado River drainage north, south, and east of Kremmling, Colorado has a relatively high density of Folsom sites and finds (Naze 1986). Naze documented 26 sites and probable sites of Folsom age in about 6,200 km^2 of the Middle Park drainage basin for a site density of about one site per 237 km. Additional discoveries have been made since Naze's initial report, but he reported 32 Folsom points, 13 channel flakes, 21 preforms, and other artifacts. About 80% of the lithic material represented by Folsom artifacts is "local" Kremmling chert, but Table Mountain jasper (from the eastern part of the drainage) and exotics such as Flattop chalcedony from near Sterling and oolitic chert from the Red Desert area of southern Wyoming are also represented. The region was an important source of quality lithic material, but a variety of site types are represented. These include camps, hunting overlooks, and isolates (Naze 1986:6). In addition, bison kill sites of Folsom or Goshen age are also known in the area (Kornfeld et al. 1992). Some sites occur above the timberline. Continued research in the Middle Park basin promises to provide important new information about Folsom and Goshen activities in the Rocky Mountains region.

Cattle Guard and San Luis Valley Sites. Cattle Guard is the most thoroughly investigated of several Folsom sites in the eastern San Luis Valley of south-central Colorado (Jodry 1987, 1992; Jodry and Stanford 1992; Emery and Stanford 1983). Other sites in the vicinity include Linger (5AL91) (Hurst 1943; Dawson and Stanford 1975), Reddin (5SH77), and Zapata (5AL90) (Wormington 1957). The sites, except for Reddin, are located along the eastern margin of the Pleistocene San Luis Lake in the vicinity of Great Sand Dunes Park. Two radiocarbon dates on bone from the Linger site are believed to be too young to represent the age of the Folsom occupation there (Dawson and Stanford 1975). But young bone dates are a common problem at Paleoindian sites on the Western Plains (Wilmsen and Roberts 1978:40; Hofman 1995b; Stafford et al. 1991). Investigations at Linger including excavation (ca. 99 m^2) and controlled surface collections, indicate that kill/butchery and camp areas are represented.

Cattle Guard (5AL101) was discovered in 1977 and test excavations were made in 1981 (Emery and Stanford 1983). Since that time several additional field seasons of intensive excavation have produced one of the most extensive and well-documented Folsom assemblages. This assemblage apparently represents a single occupation surface which is now buried about 25 cm below the present surface. Excavation has documented several spatially discrete activity areas apparently associated with hearths which occur some 20-30 m from the primary bison bonebed (Jodry 1987). The thickness of the occupation zone is about 30 cm with numerous refitted artifacts serving to link the assemblage through and across this unit (Jodry 1992; Jodry and Stanford 1992). A large assemblage of Folsom artifacts and bison remains has been recovered from the site. Spatial analyses are providing important insights to the organization of activities at this Folsom camp and kill/processing site. A series of probable hearth areas have yielded evidence for a variety of activities including tool maintenance. Projectile point bases (discarded), preforms, channel flakes, and production debris occur in each hearth-related artifact cluster. This suggests that fluting Folsom points was done by several different individuals, rather than by a single specialist. A kill area is located 20-30 m from the hearths and camp and may have included about 25-30 bison (Jodry 1992, personal communication 1994). Also, site formational studies conducted at Cattle Guard are of significance to all investigations in sand dune situations. The artifact assemblage from Cattle Guard includes numerous projectile points, point preforms, channel flakes, scrapers, gravers, unifacial tools, utilized flakes, hammerstones/anvils, chopping tools, abraders, red ochre and an assortment of other artifact types. Lithic material sources include artifacts of Alibates flint, Washington Pass chalcedony, Trout Creek jasper, and Black Forest silicified wood among other materials. Artifacts around hearth areas indicate that several preforms were finished into points near each hearth area.

Black Mountain Site, 5HN55. This high altitude site is in a mountain pass in the San Juan Mountains in Hinsdale County (Jodry et al. 1993). Only preliminary investigations have been conducted, but a campsite and overlook with point production debris and a variety of other tools is indicated.

Nolan Site. The Nolan site in Chase County, Nebraska was discovered and first reported in the 1930s when this sand dune area was severely deflated by wind erosion (Schultz 1932; Barbour and Schultz 1936). Myers' (1987) Folsom points from Chase County are primarily from Nolan. Folsom points, preforms, endscrapers, unifacial tools, gravers, and large biface thinning flakes are represented in the site collection. Lithic materials include both Niobrara or Smoky Hill jasper and Flattop chalcedony (White River Group, Hoard et al. 1992).

12 Mile Creek Site. Excavation of a late Pleistocene bison bonebed east of Russell Springs, Kansas on the Smoky Hill River in 1895 by paleontologists from the University of Kansas yielded the first evidence from the Central Plains region of an artifact associated with an extinct form of bison (Williston 1902; Rogers and Martin 1984; Hill 1994, 1996; Hill et al. 1993). A single projectile point was found laying beneath and against the dorsal surface of a scapula of a large articulated bison substantiating the contemporaneity of the artifact and the bison remains. Unfortunately, the point was lost soon after discovery and only a sketch and photograph remain. The point was fluted and the banding suggest it may have been made of Alibates flint (Stanford 1983). A series of three radiocarbon dates are now available for the site based on bone from the original excavation (Table 15). These all are in close agreement and well within the range of other Folsom-age dates.

The projectile point from 12 Mile Creek is considered by Haynes (1993:Figure 1), Rogers and Martin (1984), and O'Brien (1984) to be Clovis. Others, including Gunnerson (1987:15), Brown and Simmons (1987), Brown and Logan (1987) consider it to be Folsom.

Restudy of the bison bones from the 12 Mile Creek site has yielded new insights into the formational history of the site and more details about the fauna (Hill 1994, 1996). At least 12 animals are represented in the bonebed, there is limited evidence of butchering, and the season of the kill was probably late winter to early spring.

Midland Complex

The Midland archeological complex was first defined based on discoveries at the Scharbaurer site near Midland, Texas. The discovery of a human skull, animal bones, and artifacts in ancient dune deposits of uncertain late Pleistocene age brought considerable notoriety to the site in the 1950s (Wendorf et al. 1955; Wendorf and Krieger 1959). Despite additional study of the type site and other deposits in the region, and study of the stratified Paleoindian assemblages at the Hell Gap site in Wyoming, the relationships between Midland and other Paleoindian complexes, especially Folsom, has remained a topic of debate. The relationships between Midland and Folsom in terms of chronology, technology, cultural groups, and archeological taxonomy remain unresolved.

The single primary difference between Folsom and Midland assemblages is that Midland projectile points are not fluted, though they share most other morphological and technical attributes or characteristics of Folsom points. Other elements of the technology are essentially identical. These include spurred endscrapers, delicate gravers, eyed bone needles, and a pattern for use of the same exotic lithic sources preferred by Folsom people. One problem is that there are few stratified sites which provide a clear indication of the chronological relationship between Folsom and Midland. There are currently no radiocarbon dates for clearly unmixed Midland assemblages. It is often assumed that Midland represents, in part, the later phase of the Folsom technology when fluting was losing "popularity." The abandonment of fluting projectile points by Paleoindians may have occurred at different times and rates in various regions of the Plains, but it is a technique which was eventually completely lost. The relationship between Midland and Folsom may, then, in part be a chronological or historical one.

It has also been suggested that these projectile point types reflect the activities of two distinct but more or less contemporary groups (Blaine 1968, 1992). Alternatively, technological aspects of projectile point production and decisions about when, and when not, to flute projectile points may have been influenced by technological considerations, availability of tool stone, time restraints, and so forth (Hofman 1992a). There are many archeological sites, such as Shifting Sands in Texas (Hofman et al. 1990) and Hell Gap in Wyoming (Irwin 1968), where both Folsom and Midland points (or unfluted Folsom points) are found together, but the integrity of the sites and the possibility of mixing remains from multiple occupations through deflation and other natural processes are generally undocumented.

As it stands at present, there are multiple possible and reasonable interpretations for explaining the relationships between the Midland and Folsom complexes. There is no question but what they are very similar in overall technology, economy, and to a large extent the time and space framework of their distributions. Because of recently improved understanding of the Goshen complex, which is an unfluted point assemblage of Clovis or Folsom age on the Northern Plains, we can no longer simply assume that Midland is necessarily a later development out of Folsom or a continuation of Folsom which simply lacked fluted points. Understanding the interrelationships of these technologies represents one of the more intriguing questions in contemporary Paleoindian research.

No Midland sites have been identified or excavated in the Central Plains, but a number of Midland artifacts have been documented from Kansas, Nebraska, and Colorado as well as further north in Wyoming and North Dakota (Frison 1991b:Figure2.38g).

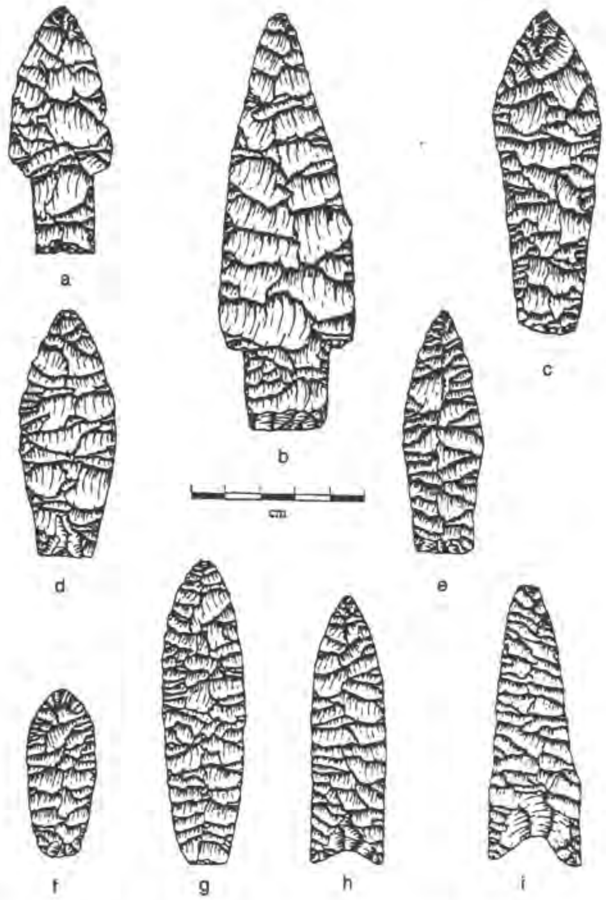


Figure 30. Late Paleoindian projectile/knives from the Central Plains. a-b. Alberta points, Hudson-Meng site, NE; c-e. Hell Gap points, Jones-Miller site, CO; f-g. Agate Basin points, Frazier site, CO; h. Plainview point, Bonner Springs, KS; i. Dalton point, Bonner Springs, KS.

Late Paleoindian or Plano Complexes

As first used by Jennings (1955), the Plano "culture" or complex was a general term used to refer to a number of distinct assemblages recognized by various unfluted, lanceolate projectile points which are known or assumed to be of post-Folsom or late Paleoindian age. The basis of the Plano complex concept, as used by most authors, is that it represents late Paleoindian, ca. 10,200-7500 B.P., groups with an economic focus on bison hunting in the Plains. It incorporates a number of more specific and often temporally or geographically restricted complexes or assemblages found throughout the Great Plains. In a typological sense, it is often used in much the same way the term "Yuma" was used during the 1930s through 1950s (usually as a reference to parallel flaked lanceolate points), until the Yuma terminology was abandoned as too vague and imprecise (Howard 1943; Wormington 1957).

The Plano taxon has been widely accepted as a useful term and has been applied to many late Paleoindian materials which are not assignable to a specific complex or when numerous distinct complexes are considered together as a group (Cassells 1983; O'Brien 1984b; Brown and Simmons 1987; Brown and Logan 1987; Krieger 1964; Lintz and Anderson 1989; Spencer and Jennings 1965; Wedel 1978d). In his later writings, Jennings (1974, 1978) included assemblages with stemmed and notched points in his discussion of Plano. Most other researchers would consider some of these materials Archaic rather than Plano. He also presented a somewhat muddled discussion of the relationships between Plainview, Firstview, Folsom, Cody, and other complexes (Jennings 1978). In this overview, Plano is used to refer to post-Folsom Paleoindian complexes. Examples of Plano projectile point types are shown in Figure 30. Late Paleoindian sites are listed in Table 18 and radiocarbon dates from Late Paleoindian sites in Table 19.

Plainview Complex

The Plainview complex was first recognized based on excavation of an extensive bison kill at Plainview, Texas (Sellards et al. 1947). The projectile points from this bonebed were used

Table 18. Late Paleoindian Sites Reported in the Central Plains.

Site	County	Complex	Site Type	Reference
Nebraska				
Hudson-Meng	Sioux	Alberta/Cody	Bison Kill	Agenbroad 1978; Todd & Rapson 92
Scottsbluff	Scotts Bluff	Scottsbluff	Bison Kill	Schultz & Eisley 1935
Clary Ranch	Garden	Allen/Frederick	Bison Kill	Myers et al. 1981
Meserve	Hall	Meserve	Bison Kill	Barbour & Schultz 1932
Red Smoke	Frontier	Plainview	Camp	Davis 1953a
Allen	Frontier	Agate Bas.	Camp/Workshop	Bamforth 1991
Lime Creek	Frontier	Scottsbluff	Camp/Workshop	Holder & Wike 1949
Kansas				
Norton Bonebed	Scott	Allen/Frederick?	Bison kill	Hofman et al. 1995
14SC6Sutter	Jackson	Allen/Cody/Frederick	Camp/Process.	Katz 1971; West 1991
Tim Adrian	Norton	Hell Gap	Workshop	O'Brien 1984a
Laird, 14SN2	Sherman	Late Paleo	Bison kill	unpublished
Burntwood	Rawlins	Late Paleo	Bison Kill	Hill et al. 1992
Baber, 14GL467	Greeley	Cody	Camp	KSHS files
Gettenger,14WC9	Wallace	Cody	Camp	Greiser 1985
Harrison,14WC8	Wallace	Cody	Camp	Greiser 1985
Colorado				
Olsen-Chubbuck	Cheyenne	Firstview	Bison Kill	Wheat 1972
Claypool	Washington	Cody	Kill/Camp	Dick & Mountain 1960; Bradley & Stanford 1987
Jones-Miller	Yuma	Hell Gap	Bison Kill	Stanford 1978,1979
Keenesburg	Weld	Agate Basin	Camp	Greiser 1985
Jurgens	Weld	Cody	Kill/Camp	Wheat 1979
Frasca, 5LO19(Dreier-Frasca)	Logan	Cody	Bison Kill	Fulgham and Stanford 1982
Frazier	Weld	Agate Basin	Bison Kill	Cassells 1983
Lamb Springs	Arapahoe	Cody	Bison Kill	Stanford et al.1981; Rancier et al 1982; Fisher 1992
Caribou Lake	Boulder	Cody	Camp	Benedict 1974
Wetzel	Kit Carson	Cody	Bison Kill	Cassells 1983
Nelson	Logan	Cody	Bison Kill	Cassells 1983
Gordon Creek	Larimer	Plano	Burial	Breternitz et al. 1971

Table 19. Radiocarbon Dates from Central Plains Late Paleoindian Sites.

Site	Complex	Date	δ avg 2	Lab. No.	Material	Reference
Frazier	Agate Basin	9600				Wormington 1988
		9650	130	SMU-31		Gunnerson 1987
		9550	130	SMU-32	soil humic acid above bonebed	
Gordon Creek	Hell-Gap?	9700	250	Gx-0530		Breternitz et al. 1971
Jones-Miller	Hell-Gap	10,020	320	SI-1989	charcoal	Stanford 1984
Red Smoke		8862	230	C-824	charcoal	Wedel 1986
		7970	210	TX-333	charcoal	Wedel 1986
Allen		10,493	1,500	C-470	charcoal	Wedel 1986
		8274	500	C-108a		Wedel 1986
Sutter	Frederick	7990	45	SM-1420		Brown/Simmons 1987
		7818	245	SM-1421		Katz 1973
		7668	237	SM-1423		
Norton 14SC6	Allen?	9080	60	CAMS-16032	bone, KOH-ext. collagen	Hofman et al. 1995

by Krieger to define the Plainview type (in Sellards et al. 1947). The type is most commonly reported in the Southern Plains region (Thurmond 1990; L. Johnson 1989; Baker et al. 1957) but is common in Kansas (Brown and Logan 1987), and occurs in Colorado as well (Lintz and Anderson 1989:116). Lanceolate points originally attributed to the Plainview type are also reported from southwestern Nebraska at the Lime Creek and Red Smoke sites (Davis 1953a, 1962; Wormington 1957), but this assignment for Lime Creek has been questioned (Knudson 1983). The Red Smoke assemblage from Zone 88 (originally Level 88) yielded a significant series of projectile points which Davis (1953a) attributes to the Plainview type. He suggests that the Meserve-like specimens with beveled and shortened blades are simply reworked Plainview points.

Discussion of the Plainview complex is provided in Hofman (1989:38-40). Plainview points are distinguished by a lanceolate outline with a concave base, lateral edge grinding, and basal thinning. They share attributes with Goshen, Milnesand, Midland, Meserve, Dalton, Clovis, and Folsom points (L. Johnson 1989; Haynes 1991b; Leonhardy and Anderson 1966; Irwin 1968; Frison 1991a, 1993). Available radiocarbon dates from the Plainview site, Lubbock Lake, Lake Theo, Bonfire Shelter, and other Texas sites indicate that Plainview assemblages date from approximately 10,100 to 9,000 years ago (Holliday et al. 1983, 1985; Thurmond 1990:Table 6). In some cases, Plainview has become a catchall category for any unfluted, lanceolate, edge-ground, basally thinned point. The variability in the type assemblage also suggests a relatively broad range of base and blade forms as well as flaking patterns. Haynes (1991b) compared metric attributes of Goshen and Plainview points and showed them to be indistinguishable. One of the Clovis points from the Domebo mammoth site in Oklahoma was compared favorably with the Plainview type (Leonhardy 1966). Knudson's (1983) technological analysis is of considerable significance in demonstrating the technological system of which Plainview points form a part. Similar technological studies of other late Paleoindian samples are needed.

Plainview Sites in the Central Plains.

Red Smoke, Nebraska. The Red Smoke site, 25FT42, has perhaps the best known and documented Plainview assemblage in the Central Plains region (Davis 1951, 1952, 1953a). This deeply stratified and multicomponent site on the north bank of Lime Creek in the Medicine Creek Reservoir area of Frontier County, southwest Nebraska was excavated between 1947 and 1952, with the primary work done between 1949 and 1952 under the direction of E. Mott Davis (Davis 1953a). More than 90 m^2 were excavated from Zone 88 which was the primary occupation level at the site and which produced the Plainview points and fragments. The occupation surface was approximately 30 cm thick and consisted of many dense concentrations of knapping debris of Niobrara jasper. Some concentrations of bone and a few surface hearths were also reported. The primary activity at the site appears to have been flint working and perhaps retooling of equipment. Many bifaces, cores, flakes, and much reduction debris was found as well as dozens of formal artifacts. The projectile points are compared to the specimens from the Meserve site in Hall County, Nebraska, and primarily to the Plainview type first identified at the Plainview bison kill in west Texas. The Meserve points from Red Smoke are argued by Davis to represent reworked Plainviews. The beveled blade edges on these specimens suggest use as knives, and they show a distinct type of blade reworking that is not common on early Paleoindian points from the Plains but is common on Dalton points on the eastern Plains margin (Myers and Lambert 1983).

Agate Basin Complex

The Agate Basin complex is named for the Agate Basin type site in eastern Wyoming (Roberts 1961) which was also referred to as the Brewster site (Agogino 1972). The complex is most well known from research at the Agate Basin site (Frison and Stanford 1982) and at the Hell Gap site located about 110 km southwest of Agate Basin (Irwin-Williams et al. 1973; Irwin 1968). Additional important sites include the Frazier site near Kersey, Colorado (Cassells 1983; Malde 1988; Wormington 1988). At present no Agate Basin assemblages are reported from Kansas or Nebraska, although Agate Basin projectile points have been found throughout the region (Brown and Logan 1987; Bozell 1994; Barbour and Schultz 1936), including western Iowa (Anderson and Semken 1980) and Oklahoma (Wyckoff 1985, 1989b).

The age of Agate Basin components overlap with Folsom, Plainview, and Hell Gap dates, and range from about 10,500 to 9,500 years ago (Frison 1991b:Table 2.2). Two radiocarbon dates are available on soil humic acid from a unit immediately overlying the Agate Basin stratum at the Frazier site but have been reported differently and often incorrectly by different authors (cf. Cassells 1983; Greiser 1985:Table 7; Gunnerson 1987; Haynes and Hass 1974; Wheat 1979). The dates are 9650 ± 130 (SMU-31) and 9550 ± 130 (SMU-32) (Haynes and Hass 1974). These provide minimum ages for Agate Basin in the Central Plains region.

The diagnostic features of Agate Basin points include their generally long lanceolate shape, rounded to straight base, and relatively thick biconvex cross section. Discussion of Agate Basin technology is provided in Bradley (1991), Frison and Bradley (1982), and Shelley and Agogino (1983).

Central Plains Agate Basin sites

Frazier, Colorado. The Frazier site is located on the Kersey terrace on the south bank of the South Platte River in Weld County, Colorado. This bison bonebed may represent a processing area and at least 43 animals are represented based on left astragali (Wormington 1988:82). Limited remains of deer and canid are also reported (Greiser 1985:69). Excavations were directed by Marie Wormington between 1965 and 1967 exposing an area of about 288 m^2. Season of death was apparently winter to early spring (Todd et al. n.d.). The tool assemblage of about 93 specimens includes 10 Agate Basin points and fragments (see Cassells 1983:Figure 5.8; Greiser 1985:Figure 23a,b), endscrapers, side scrapers, bifaces, notches, spurs, beaks, and denticulates (Wormington 1988; Irwin and Wormington 1970). A few possible modified bone pieces or bone tools may be represented. Several small concentrations of debitage were also recorded in the bonebed and probably primarily reflect resharpening of tools. Lithic materials include quartzite, jasper, Flattop chalcedony, and a significant percentage of Alibates flint.

Allen Site, Nebraska. The Allen site, 25FT50, is located in the Medicine Creek Reservoir in Frontier County and was excavated between 1947 and 1949 primarily under the direction of Preston Holder and Joyce Wike (Holder and Wike 1949). Two primary occupation levels were identified and correlate with buried soils separated by about 45 cm of lighter colored sediments with minimal cultural materials. This was referred to as the Intermediate Zone sandwiched between the lower Occupation Level I (15-20 cm thick) and the upper Occupation Level II (12-18 cm thick). All three units were buried below about 6 m of terrace fill on Medicine Creek (Holder and Wike 1949:260-261). Radiocarbon dates and projectile points indicate the occupation levels reflect Paleoindian activity, but the cultural affiliation and precise chronology remain somewhat problematic. Bamforth (1991a:361) suggests that the projectile points from the lower occupation are referable to the Agate Basin type, but that obliquely flaked lanceolate points are also in the site collection and may be from Occupation Level II. Available radiocarbon dates suggest that possible Agate Basin and later components are present, and the site is included here with Agate Basin for convenience until final assessment has been made.

Occupation Level I yielded 68 artifacts, evidence of nine hearths, and the majority of faunal material from the site (Holder and Wike 1949:261). Level I excavation included 15.37 m^3 of matrix, compared to 46.1 m^3 from the Intermediate Zone and 18.37 m^3 from Occupation Level II. Level II held evidence of 10 hearths and 26 artifacts. The projectile points are lanceolate and at least some have thinned bases. They were initially compared with the Plainview type (Holder and Wike 1949:262), Wedel (1986:70) compares them with the Angostura type, and Bamforth (1991a:361) suggests that at least two specimens are Agate Basin points and others are obliquely flaked and so share at least this attribute with points in the Frederick/Allen complex discussed below.

Radiocarbon dates include three reported by Libby (1955; and Wedel 1986:71; Wormington 1957:138), which are not very consistent and have large standard deviations. These charcoal dates are 10,493 ± 1500 (C-470) and 8274 ± 500 (C-108a) from Occupation Level I and 5256 ± 350 (C-65) on a combined charcoal sample (Wormington [1957:138] indicates this date is based on soil) from both occupation levels. Reports on the associations and derivation of these dated samples are conflicting (Wormington 1957:138). New dates reported by Bamforth (1991a:360-361) for both occupation levels are more consistent, though still having large deviations. The new Occupation Level I dates are 10,260 ± 360 B.P. (TX-6596) and 10,600 ± 620 (TX-6594) which are comparable to the oldest of the previously run samples and are in general accord with other dates on Agate Basin (Frison 1991a). The Occupation Level II date is 8680 ± 460 (TX-6595), which is late for an Agate Basin date but is in agreement with dates on obliquely flaked lanceolate points from other sites (Frison 1991b) as discussed below (see Bamforth 1991a).

Projectile points await detailed description and comparison, but Bamforth (1991a:361) identifies two Agate Basin points from Occupation Level I. Unprovenienced points include specimens with parallel oblique flaking. Holder and Wike (1949:262) indicate that the points and fragments were about evenly distributed between the upper and lower occupation levels. Numerous bifaces representing biface reduction were recovered from the site and reflect the intensive use of the locally available Niobrara or Republican River jasper. Bamforth (1991a:362) reports that most of the bifaces represent early stage reduction, mostly stage 2 in Callahan's terminology. There were 94 (68.6%) stage 2 bifaces, 34 (24.8%) stage 3 bifaces, and only 9 (6.6%) stage 4 bifaces. Twenty points and fragments, a few drills, 144 worked pieces and flake tools, and 29 trapezoidal scrapers were recovered. This last category includes specimens comparable to Clear Fork gouges from Texas and Oklahoma (Hofman 1978) and Munkers Creek gouges from Archaic sites in eastern Kansas (Witty 1982). Such tools occur in late Paleoindian contexts in Texas at several sites (Turner and Hester 1994; Birmingham and Hester 1976). The Allen site assemblage also includes eyed needles, bone awls, abraders, hammerstones, and a grooved spherical piece of Niobrara chalk which is suggested to have been a bola stone.

Faunal material is primarily from the lower occupation level and includes bison, antelope, deer, coyote, rabbit, mice, prairie dog, and rare beaver and fish. Some reptiles, amphibians, and birds are also represented as are freshwater mussels. Fauna from Occupation Level II was limited essentially to bison. Whether some of this assemblage may represent naturally occurring background fauna is uncertain, but Holder and Wike (1949:261-262) indicate that almost all of the large mammal bone had been modified by breakage, cutting, or other activity. Hackberry seeds and small gastropods also occur but are not attributed to human activity. Numerous nests of mud dauber wasps were also found and it has been suggested that they were used as food (Wedel 1986:71), and that they reflect the presence of structures at the Allen site. It is certainly possible, however, that the nests were built against nearby rock exposures or cutbanks along the creek. Though no structural remains were found, numerous surface hearths were documented. These ranged from intensively to lightly used and indicate repeated and perhaps intensive occupation. Holder and Wike (1949:262) refer to "windrows of broken and disarticulated bone scattered along the old surface" of Occupation Level I. These may reflect some natural formational features at the site which could result from erosional processes. These "features" were apparently separated from the hearths. The ongoing study and evaluation of the Allen site by Bamforth and his colleagues will aid considerably in improving our understanding of the site and its potential relationship with the Agate Basin and other complexes.

Hell Gap Complex

The Hell Gap complex is named for the Hell Gap site located near Guernsey in eastern Wyoming (Irwin-Williams et al. 1973; Irwin 1968; Sellet and Frison 1994). This is an important stratified campsite in a protected canyon/foothills setting. Several distinct occupation areas and cultural units ranging from Goshen to Lusk are represented. Stratigraphic evidence here and at the Agate Basin site as well as radiocarbon dates indicate that Hell Gap assemblages are slightly younger than Agate Basin ones and generally date between 10,100 and 9600 B.P. (Frison 1991b; Frison and Stanford 1982; Irwin-Williams et al. 1973).

Other reported Hell Gap sites include Sister Hill, a campsite in northern Wyoming (Agogino and Galloway 1965); Casper, a bison kill in a sand dune situation in central Wyoming (Frison 1974); and Seminoe Beach (Miller 1986), a camp and workshop site. Hell Gap points are reported throughout the Central and Southern Plains region (Brown and Logan 1987; Mallouf 1990; Polyak and Williams 1986; Thurmond 1990), but documented assemblages south of Kansas are not known.

Central Plains Hell Gap Sites

Jones-Miller Site, 5YM8. In the Central Plains, the best known Hell Gap site is Jones-Miller (Stanford 1974, 1975, 1978, 1979b, 1984), an extensive bison kill located in eastern Colorado near the Kansas and Nebraska state lines. The site is on a terrace of the Arikaree River, a few miles downstream (east) from the historic Beacher's Island battle site, and was discovered by the late Robert Jones in 1972. Jones-Miller is in many ways one of the more important bison kill sites yet reported from the region (Stanford 1978, 1979b, 1984; Todd and Stanford 1992). The site is an extensive bonebed estimated to contain more than 250 bison representing at least two kill events which occurred during the winter. A radiocarbon date of 10,020 ± 320 (SI-1989) is available for the site. Lithic materials include a significant amount of Niobrara (Republican River) jasper perhaps from sources in the area of the Tim Adrian or Walsh sites in Kansas. Also Flattop chalcedony with its source near Sterling, Colorado was a significant source for the Jones-Miller site assemblage and Alibates flint from the Texas Panhandle is also represented. The materials may have been introduced to the site when the group making the kills was moving from different directions. Several hearth areas are present around which various flint knapping and bone processing activities were conducted. There is no evidence for a post corral, but it is possible that deep snow, logs, or brush was an aid in entrapping or containing the bison in this limited area.

An important feature near the center of the bonebed at Jones-Miller was a postmold (22 cm in diameter and 46 cm deep), next to which was found a miniature Hell Gap point, a bird bone probably representing a flute, and remains of a butchered dog. This feature has been interpreted to represent a shaman's "medicine" pole analogous to those reported in early historic time for other Plains groups.

Tim Adrian Site. In northwestern Kansas, O'Brien (1984a) reported the Tim Adrian site which is a lithic quarry/workshop with Hell Gap evidence at a Niobrara jasper source in Norton County. A Hell Gap point and a number of tools were found with an abundance of workshop debris. It is notable that numerous Hell Gap points made from Niobrara jasper have been identified in museum and private collections in western Kansas. On the Saline River in the northeastern Grove County area, a cache of large jasper bifaces (the Walsh cache) which appear to be early stage Hell Gap points is also known (Stanford 1984).

Gordon Creek Site. The Gordon Creek burial (Breternitz et al. 1971; Cassells 1983) is one of the few Paleoindian-age human burials documented in the Plains region (Table 20). This burial, considered by Irwin (1971) as possible Agate Basin age, has been radiocarbon dated to 9700 ± 250 (GX-0530). The remains of a 25-30 year-old female about 152 cm tall (a little under 5 feet) were discovered in this isolated burial in north-central Colorado, northwest of Fort Collins. The body was in a flexed position and was covered with red ochre. A fire on or near the body destroyed some of the evidence but is believed to have been part of the burial process or ritual. A number of artifacts were recovered with the remains, but none were diagnostic. They included three bifaces, a hammerstone, an endscraper, utilized flakes, a smoothed stone, cut bones, and perforated and broken elk teeth. Whether these materials were personal possessions or offerings, or both, is unclear.

Table 20. Paleoindian Human Remains and Burials in the Plains.

Site/Location	Position	Ochre	Complex	Dates	Source
Anzick, MT?		yes	Clovis		a
Gordon Crk, CO	flexed	yes	Hell Gap?	9,700	b
Browns Valley			yes	Plano	c
Shifting Sands	?		?	Folsom?	d
Scharbauer	?		?	Midland?	e
Renier	cremated		Cody		f

Sources: a. Lahren & Bonnichsen 1974; Jones & Bonnichsen 1994; b. Jenks 1937; c. Jenks 1937; d. Hofman et al. 1990; e. Holliday and Meltzer 1993; f. Mason and Irwin 1960.

Angostura Complex

Excavation in the Angostura Reservoir of South Dakota at the Long site in 1948 (Hughes 1949) yielded evidence of an early component(s) with lanceolate points originally named Long points. The site is located approximately 55 km east of the Agate Basin site. After continued fieldwork in 1949 and 1950, the point type was renamed Angostura (Wheeler 1954a, 1957). Three primary excavation areas were opened at Ray Long (Wheeler's final report has recently been published, 1995). A variety of tools and hearth areas were recovered. Wormington (1957:139) illustrates a specimen which has generally been assumed to represent a classic Angostura point but which is actually distinct from the specimens from the Long site (Hannus 1986:Figures 10,11). Wormington (Wormington and Forbis 1965:22-23) later concluded that the specimens from the Long site were not typologically like Angostura but more similar to Agate Basin. She encouraged the abandonment of the type Angostura until a more detailed report on the Long site specimens was available. She further suggested that many specimens previously referred to as Angostura were more appropriately classified as Frederick based on research at the Hell Gap site. About the same time, others (Agogino and Rovner 1964) argued for the distinctiveness of the Agate Basin and Angostura types, and in so doing gave continued reason to distinguish the latter type.

Radiocarbon dates from the Ray Long site do little to clarify the situation. Two dates of 7073 ± 300 (C-604) and 7715 ± 740 (C-454) are on charcoal but not clearly associated with Angostura points (Thoms 1993:19). A third date, 9380 ± 500 (M-370), is a composite charcoal date from a zone which produced Angostura points in place. This latter date is certainly in the right order of magnitude given information on other late Paleoindian site chronology.

Reinvestigation of the Ray Long site between 1985 and 1994 by Hannus (1986) has focused on the stratigraphic, geomorphic, and paleoecological aspects of the site area. This has added substantially to an understanding of the stratigraphic and formational history of the site and the relevance of the three original radiocarbon dates but has not fully clarified the typological problems. The site's stratigraphy is complex and continued investigations should provide clarification of the cultural and geologic layers. Multiple occupational surfaces and hearths are indicated, and a series of four new radiocarbon dates indicate that a pre-Angostura component is probably represented (Hannus 1986:Table 1). The new dates from hearth features in Trench F, just east of Area B excavated by Wheeler, indicate that multiple cultural components are probably represented. The dates, 8950 ± 140 (I-14239), 9540 ± 540 (I-14240), 10,400 ± 360 (I-14245), and 11,000 ± 310 (I-14241), are not yet associated with diagnostic artifacts but are derived from charcoal. The three oldest dates are from features at the base of Trench F at a depth of more than 2 m below the surface. A hearth and Clovis point base were recently discovered below the Angostura level (A. Hannus, personal communication, 1995). The younger date, perhaps of Angostura age, is from about 1.5 m below surface and compares fairly well with previous dates from the site.

The relationships between the Long site Angostura points need to be critically compared based on technology and metric information with Agate Basin and Frederick point samples. Recent investigation at the Richard Beene site in Texas (Thoms 1993) has finally provided some well-controlled assemblage information on Angostura material from Texas, where the type is commonly reported and even divided into several varieties (Turner and Hester 1993; T. C. Kelly 1982; Thurmond 1990:Table 5, Figure 10), but where discrete assemblages have been essentially unreported. Some of the original Ray Long site diagnostic artifacts have been lost, but casts of some points are still available (Hannus 1986). Based on his recent reinvestigation of the site and available collections, Hannus (1986:96) writes, "Due to the limited number of points available, it is still premature to render a conclusive statement as to whether angostura as a Type is to be considered valid, or whether it should be discontinued to be subsumed under the Agate Basin complex of projectile points as a local variant, or be considered closer in affiliation to the more recent Frederick or Lusk types." One of the largest assemblages of projectile points considered to represent the Angostura type is from the Travis 2 site (39WW15) near Mobridge, South Dakota (Ahler et al. 1977; Toom 1994). This distinctive assemblage from a deeply stratified site may provide some critical insights into the Angostura cultural complex.

Cody Complex

The variety of sites and projectile point types which constitute the Cody complex represent a significant portion of the Paleoindian archeological record in the Plains and Rocky Mountains region. Cody complex is a term suggested by Wormington (1957:136) to designate the range of artifact types including Eden, Scottsbluff, and Cody knives which are believed to be closely associated based on research at the Horner site near Cody, Wyoming (Jepsen 1953; Frison and Todd 1987), the Finley site near Eden, Wyoming (Frison 1991b; Howard 1943; Moss et al. 1951; Satterthwaite 1957), Claypool, Colorado (Dick and Mountain 1960; Wheat 1972; Bradley and Stanford 1987), and elsewhere. The discovery of a Cody knife with the Alberta assemblage from the Hudson-Meng site in northwestern Nebraska, provided support to the argument that the Alberta complex should also be included with Cody (Agenbroad 1978a, 1978b). More recent technological analyses (Bradley and Frison 1987; Bradley and Stanford 1987; Ingbar and Frison 1987; Huckell 1978; Read 1982; Wheat 1972, 1976, 1979) indicate that the typological relationships are complicated, and there are multiple models of the technological and historical relationships of the types in the literature.

At least 10 projectile point types have been defined which are considered to be part of the generalized Cody complex or technological tradition as envisioned here. These types include Alberta, Scottsbluff I, Scottsbluff II, Eden, Alberta/Cody I, Alberta/Cody II, San Jon, Firstview, and Kersey (see Table 21). In addition, at least two forms of Cody knives are recognized

Table 21. Cody Complex Projectile Point Types and Sources.

Type	Sites	Sources
Alberta	Hudson-Meng	Agenbroad 1987,Huckell 1978
Scottsbluff I	Claypool/Horner	Dick & Mountain 1960; Bradley & Frison 1987
Scottsbluff II	Larson Cache	Ingbar & Frison 1987
Scottsbluff III	Finley?	Satterthwaite 1957;Wheat 1972
Eden	Claypool/Finley Horner	Dick & Mountain 1960; Satterthwaite 1957
Firstview	Olsen-Chubbuck	Wheat 1972
Kersey	Jurgens	Wheat 1979
Alberta/Cody I	Horner I and II	Bradley & Frison 1987
Alberta/Cody II	Horner II	Bradley & Frison 1987
San Jon	San Jon, N.M.	Roberts 1940
Cody Knives	Horner, Claypool	Bradley & Frison 1987
	Hudson-Meng	Dick & Mountain 1960; Agenbroad 1978b

(Bradley and Frison 1987). The primary sources for description of the Cody point types can be found in Wormington (1957), Wheat (1972, 1979), and Bradley and Frison (1987). Also, important discussions or assemblage descriptions include Agenbroad (1978a), Agogino et al. (1976), Bonnichsen et al. (1992), Bonnichsen and Keyser (1982), Davis (1962), Ebell (1988), Fulgham and Stanford (1982), Forbis (1968), Forbis and Sperry (1953), Frison (1984), Greiser (1985), Huckell (1978), Knudson (1983), Mason and Irwin (1960), Meyer 1985, Schultz and Eiseley (1935), Stanford et al. 1981, Stanford and Patten (1984), and Wormington and Forbis (1965).

For purposes of this review, I follow primarily the classification of Bradley and Frison (1987). They include Scottsbluff I and Eden points and Cody knives as part of the traditional Cody cultural complex as defined by Wormington (1957). Bradley and Frison also argue that the variability represented by Firstview and Kersey points can be easily accommodated by the reduction technology and hafting or rehafting of Scottsbluff and Eden points (also Bradley and Stanford 1987). I agree with this grouping as do several other investigators (Stanford and Patten 1984; Fulgham and Stanford 1982; Bradley and Stanford 1987; and cf. Greiser 1985:76). They also refer to this traditional Cody complex as the Scottsbluff/Cody technology. They see the Alberta/Cody point types as intermediate technologically (and chronologically ?) between Alberta and Scottsbluff/Cody. Bradley and Frison (1987:229) indicate that a larger generalized Cody complex or technological tradition might be recognized, but they emphasize that the Scottsbluff/Cody and Alberta/Cody types are technologically distinctive and readily recognizable and provide an opportunity to trace the technological development of the Cody complex. For present purposes, I have included all these types, including Alberta, within the Cody complex which might be thought of as a technological tradition and type cluster.

The spatial distribution of point types at the Horner site and the radiocarbon dates available from there also help in untangling the technological and chronological relationships between Cody industries. Horner I, excavated as two discrete areas in 1949, 1950, and 1952 in the northern portion of the site complex, yielded distinctive assemblages. The South excavation (1949, Area 1 of Horner I) and North (1950, 1952, Area 2 of Horner I) excavations had radically different frequencies of projectile point types. The North (1950, 1952) Area 2 excavation yielded almost exclusively Eden points (16 of 19 from the Horner I excavations), while the South (1949) Area 1 excavation had mostly Scottsbluff points (10 of 13 from Horner I). Furthermore, no Eden or Scottsbluff points were recovered from the Horner II (1977, 1978) excavation located 35 to 40 m south of the 1949 excavation. In the Horner II excavation, only Alberta/Cody points were recovered and radiocarbon dates indicate that this area is as much as 1,000 years older than the Horner I assemblages (Frison and Todd 1987). In addition, Alberta/Cody points were common (19 of 21 from the Horner I areas) in the 1949 excavation at Area 1 of Horner I where Scottsbluff points were also common. Whether there is a significant age difference between Areas 1 and 2 of Horner I remains unclear. The spatial evidence suggests a close relationship between Alberta/Cody and Scottsbluff types and technological analyses indicate close links between Alberta/Cody and Alberta points and between Scottsbluff and Eden points (Bradley and Frison 1987). Scottsbluff and Eden points occur together at the Finley (Moss et al. 1951), Carter/Kerr-McGee (Frison 1984) and Claypool sites (Dick and Mountain 1960).

The Cody complex, then, is not as simple a taxonomic grouping as it once was, nor is it well understood throughout the Plains region as a whole. It is apparent, however, that there is both chronological and technological variability represented in the Cody cultural complex or technological tradition as reflected by the diagnostic projectile point types. The interpretation of this variability is somewhat limited by inadequate chronological control for most assemblages, including that from the Horner site (Frison 1987).

Radiocarbon dates from Horner, Finley, Jurgens, Dreier-Frasca, Hudson-Meng, and Olsen-Chubbuck indicate a time frame of 10,000 to 8,800 years ago for the Cody complex (Frison 1987:105, Table 4.1). A date from the Mammoth Meadow site in Montana, 9390 ± 90 (T0-1976), also supports this time frame (Bonnichsen et al. 1992). On the Southern Plains, radiocarbon dates for Firstview levels from the Lubbock Lake site indicate a similar time span (Holliday et al. 1985; E. Johnson 1987).

Cody complex radiocarbon dates for the Central Plains are listed in Table 22. The earliest date in the region is from Olsen-Chubbuck and is 10,150 ± 500 B.P. based on bone (Wheat 1972). This date has generally been considered as too early, but radiocarbon dates on bone in the region generally date too recent, not too old. Also, the early dates now available from Horner (Frison and Todd 1987) and Hudson-Meng (Agenbroad 1978a; Todd and Rapson 1991), which average about 9700 B.P., indicate that the Olsen-Chubbuck dates may not be too old (within one sigma). If correct, then the relatively contemporary technological variability in Cody assemblages (Alberta, Scottsbluff, Alberta/Cody) offers some interesting explanatory problems. What is the significance of lithic material quality, variability, social groups, and perhaps even knapping specialists during Cody times? Dates from other Central Plains Cody components Frasca, Nelson, Wetzel, Caribou Lake, and Lamb Spring are younger by 1,000 or more years than the Olsen-Chubbuck date. The Lime Creek, Nebraska date is closer (9524 ± 450 B.P.), but it is not unquestionably of Scottsbluff age. A similar divergence is evident in the dates from the Horner I and Horner II sites (Frison and Todd 1987) and is at least in part attributable to bone dates that are too young based on direct dating of whole bone (cf. Stafford et al. 1991).

Table 22. Radiocarbon Dates for the Central Plains Cody Complex.

Site	Complex	Date	δ	Lab No.	Reference
Olsen-Chubbuck	Firstview	10,150	500	A-744 bone	Wheat 1972
Jurgens 3	Cody	9070	90	SI-3726	Wheat 1979
Caribou Lake	Cody	8460	140	I-5449 charcoal	Benedict 1974
Frasca	Cody	8910	90	SI-4848	Fulgham & Stanford 1982
Lamb Springs	Cody	7870	240	SI-45 bone	Fisher 1992
	Cody	8870	350	M-1463 bone	Fisher 1992
Wetzel	Cody	7160	135	SI-4849 bone	Cassells 1983
Nelson	Cody	7990	80	SI-4898 bone	Cassells 1983
Hudson-Meng	Alberta	9820	160	SMU-224 charcoal	Agenbroad 1978a
		8990	190	SMU-52 bone apatite	
		9380	100	SMU-102 bone collagen	
Lime Creek		9524	450	C-471 charcoal	Wedel 1986

Additional information on the Cody occupation of the Plains region is documented at the Mammoth Meadows site (Bonnichsen et al. 1992) where remains of a possible Cody rectangular structure with stone-lined walls is reported. Within this feature was found a concentration of red ochre. Ochre was also found covering the surface of several Cody artifacts. Evidence of a possible semicircular stone lined structure is also reported by Stanford and Patten from the R-6 lithic workshop and campsite in northeastern New Mexico. A Scottsbluff burial is reported by Mason and Irwin (1960) from the Renier site in Wisconsin which consisted of a cremation and associated projectile points.

The economy of Cody tradition people was focused on bison, but a variety of other species are represented from sites such as Mammoth Meadows (Bonnichsen et al. 1992), Medicine Lodge Creek (Frison 1991b; Walker 1975), and Lime Creek, Nebraska (Davis 1962). Bison kills range from a few to several hundred bison and were made throughout the year (Bonnichsen et al. 1987; Todd 1991). Seasonality of Cody bison kills is as follows (Todd 1991:Table 11.1): Scottsbluff, late spring-summer; Olsen-Chubbuck late summer-early fall; Hudson-Meng fall; Finley, Horner I, and Horner II late fall to early winter; and Carter/Kerr-McGee early winter. The traditional interpretation that bison kills occur primarily in the late fall or winter (e.g. Bamforth 1988, 1991b) simply does not hold for this significant part of the Paleoindian record.

Several Cody complex sites in the Central Plains region have received detailed investigation. Numerous other sites are known or reported based on limited surface finds or severely mixed components (Greiser 1985).

Central Plains Cody Complex Sites

Scottsbluff Site. This is the type site for the Scottsbluff point type, but interestingly, only one of the eight artifacts is a complete Scottsbluff I type point (Barbour and Schultz 1932; Schultz and Eiseley 1935). Three other points were found, one is most similar to Plainview, one compares to the Scottsbluff II type, and the last is a tip fragment. Four tools were also collected from the bonebed. The bonebed was a relatively thick deposit and an MNI has not been established, nor is it clear whether one or multiple kill events are represented. Season of the kill(s) has been determined based on tooth eruption and wear to have been late spring to summer (Todd et al. 1990).

Claypool Site. This site is located in a dune field in Washington County, Colorado. The primary document on this important surface collection is Dick and Mountain (1960; Malde 1960; see also Wormington 1957), but subsequent geological investigations are reported by Stanford and Albanese (1975), and additional artifact analysis is provided in Bradley and Stanford (1987). The site collection was made primarily by Bert Mountain and Perry Anderson with limited excavation in 1953 by the University of Colorado (Dick and Mountain 1960). The site has been interpreted as a camp rather than a kill situation (Dick and Mountain 1960:225). The assemblage is dominated by "square-based" points (Bradley and Stanford 1987) of the Eden and Scottsbluff types (about 60), but a small number (N=15) of non-Cody complex points were also found, including Clovis, Folsom, Midland, Plainview, Hell Gap, Agate Basin, and a few Archaic points. Cody knives are also well represented, and there are a variety of scrapers, drills, and other tools. A bonebed was also present at the site but was severely deteriorated and unstudied. The lithic material at Claypool includes a number of pieces which are similar to Madero formation chert, comparable to that which dominates the R-6 workshop/campsite assemblage in northern New Mexico (Stanford and Albanese 1975; Stanford and Patten 1984). Also, the Eden/Scottsbluff technology at Claypool is very similar to that from the Horner I site (Bradley and Frison 1987).

Hudson-Meng Site, 25SX115. Hudson-Meng, located northwest of Crawford in Sioux County, Nebraska, is the largest Paleoindian-age bison bonebed known in the New World (Agenbroad 1978a). Hundreds of bison are represented in association with a relative few Alberta projectile points and tools. Testing at the site began in 1968 and more intensive work was conducted from 1971 through 1975. Remains of about 400 animals (MNI of 396 for humerus and tibia, Agenbroad 1978a:Table 1) were documented and it is estimated that as many as 600 animals may be represented at the site. It is unclear how many kill events may be represented, but the season of death was fall. It is interesting that only 20 projectile points were recovered from the excavated area, a small number given the number of animals present. One Cody knife (Figure 31), three gravers, 14 flake knives, one preform and three scrapers were also found in the bonebed excavations (Agenbroad 1978a:85). More than 600 m² was excavated and there was more than 100 m² of trenches and tests, and it is notable that it was the fourth year of testing before an artifact was found in situ with the bones (Agenbroad 1978a:5, 9).

Continued research at the Hudson-Meng site since 1991, supported by the U.S. Forest Service to enhance potential site development, has been directed toward a more complete understanding of the site's formation history and processes of bonebed formation and subsequent modifications (Todd and Rapson 1991). The initial puzzle of why skulls were so rare at the site has been resolved through detailed taphonomic study. The dense inner ear, petrous portion of skulls is well represented, but the less durable cranial elements have been lost to deterioration due to their higher than average "weathering profile." When the majority of carcass elements became buried, the crania were generally left exposed and suffered more prolonged weathering by comparison to other flat-lying elements (Todd and Rapson 1991). The puzzle as to how the bison were killed and how many kill episodes may be represented remains, despite continued investigation of the site geomorphology and paleotopography. A series of new radiocarbon dates generally support the previous dates and indicate that the bonebed dates to about 9700 B.P. The artifacts found in the recent excavations have occurred several centimeters above the bone level.

Lime Creek Site, 14FT41. Lime Creek is one of three important and deeply buried Paleoindian sites in the Medicine Creek drainage (Wedel 1986; Davis 1953a, 1962; Bamforth 1991a; Holder and Wike 1949). Lime Creek represents a camp and lithic workshop which was exposed by creek bank erosion, and the primary cultural level Zone I was buried nearly 14 m below the surface (Davis 1962). Dynamite and bulldozers were used to remove overburden in order to gain access to the cultural levels prior to flooding of the site by Medicine Creek Reservoir.

This location yielded diagnostic Cody complex projectile points and fragments in occupation Zone I. One of these was originally referred to as a Milnesand point (Davis 1962), but the form and distinctive flaking conforms well with points from other Central Plains Cody assemblages such as Claypool. Numerous projectile point preforms originally called "Lime Creek Knives" were recovered from the site, and the Zone I occupation can best be interpreted as a workshop and camp location (Wedel 1986:Plate 4.4). The site is located near Niobrara jasper outcrops, and this was the dominant material represented in lithic artifact assemblage (Davis 1962:41).

Of the more than 200 artifacts reported from the site (excluding lithic debitage), 158 are from Zone I, and these include a variety of scrapers, bifaces, preforms, flake tools, cores, and several ground stone pieces (Davis 1962:Table 1). An area of approximately 133 m² was excavated in Zone I. Fauna from Zone I is dominated by antelope and beaver, but bison is most common in the higher later Paleoindian component of Zone III. Limited bones of bison, deer, elk, prairie dog, gopher, jackrabbit, raccoon, and coyote or dog are also present in Zone I. Beaver may have been emphasized because of their pelts or fat as the site was occupied during winter when fats and warm clothing would have been at a premium. Bison from Zone I are interpreted as *Bison antiquus,* but the sample is small. Bison remains were apparently the only bones recovered from Zone III. The Zone III bison are also noted to have been larger than those from Zone I (Davis 1962:29); this may simply reflect sexual dimorphism, small samples from Zone I, or seasonal differences in herd composition and site use (cf. Speth 1983).

A radiocarbon date of 9524 ± 450 (C-471) was derived on charred wood from Zone I. Zone III received less intensive study but contained a later Paleoindian component(s) which included a Plainview-like point, a square-based point, and an obliquely flaked lanceolate which is most comparable to Frederick and Allen material. This provides support for evidence from other locations, such as Hell Gap, Wyoming, where Frederick postdates Cody material (Irwin-Williams et al. 1973).

Olsen-Chubbuck Site. Perhaps more than any other site, Olsen-Chubbuck has served to characterize the nature of Paleoindian bison hunting in the Great Plains region as detailed in numerous archeology text books and summaries. This is in large part due to the innovative, creative, and detailed analytical approach brought to the site by Joe Ben Wheat (1972). Wheat's research at Olsen-Chubbuck helped demonstrate the critical importance of bonebeds, and not just the artifacts in them, as an interpretive resource which can contribute to an understanding of the archeological record and prehistoric behavior (also Frison 1970, 1974; Frison and Todd 1987; Reher and Frison 1980). Olsen-Chubbuck is located in Cheyenne County, Colorado near the communities of Kit Carson and Firstview. The excavation was conducted between 1958 and 1960 following initial testing by Jerry Chubbuck and Sigurd Olsen. About 80 m² were excavated along an ancient arroyo which had been used to trap the bison as they stampeded across it. About 190 bison were killed in this location during the late summer or early fall (Wilson 1974). The bison were apparently stampeded across the arroyo from northwest to southeast where many were killed or trampled and speared. Interesting patterning is evident in the butchering and sorting of carcass portions along the bonebed.

Sixty artifacts were recovered from the bonebed and immediate vicinity, of which 27 are projectile points and fragments. This is a ratio of only 0.14 points per bison (27/190) which suggests fairly good recovery of weapon tips and perhaps that many animals died from the fall or trampling. Lithic materials represented include Knife River flint from western North Dakota and Alibates flint from the Texas Panhandle. The projectile points from Olsen-Chubbuck were used by Wheat as the basis for defining the Firstview type, which others believe to fall within the technological and morphological range of Eden and Scottsbluff (Bradley and Stanford 1987; Bradley and Frison 1987). The sample compares well with that from Claypool, which Wheat refers to primarily as San Jon points, and to Lime Creek, Nebraska, MacHaffie, Montana, and San Jon, New Mexico. The San Jon points have minimal shoulders often apparently produced only by grinding, whereas the Firstview points lack obvious shoulders. All fall within the "square-based" points discussed by Bradley and Stanford (1987).

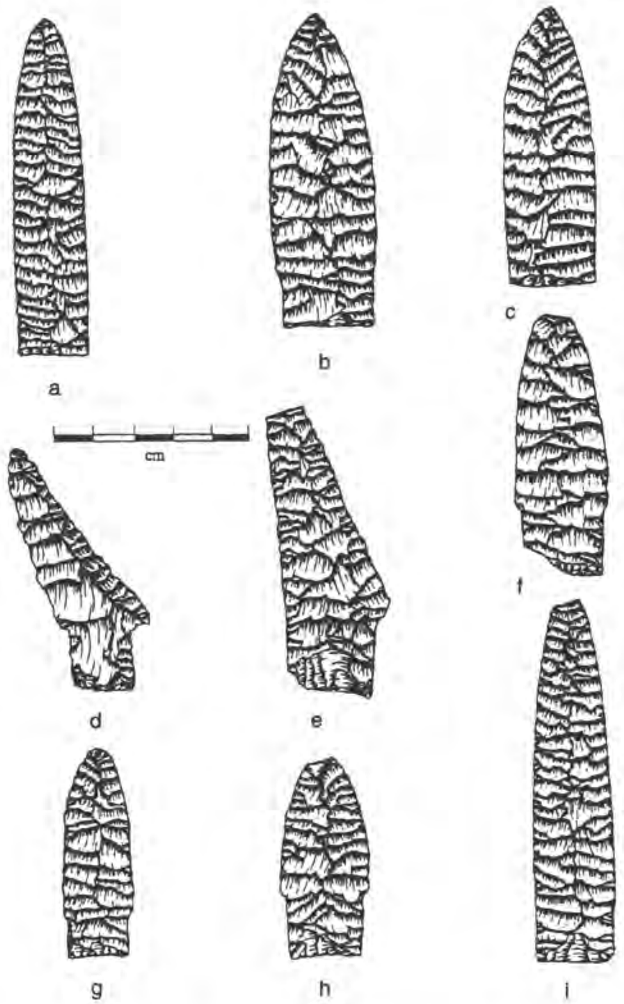


Figure 31. Cody complex artifacts from the Central Plains. a-c. Olsen-Chubbuck site points, CO; d. Cody knife, Hudson-Meng site, NE; e. Cody knife, Claypool site, CO; f. Scottsbluff point, Lime Creek site, NE; g-i. Jurgens site points, CO.

Other artifacts include a few endscrapers, side scrapers, and flake tools, several of which were manufactured from Alibates flint. A hammer/anvil stone and a piece of limonite were collected and a few bone artifacts are represented including a possible needle preform.

A single radiocarbon date on bone is available for the Olsen-Chubbuck site. This date, 10,150 ± 500 (A-744) is at the early end of the available Cody complex dates. New bone dates are being assayed at present.

Jurgens Site. Jurgens is a complex of three activity areas or artifact concentrations located on the Kersey terrace of the South Platte River near the town of Kersey in northeastern Colorado (Wheat 1979). Excavations were conducted by Wheat during 1968 and 1970, revealing three distinct areas associated with bison processing and camp activities. A total of 248 m² was excavated in the main areas at Jurgens with numerous additional corings and tests. The recovered artifacts totaled

2,635 including numerous surface specimens and a few bone tools. The collection includes 63 points and fragments, 32 knives of various forms which probably include points used as knives, 84 endscrapers, 23 beaks and gravers, and a variety of other chipped stone tools. More than 2,000 flakes are also represented. Interestingly, some 30 ground stone artifacts including grooved abraders, handstones, and grinding stone fragments were recovered. The ground stone pieces were primarily in the excavations (rather than surface finds) and represent one of the more diverse Paleoindian-age ground stone assemblages. Totaling the counts for the three separate areas, there may have been 68 bison represented at the site, and remains of seven or eight antelope. Numerous other vertebrate species are minimally represented. The variety of animals represented gives some support to the notion of an extended occupation at the site, or there may have been multiple occupations.

Area 1 had evidence of a wide range of activities and mostly informal tool forms with the remains of about 31 bison as well as limited remains of moose, elk, deer, pronghorn, birds, turtle, and fish. This area is interpreted by Wheat as a long-term camp, and the excavation exposed an area of 108 m². Lithic materials are dominated by Flattop chalcedony but included Spanish Diggings quartzite and a few pieces of Knife River flint.

Area 2 had remains of only two bison and numerous tools with Flattop the most common material. Alibates artifacts were included in the lithic sample of Area 2 and 3. Area 2 excavations exposed 52 m² and yielded numerous antelope bones (MNI of three antelope). The area is interpreted as a short-term camp, and a number of the ground stone tools were found here. Two flake concentrations were documented in this area, most of them preforms, several core-hammerstones, and a high frequency of endscrapers relative to bison remains. The lithic assemblage and fauna are notably different than that from the other areas.

Area 3, considered to be a processing site, yielded remains of at least 35 bison and 29 projectile points from 88 m². A few bones, 73 of 3,028, are nonbison and include antelope, deer, elk, and rabbits. Tools from Area 3 include a variety of knives, preforms, perforating tools, and debitage, but relatively few scrapers compared to the other areas and in relation to the number of bison represented. Jaspers were more important in Area 3 than either Flattop or Knife River flint.

Seasonality studies of the bison teeth have not been conducted, nor has the assemblage been investigated using current taphonomic analyses. It is very likely, however, given the shallow nature of the bonebeds and the relatively poor preservation, that the faunal assemblage recovered at Jurgens has an overrepresentation of durable high-density elements and an underrepresentation of less durable elements and elements with high "weathering profiles" (Todd and Rapson 1991), such as skulls. The interpretation of Area 3, especially, as a secondary butchering rather than kill area is questionable. Evidence from the site as a whole, however, is supportive of the interpretation of a relatively long-term and varied occupation or of multiple occupations. Projectile points are considered by Wheat to represent a distinct type which he terms Kersey and reworked Kersey points. Others have generally included these within the Cody complex and do not see a substantial difference between the Jurgens site specimens and Eden and Scottsbluff point variability. A single radiocarbon date of 9070 ± 90 (SI-3726) is available for Area 3.

Dreier-Frasca Site. The Dreier-Frasca or Frasca site is located northwest of Sterling in northeastern Colorado and was investigated in 1979 and 1980 by Fulgham and Stanford (1982). This Scottsbluff bison kill site appears to have been an arroyo trap and yielded evidence of about 60 bison with numerous articulated units. Season of the kill was winter, and a radiocarbon date of 8910 ±90 (SI-4848) is reported. Two areas of bone concentration are documented, the largest, Area 1, covers about 28 m² and is up to a half meter in thickness. Area 2 is separated by about 100 m and is a smaller thin bonebed covering about 9 m². Nearly 8,000 bones and bone fragments were recovered from Area 1 including numerous articulated units and complete carcasses of six animals. At least 56 bison are represented by the bone in Area 1, plus remains of perhaps five bison fetuses. Direct evidence of butchering is minimal. A large dog or wolf is also represented in the Area 1 fauna. Eight stone artifacts were recovered from Area 1 including seven Cody (Eden and Scottsbluff) points and fragments and a flake knife. Sixteen chert flakes were also recovered in Area 1. Lithic materials include local chert and quartzite and Flattop chalcedony probably from Flattop Butte about 35 km northeast of the site.

Area 2 produced about 190 bones with few articulations representing at least four bison. Two flakes but no diagnostic artifacts were recovered. Dentition studies and the fetuses indicate that the kill(s) occurred in winter.

Lamb Spring Site. Lamb Spring, located southwest of Denver at Littleton, Colorado, was first excavated by Wedel in 1961 and 1962 who investigated the Eden/Scottsbluff component, excavating about 216 m², and identified a potentially very early lower component. Investigations between 1979 and 1981 were directed by Dennis Stanford and focused on the lower pre-Clovis-age deposits (Rancier et al. 1982; Stanford et al. 1981; Fisher 1992) exposing about 116 m² to a depth as much as 3.5 m. The Cody component at Lamb Spring was apparently a bison kill with the bonebed situated in an old channel deposit near a spring vent. The remains of at least 22 bison are represented. Eight Cody points and fragments were recovered. Two radiocarbon dates on bone produced only one that was accepted by the researchers (Rancier et al. 1982) of 8870 ± 350 B.P. (M-1463), and a second which is somewhat young for Cody (7870 ± 240, SI-45). Overlying the Cody component(s) is evidence for Archaic (McKean complex) occupation.

Wilber Thomas Rockshelter. The lowest cultural level at Wilber Thomas Rockshelter, 5WL45, in northern Colorado south of Cheyenne, Wyoming yielded a Scottsbluff point base and a flake tool (Breternitz 1971:Figure 6) well below most other cultural material. This find, and a similar occurrence in Deluge Shelter in the Dinosaur National Monument in northwestern Colorado (Leach 1970; Cassells 1983:64), probably indicate the use of small shelters as bivouacs or temporary camps by Cody complex peoples in the central Rocky Mountains region.

Frederick/Allen Complex

In general, the latest Plains Paleoindian cultural complexes are even less well understood than the earliest ones. The period from 9,500 to 8,000 years ago was a critical one for technological, economic, and environmental change in the Plains region. During this period and soon thereafter, fundamental changes were occurring in the climate and ecology of the region and this is apparently reflected in a changed technology and settlement system during the late portion of the early Holocene. By 7000 B.P., the Central Plains region was a very different place than it had been at 10,000 years ago. The nature of the transition between the Paleoindian and Archaic cultural traditions, and the similarities and differences between these archeologically recognized groupings, remain to be adequately investigated. The latest Plains Paleoindian technological complexes are recognizable by lanceolate unfluted projectile points and other distinctive tools forms.

One of the distinctive markers of this late Paleoindian period is the common occurrence of oblique parallel flaking on lanceolate projectile points (Frison 1991b). According to Frison (1991b:74), "Angostura, Frederick, James Allen, Lusk, and others may be local or regional variants of the terminal Paleoindian manifestation for the Northwestern Plains." To this list in the Central Plains, we need to add Meserve and Dalton. The Allen and Frederick complexes are two of these late Paleoindian complexes which are combined here because of apparent similarity (Irwin 1971). The Jimmy Allen site near Laramie, Wyoming was studied by Mulloy (1959) and provided the basis for the Allen complex (not to be confused with the Allen site on Medicine Creek in Nebraska). The bison kill at the Allen site yielded a minimum radiocarbon date of 7900 ± 400 derived from bone. Thirty points and fragments were recovered with a minimum of 15 bison represented. The 38 tools included six scrapers and two flake tools or knives. The projectile points were well made, having oblique parallel flaking, deeply concave bases, and nearly parallel to slightly convex blade edges. Many were manufactured from high quality quartzite.

Similar points from the Hell Gap site were used to define the Frederick type (Irwin 1968; Irwin-Williams et al. 1973). The Frederick component at Hell Gap included possible evidence for a temporary structure in Area 1 (Irwin 1971). Available radiocarbon dates indicate that the Frederick complex dates between about 8,400 and 8,000 years ago (Frison 1991b). Benedict (1992) reports that most terminal Paleoindian obliquely flaked lanceolate points from the Rocky Mountains in Colorado are made from quartzites, especially Dakota orthoquartizte. The Caribou Lake site (5GA22) in Grand County represents a Paleoindian lithic workshop where this material was procured.

Artifacts from the Betty Green site and Hell Gap site have been used to define the Lusk complex which is here included with Frederick/Allen (Greene 1967) with which it is generally assumed to be related (Frison 1991b). Lusk material may be slightly later than and perhaps derived from Frederick/Allen.

Norton Bonebed, Kansas. The Norton site, 14SC6, was discovered in the late 1970s during quarrying operations in a sand pit on Ladder Creek in Scott County, Kansas (Hofman et al. 1992, 1995; Hill and Hofman 1992, 1995). The site was brought to archeological attention by Charlie Norton in 1992 and preliminary excavations in 1992 and 1993 yielded an assemblage of generally fragmentary bison bone, several hundred flakes, scrapers and cutting tools, and point fragments. A complete projectile point was found with the bones in the bank exposure prior to excavation, and additional point fragments were found during excavation (Figure 32). Two of the projectile points have concave bases and oblique flaking, but the overall form is broader and with more convex edges than typically found on Allen points. These pieces are, however, similar to a point from the Clary Ranch site in Nebraska (see below) which was compared to the Frederick type. The base of a third point appears to represent a square-based or Cody complex artifact, and its potential association with the obliquely flaked points remains unclear.

The sand and gravel quarrying operation which originally exposed the bonebed deposit was terminated once the bones

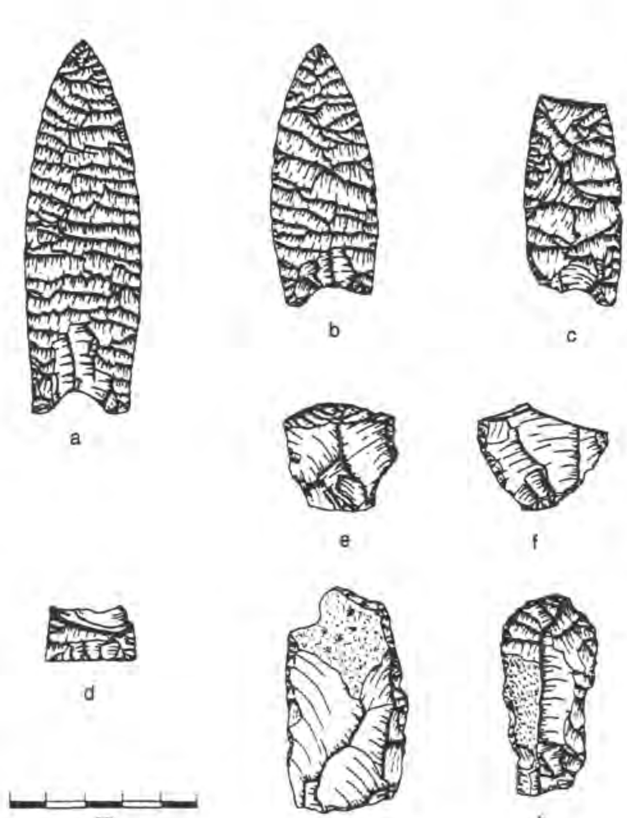


Figure 32. Artifacts from the Norton Bonebed, Scott County, Kansas. a-c. Allen Points; d. Cody Point base; e,h. endscrapers; f, g. flake tools.

were recognized. Subsequently, more than a decade of erosion has occurred on this vertical bank resulting in an unknown amount of slumpage and site loss. The bones occur on the floor, along the margins, and in the brown silt fill of an old channel which had cut into the underlying Pleistocene-age sand and gravel deposit that was the focus of quarrying activity. Mammoth, horse, turtle and other Pleistocene faunal remains have been found in this sand and gravel. Spoil dirt from quarrying operations has been deposited on top of the site in some areas resulting in a maximum depth below surface for the bonebed of about 5 m in the western excavation area. To the east and north the bonebed is more shallow reflecting both prehistoric and modern topographic factors. The ancient channel or gully apparently drained to the north toward Ladder Creek, but the head wall and most of the western margin of this gully have been removed as a result of quarrying activity. The remains of at least eight bison, and probably many more, have been recovered from the channel fill and margins. It is assumed that the old arroyo was a significant feature used in the trapping of these bison, but substantial postdepositional movement has occurred and much of the bone excavated from the channel fill has been moved or rearranged by water action and slump blocks. The number of kill events is unknown and the season has not been determined. Although faunal remains are dominated by bison, a few elements of antelope are also represented.

Three radiocarbon dates are available for the site, two on humates from a late Holocene soil which caps the old arroyo and one on bison bone. The total humate samples from the 45 cm thick soil are 410 ± 50 (TX-7815) for the topmost portion and 1790 ± 60 (TX-7941) for the bottom of the soil. This provides a minimum age for the end of filling and stabilization of the gully containing the bison bone. The bone collagen date of 9080 ± 60 (CAMS-16032) is based on a humerus found near the location of an Edwards chert endscraper and the original point find.

Lithic artifacts include several unifacial tools in addition to the projectile points. An endscraper of chalcedony (from the local Ogallala Formation) and another of Edwards chert (from central Texas) were found among the bone in the gully fill. Unifacial tools of basalt (from local gravels) and Flattop chalcedony are also represented. The points are made from quartzite, Niobrara jasper, Alibates, Flattop chalcedony (the square based specimen), and fossil wood (an impact damaged tip). Lithic debitage is dominated by small retouch flakes made predominantly of Niobrara jasper, but with other lithic types including opaline, Florence, Alibates, basalt, quartzites, and Flattop represented. Further investigations are planned for the site and it should be possible to learn more about the seasonality, assemblage, site history, number of episodes of site use, and cultural affiliations.

Clary Ranch, Nebraska. Excavation in 1979 at Clary Ranch in Garden County, Nebraska revealed a bison kill/processing site with projectile points comparable to the Frederick and Meserve types (Myers et al. 1981). Clary Ranch (25GD106) was buried by about 2 to 15 m of sediments in a terrace-2 fill on Ash Hollow Creek. The bonebed was in a water-deposited silt and was capped by a high energy deposit containing siltstone slabs and then recent alluvium. The bones were in relatively fragile condition, but an area of 50 m^2 was exposed and about 40% of the bison remains was collected. Nonbison fauna and snails were also collected. In addition to bison, box turtle and canid remains were present. A canid humerus had been grooved and snapped, perhaps in the manufacture of beads. Most of the bison material was highly fragmented, but this may be due in part to natural processes. The number of individuals is about 12 (M.G. Hill, personal communication 1994; Myers et al. 1981 originally reported an MNI of 7 or 8). Tooth eruption and wear data suggest a late spring or early summer kill (Myers et al. 1981).

Two projectile points, more than a dozen flakes, a point tip, and a knife were collected from the site. The two complete points were recovered in the bonebed. The largest is referred to as a Frederick point and is made from Niobrara (Republican River) jasper. The second point has a reworked blade and is referred to as Meserve. This specimen is made from Flattop chalcedony. The specimens are closely comparable to points found at the Norton Bonebed in western Kansas.

Pryor Complex

In the Rocky Mountains and foothills adjoining the western Plains the latest cultural complex usually attributed to Paleoindians is recognized by parallel-oblique flaked lanceolate or slightly stemmed projectile points with concave bases and alternate beveling on the blade edges (Frison and Gray 1980; Frison 1991b, 1992). The complex takes its name from Pryor Mountain on the Wyoming-Montana border where research by Husted identified a series of rockshelters with Pryor Stemmed points in the lowest levels (Husted 1969). Research at a number of additional sites indicates a time frame from about 8300 until 7800 for Pryor Stemmed and associated assemblages (Frison 1991b:71; Frison and Grey 1980). In contrast to earlier Paleoindian assemblages, components with Pryor Stemmed points are found in numerous cave sites (Frison 1992). Also, economic orientation was apparently not focused on bison but on other species. Artifacts which may represent the Pryor complex are present in southeastern Wyoming and occur in limited numbers in northern Colorado's front range (Benedict 1992:348).

Meserve Complex

In much of the Central Plains, lanceolate Paleoindian projectile points with beveled blade edges or steeply reworked distal ends are classified as Meserve points. This type takes its name from the Meserve site south of Grand Island in Hall County, Nebraska (Davis 1953a; Meserve and Barbour 1932; Barbour and Schultz 1936; Schultz 1932; Wormington 1957). The remains of at least two bison have been found in association with two projectile points in a soil horizon buried by more than a meter of sediment (Barbour and Schultz 1932a:Figure 168). The site was investigated several times, initially by high school students in 1923, who donated a bison skull to the museum at Grand Island College where it attracted the interest of F. G. Meserve. Meserve was a biology professor at Grand Island College and later at Northwestern University. In 1923, he returned with a number of helpers and excavated at the site recovering another skull, postcranial material, and the first Meserve point. The point was found in place below the left scapula of bison No. 1 about "two inches back of the glenoid cavity" (Meserve and Barbour 1932:240). Meserve later donated this point and the collections to the Nebraska State Museum (Barbour and Schultz 1932a). Two essentially complete animals were recovered by this work. In 1931, a crew lead by C. B. Schultz excavated at the site recovering additional material including a second projectile point, very similar to the first, found in place among ribs and near vertebrae. These were apparently the only artifacts found in the deposit, and it is unclear whether more than two bison were represented.

The Meserve point type is widely recognized (Bell 1958; Thurmond 1990; Turner and Hester 1993; Wormington 1957) but was actually named by Davis (1953a), based on work at the Red Smoke site in the Medicine Creek Reservoir, southwest Nebraska. Red Smoke yielded Plainview or similar points, including some with reworked blades which Davis referred to the Meserve type based on similarity with the points from the Meserve site. Several authors have questioned the validity of Meserve as a distinct point type (Story et al. 1990; Gunnerson 1987:21; Wheat 1972), and many consider it to simply represent Plainview or other types with reworked blades (Goodyear 1982:383). Myers and Lambert (1983) argue that Meserve represents a Western variant or attribute of the Dalton technological complex.

A number of recent syntheses omit the Meserve complex from consideration (e.g., Wedel 1978). General consensus appears to be that Meserve is not a valid cultural-historical or technological complex but simply a modified blade form when projectile point blades are resharpened, especially during use as knives. It should be noted, however, that the points found at the Meserve site were apparently lost during use as projectile and not as knives. The beveled blades on the Meserve site points may reflect previous use as knives or a distinctive technological trait reflecting situational or other factors. Nevertheless, the basal form of so-called Meserve points can generally be easily subsumed within other types such as Plainview or Dalton.

Dalton Complex

On the eastern Plains margin and along streams reaching well out into the Great Plains, projectile points of the Dalton technological complex are well documented (e.g., L. Johnson 1989; Brown and Logan 1987; Galm and Hofman 1984; Turner and Hester 1993; Story et al. 1990; Thurmond 1990; Wetherill 1995; Wyckoff and Bartlett 1995). The Dalton complex is well known from a number of stratified sites in Missouri (Wood and McMillan 1976; Kay 1982; Klippel 1971; Chapman 1975), and from single component Dalton sites in Arkansas (Morse 1971, 1982; Goodyear 1974, 1982). Additional information comes from the stratified and well-dated Packard site in Oklahoma (Wyckoff 1985, 1989b).

The Dalton technological complex has a highly distinctive tool assemblage which includes stemmed, concave based, edge and basally ground projectile point/knives. These are commonly basally thinned or fluted, and the overall form of the base sometimes has prominent corners or ears isolated by concave lateral and basal margins. There is substantial variation in basal form and overall morphology. Blade edges are commonly serrated and often beveled with considerable morphological variation resulting from use, dulling, breakage, and reworking or resharpening of the blade (Morse 1971; Goodyear 1974). In addition to points, Dalton adzes are an important and distinctive tool type, apparently used primarily in wood working activities (Morse and Goodyear 1973). Much of the remainder of the tool complex is comparable to that found in Paleoindian assemblages and includes spurred scrapers, gravers, spokeshaves, and a variety of unifacial flake tools.

The time frame for Dalton is argued by Goodyear (1982) to be from about 10,500 to 9900 B.P. and he suggests that it always predates notched point assemblages. Evidence from the Packard site in eastern Oklahoma, however, shows Dalton assemblages stratified well above Agate Basin and notched point types dating to about 9700 B.P. Story et al. (1990) argue, based on typology and some stratigraphic occurrences, that Dalton developed out of Clovis. The common fluting on Dalton points provides some support for this interpretation.

In eastern Kansas, Dalton points are relatively common in the Kansas River basin (Wetherill 1995; Brown and Logan 1987; Rogers and Martin 1982, 1983). No stratified or single component sites are yet documented west of the Missouri in the Central Plains region. The projectile point from the Laird site northeast of Goodland, Kansas, however, is typologically most similar to Dalton. This very western occurrence of a Dalton-like point is of particular interest. The specimen was found in association with bison bone and appears to be made from fossil wood similar to material that occurs along the front range in central Colorado. Continuing investigations may shed additional insight on the typological affiliation and age of this find. Kornfeld (personal communications 1995) reports late Paleoindian points morphologically similar to Dalton in the Middle Park region of northern Colorado.

Problems in Paleoindian Archeology

Human groups were living in the Great Plains region of the New World by soon after 11,500 years ago, based on the undisputed evidence from a number of Clovis sites (Bonnichsen and Turnmire 1991; Frison 1991b; Haynes 1987). Clovis people were apparently not the first to inhabit the New World, however, as somewhat older evidence, dating to about 12,500 years ago and represented by a distinctly non-Clovis technology, is present in southern Chile (Dillehay 1989). The initial peopling of the Great Plains region remains problematic in terms of the timing and direction of entry of the first inhabitants. We can no longer assume, as was common two decades ago (e.g., Jennings 1974, 1978; Wormington 1957), that people necessarily first entered the lower latitudes of North America by way of an "Ice-Free Corridor." This corridor would have opened from the Porcupine River region of southeastern Alaska as the massive continental glaciers melted away and created a late Pleistocene pathway which connected with the Great Plains near Edmonton, Alberta. This corridor would also have been open during previous interglacials. The prospect of alternative migration routes that may have been available, before or while the "Ice-Free Corridor" was open, holds multiple possible scenarios for the peopling of the North American continent (Bryan 1986, 1991). The possibility of a coastal route of colonization along the western margin of North America (Fladmark 1979, 1986) leaves open the very real prospect that we do not know when, or from which direction, the Great Plains region was first inhabited. We must at least acknowledge the reasonable possibility that people first entered the Plains region from the west, south, or east rather than from the north.

Clovis is no longer the earliest uncontested New World cultural complex. The Nenana complex in Alaska and the El Jobo complex in South America both are slightly older (Goebel et al. 1991; Bryan 1986). Clovis may be the oldest complex in the Plains region. The widespread occurrence of distinctive Clovis artifacts and sites (Bonnichsen and Turnmire 1991) also leaves open the possibility that Clovis culture, which was originally defined based on discoveries at the Blackwater Draw site in New Mexico, Miami, Texas, and at Dent, Colorado, may have originated outside the Plains region (e.g., Bonnichsen 1991; Stanford 1991). We can no longer simply assume that Clovis culture originated in the Plains or that these people spread throughout North America by way of the Great Plains. We must admit that relatively little is known about this prehistoric group other than some aspects of their economy and technology, from which overall organization and lifeways are postulated (Bonnichsen and Turnmire 1991; Kelly and Todd 1988). Plains Clovis origins and lifeways are problem areas in need of further empirical evidence and investigation.

Information on Clovis culture in central North America is based primarily upon excavations of mammoth (less commonly bison or mastodon) kill/butchery sites, surface finds of Clovis projectile points, and some artifact caches consisting of stone or stone and bone or ivory tools. Substantial recent developments have been made in study of the mammoth and other bone from Clovis sites (Frison and Todd 1986; Saunders and Daeschler 1994; Kreutzer 1988), and the artifact caches have provided valuable insights to lithic technology (Bradley 1991; Wilke et al. 1991), lithic material use patterns and mobility (Frison 1991a; Hoard et al. 1992), and some clues about possible mortuary practices (Lahren and Bonnichsen 1974; Steele and Powell 1994). Relatively little information is available, however, concerning the few known occupation sites or camps of Clovis people (Haynes 1982; Ferring 1994; Frison 1982a).

There remain significant limitations in our understanding of Clovis culture in the Plains region and elsewhere, and critical gaps in the available information base representing this very early New World culture. A primary area of concern needing further investigation is the potential pre-11,500 year old sites and deposits in the Plains region. The origins of Clovis can be addressed more effectively if sites and deposits dating before 11,500 B.P. are studied in detail. A number of sites in the Central Plains and elsewhere have yielded suggestive evidence of human activity in the region before Clovis time (e.g., Holen 1994; Stanford 1979a; Wyckoff and Carter 1994). We can no longer begin our analyses with the assumption that Clovis culture arrived in the Plains fully developed, or that it developed in isolation, or that it was the earliest human culture in the region.

Similar problems abound in the study of later Paleoindian complexes. As argued by Frison (1993), we can no longer assume a simple unilinear development of Paleoindian complexes from Clovis onward. The cultural and historical relationships among the various recognized Paleoindian complexes remain for the most part poorly defined. The possibility of contemporary distinctive traditions has been suggested (e.g., Pettipas 1982) and remains an important possibility (probability) for Paleoindian times, especially if we consider the Plains and Rocky Mountains regions together. Even on the Plains proper, there are numerous overlapping radiocarbon dates representing distinct complexes and sites with multiple point types in close association. These data could reflect mixing, problems of context, co-traditions, variability in the technology of single cultural groups, and numerous other factors.

Other fundamental issues in the study of Central Plains Paleoindian archeology include site recognition and accessibility due to geomorphic processes, technological analyses of assemblages (not just points and formal tools), precise dating, site formational studies, lithic material source studies, investigation of hunting technology, recognition and documentation of structural remains, study of mobility and land use patterns, evaluation of the importance of trade, detailed studies on nonbison resource utilization, information on ideology and symbolism, gender roles, the relationships between Paleoindian and Archaic complexes and many more. Some key issues which are currently evident are listed here, but the order is not intended to imply relative significance.

1. The problem of buried site recognition and documentation and the need for systematic regional studies of quaternary geology and geomorphology are basic to progress at the site, regional, and area scales of Paleoindian investigations (Artz 1983; Bettis and Benn 1984; E. Johnson 1987; W. C. Johnson and Logan 1990; E. Johnson and Holliday 1990; Holliday 1982, 1986; Mandel 1992, 1995; May and Holen 1993). Alluvial processes, stream channel histories, depositional history of upland loess deposits, study of dune field formation and change, playa lake fluctuations, and general knowledge of landscape evolution are essential for modeling and interpreting buried sites, for finding and recognizing such sites, and for determining where they may and will not occur. Geomorphology must be an integrated part of all effective Paleoindian site and regional studies. The radical changes which have occurred in Great Plains landscapes during the past

8,000 years necessitates georarcheological research in order to interpret Paleoindian sites.

2. A further concern is the need for extensive excavations at sites which may be deeply buried and which often have a light density of artifacts. Decades of site studies have shown that our most significant assemblages for many kinds of studies can result only from extensive excavations (Sellards 1952; Frison 1991b; Hester 1972; E. Johnson 1987; Wilmsen and Roberts 1978). The ephemeral nature of many hunter-gatherer occupation sites, combined with the large area encompassed by dispersed activities (e.g., Binford 1978; O'Connell et al. 1992; Yellen 1977), suggests that most of our archeological investigations of Paleoindian sites are spatially inadequate. We will probably continually face the problem of the need for extensive site studies and relatively small or inadequate fieldwork budgets. A good understanding of site geomorphology is critical to making the most of available research support. Ferring's (1990, 1992, 1994) research at the Aubrey site in northern Texas, and Haynes' (1982) research at the Murray Springs site in Arizona, are excellent examples of these problems.

3. Regional investigations which reach beyond specific sites are also critical to Paleoindian and other hunter-gatherer studies. It is important to utilize the archeological record at many scales in order to gain a more holistic perspective on the overall activities and land use practices of prehistoric hunter-gatherers. Surface-derived information can complement excavation data toward defining general trends in regional activity, population changes, resource use, and so forth (Amick 1994; Hester and Grady 1977; Hofman 1988, 1991b; Judge 1973; Dawson and Judge 1969). Surveys of diagnostic projectile points at the state and regional levels are also important to defining patterns of activity, changes through time, and identification of data gaps and problem areas (e.g., Brown and Logan 1987; Davis 1988; Hofman 1994b; Meltzer 1987; Morrow and Morrow 1994; Myers 1987; Naze 1986; Schneider 1982). Regional studies can also make important contributions to the problems of recognizing site variability and utilizing the tremendous information attainable through study of well-documented avocational collections. Many patterns of landscape and resource use will simply not be visible if we only study a selected handful of "productive" sites.

4. Dating of Paleoindian sites and complexes remains a major problem area in need of further research. Although some complexes seem to be relatively well dated (e.g., Haynes 1993), the precise chronological age and historical relationships among many complexes remain obscure. There are many examples of these problems of which the Cody complex is an excellent case. At this time we lack a clear understanding of the chronological limits of the Cody complex and of the precise age limits of the various Cody point types. Obviously a combination of chronostratigraphic and technological research is needed. Also, the relationships among the Plainview, Goshen, Midland, Folsom, and Clovis types remain unresolved. Beyond the issue of dating and chronology with respect to archeological complexes and types, we have the extremely critical issue of dating techniques and reliability of methods. Dramatic improvements in radiocarbon dating (Haynes et al. 1984; Haynes 1992; Stafford et al. 1987, 1991) have provided a considerable boost to the understanding of Paleoindian chronology and in the identification of "out of sync" dates. The accelerator mass spectrometer (AMS) technique in radiocarbon dating and improvements in dating of bone and soil samples are especially notable advances, but they come with an increased analytical cost. Other dating methods are also important to Paleoindian studies including thermoluminescence, electron spin resonance, and, potentially, archeomagnetism. In all cases, critical assessment of samples and results is needed (e.g., Allerton 1980), and there is a significant need for using multiple lines of dating whenever possible.

Methods of relative dating are also of significance and this includes studies of patination (Frederick et al. 1994), bone weathering, and isotope analyses which may be correlated with other evidence (e.g., Todd 1995).

5. Remaining near the top of the "headaches and problems" list for Paleoindian researchers are the issues of artifact and site typology. Artifact typology in Paleoindian research has been dominated by consideration of projectile points, although systematic typologies for other tool forms have been offered (e.g., Irwin and Wormington 1970). A number of Paleoindian sites and components have yielded a variety of projectile points including specimens which would generally be classified as distinct types. Sites exhibiting such variability include Scottsbluff (Schultz and Eisley 1935), Rex Rodgers (Willey et al. 1978), Domebo (Leonhardy 1966), Clary Ranch (Myers et al. 1981), Norton (Hofman et al. 1995), and others. Discussions concerning the relationships among defined types, such as Goshen, Folsom, and Plainview, also provide evidence that we still have much to learn from technological, stylistic, and functional studies of Paleoindian projectile points and other artifacts.

A key factor for future progress in understanding Paleoindian projectile point typology may be in taking a polythetic typological perspective (Clarke 1968). In such a framework, typological affiliation is determined by the co-occurrence of a number of specified attributes, no one of which is required or sufficient for definition of (or inclusion of an artifact in) the type. Such an approach changes the initial level of comparison and classification from the type to the attribute, and so enhances the potential to recognize, define patterning in, and accommodate unusual, "nontypical", or "nontyped" specimens within the analytical framework. Some key attributes, fluting in Folsom points for example, may occur in a majority of examples of the type but are still not required for inclusion nor sufficient for definition of the type. Folsom points may have two, one, or no flutes, and other points including Clovis, Dalton, and Cumberland may be fluted and not be Folsoms. By conducting analysis of assemblages and regional samples based first on attributes, and only secondarily on types, we may define patterns and relationships which would not otherwise be recognized or obvious. Such study of variability is key to the study of change. The need for analytical comparisons which are not limited to previously defined types is evident to anyone who has studied large numbers of projectile points. Avocational collections of Paleoindian projectile points in the Plains region almost always include specimens (sometimes a large percentage) which do not fit easily within defined types but that, nevertheless, exhibit distinctive Paleoindian attributes. For example, fluted "Hell Gap" points or a "Agate Basin" points with concave bases. Documentation of such variability is important but would commonly be masked if analysis began at the type rather than attribute level.

Another problem area is the typology of nonprojectile point artifacts. Endscrapers, gravers, bifaces, flake tools, grinding stones, hammerstones, and so forth have not been sufficiently investigated as to functional, technological, and stylistic variability within and between assemblages. Certainly the same forms can be and were used in multiple ways, and the same function can be extracted from tools having different technological histories or styles. A variety of situational factors (independent of archeologically ascribed site type or artifact type) will influence tool form and function, maintenance and recycling, loss and discard rates, and redundancy in these features.

Site typologies have perhaps done as much to limit archeological interpretations as to enhance them in the context of Paleoindian studies. Although a variety of site types have been defined or alluded to in the literature, the commonly recognized (expected) Paleoindian site types include kills, camps, butchering/processing sites, workshops, and hunting overlooks. Unfortunately, rather than enhancing the study of past behavior and variability, these site types have often been used with minimal definition as if all archeologists knew or agreed upon what characterized each type, and as if there was minimal or only insignificant variation within each site type. It is commonly assumed that, other than overall size, there is only minimal or unimportant differences within the types: campsites, kill sites, workshops, etc. Partially as a result of this perspective, we have an inaccurate and incomplete understanding of site variability and assemblage variability. Variation among campsite assemblages and among kill site assemblages from Plains Paleoindian sites is extreme and poorly understood, and definition of site types has largely been on a post-hoc accommodative level. One of many unfortunate results of this situation are the common assumptions that campsites and kill sites will necessarily be separated in space, and that campsite assemblages will always differ radically from kill site assemblages. Recent evidence suggests that these may well be unjustifiable assumptions for Plains Paleoindian sites. More research needs to be directed toward documentation and evaluation of assemblage variability, independent of prior site type expectations.

6. Taxonomic consideration of archeological complexes is closely related to, and really just another version of, the typological problems mentioned above. Archeological unit concepts currently employed in Paleoindian studies are a mishmash of ideas derived from the Midwest Taxonomic System (Willey and Phillips 1958) and numerous other sources (e.g., Beardsley et al. 1956; Wormington 1957). The terms "complex," "assemblage," "industry," "phase," "culture," "technocomplex," and others are found throughout the literature on Plains Paleoindian. These terms sometimes appear with specific definitions, but more commonly are used interchangeably without clarification and are often characterized primarily by one or several point types. The Cody "complex" as discussed above is an example of the wide range of interrelated archeological unit concepts which occur in reference to potentially related segments of the Paleoindian record. Other taxonomic issues revolve around the interrelationships of identified complexes. The Goshen cultural complex is an example of the inherent problems in precisely defining the relationships between "new" and existing archeological units. Resolution of many such issues will require more site studies, better dating, improved understanding of typology, clear definition of analytic tools, and so forth.

7. Historically, one important component of success in Paleoindian research has been active cooperation of avocationists. Artifact collectors and avocational archeologists have identified and reported a significant number of the more important Paleoindian archeological sites and collections now known and studied. Developing and maintaining an effective relationship between professionals and amateurs is a key to making the most of available research time and resources. If archeologists were dependent solely upon their own brief surveys for knowledge of archeological site occurrences and for evaluation of sites and localities, our current information would be reduced tremendously. It stands to reason that if we exclude or disallow avocational input in our modern surveys, excavations, and regional studies, then we do so by ignoring a wealth of often high quality information that can dramatically enhance understanding of the archeological record and improve decision making in the mitigation or research process.

During the past 25 years, the number of practicing archeologists in the Plains region has increased dramatically. This is true for the academic, governmental, and private sectors. It is unclear, however, whether the active avocational archeology community, judging by membership in state and local archeological societies, has grown in stride. It is evident that the current and prior generations of archeologist have included numerous individuals who undervalue or disclaim the significance of avocational cooperation for doing effective and high quality archeological research. The benefits brought to archeology by avocationalists cannot, however, be ignored as many key studies have relied heavily upon their work (Hester 1972; Hofman 1992b; Naze 1986; Judge 1973; Frison 1987b). Part of the background investigation for all cultural resource management and research projects should include interviews with avocational archeologists and documentation of existing knowledge and collections. This step can provide for informed decision making in archeological endeavors where funding, time, and resources are almost always inadequate.

8. Were there Paleoindian co-traditions? Pettipas (1982) has provided an interesting discussion of possible co-traditions

during late Paleoindian time. This is a possibility which is receiving increased attention as complexes become better dated and evidence for chronological overlap continues to be found. Again, the cases of the Goshen and Cody complexes are excellent examples of why we can no longer easily accept a single linear progression of Paleoindian cultures for the Plains as a whole or for lesser regions.

9. The relationships between Paleoindian and Archaic complexes remains a key issue which has received only limited systematic attention. Similarities in technology, economy, and organization have been alluded to in many studies (Forbis 1992; Meltzer and Smith 1986; Simms 1988). Were changes in demography and ecology enough to account for the commonly offered differences between Paleoindian and Archaic archeological records?

10. Elements of technology, symbols, and ideology have been hinted at by a variety of finds including ochre quarries, engraved stones, possible burials, flint knapping activities associated with fluting, ornaments or items of personal adornment, unusual arrangements of features and artifacts, and odd sized (too large or too small) artifacts. The Paleoindian mind may be a terrain lacking a road map or direct access, but clues pertaining to organization of groups, domestic use of space, spatial arrangement of activities at campsites and across the landscape, the division of labor, sharing among family groups, value systems, and planning ability are all things for which clues can be found in the archeological record. The perception of Paleoindians only as hunters who ate meat is inappropriate and incomplete. In order to do more with the archeological record, we need a better understanding of what it is and what we want to learn from it.

Mesoindian Archeological Record

Archaic sites on the Plains are often perceived as relatively unexciting and redundant lithic scatters, sometimes with associated hearths or roasting pits. A stereotypic description of Plains Archaic lifeways might be as follows.

> They ate grass seeds, tubers, and rodents, wore yucca sandals and deer hides, and hunted bison when they could be found. They occupied the margins of the high plains, except for seasonal forays in good years. Their's was a diffuse economy making use of diverse resources in limited regions. Yearly rounds of activity resulted in recurrent use of specific sites, ornaments are rare but simple flexed burials occasionally are found.

Such bleak hand-to-mouth portrayals of middle Holocene, Middle Period, Mesoindian or "Archaic" hunter-gatherers in the Plains region have been recurrent in the archeological literature (e.g., Mulloy 1958; Wedel 1986:72). The newest views of the Archaic, as witnessed by recent research, often diverge dramatically from this traditional view. Many basic issues remain unresolved including aspects of group organization, mobility, economic variability, technology, and causes of change. Now, however, the Archaic is recognized as key in many ways to understanding Plains archeology. It is no longer beneficial or realistic to view the Archaic only as a discrete and simple archeological construct to be studied independently of what came before or after. An enhanced understanding of the preceding and following periods will ultimately derive from the improved understanding of the diversity within the Archaic itself, not as a discrete and separate entity but as part of the continuum of human occupation in the Plains region since the Pleistocene. Archaic studies are no longer limited to economy and technology, but art, ideology, land use patterns, and social organization are increasingly the topics of concern (e.g., Francis et al. 1993; Ingbar 1985; Larson 1990; Keyser and Fagan 1993; Metcalf and Black 1991).

What is the "Archaic"? Is it an appropriate term in its implications and usages, and how do we improve our understanding of the diversity of Holocene hunter-gatherers on the Plains regardless of the references we use to represent them? The Webster's definition of archaic is more or less apropos of Ritchie's (1932) initial usage, "that which comes before—remote period," but our perception of chronology and preceramic archeology has changed dramatically since the 1930s. The term "Archaic" is pervasive in archeological usage but is perhaps an unfortunate term as a referent to the many, diverse, creative, and largely successful hunting and gathering societies who lived in the Plains and Rocky Mountains during the Holocene. Public perceptions of 'Archaic lifeway' or 'Archaic people' in archeological usage could mistakenly be taken to indicate that these hunter-gatherers were less than fully modern in abilities, technology, or ideology. For this reason, I prefer the term "Mesoindian" over "Archaic." There are plenty of alternatives which lack such embedded connotations about the lifeways and abilities of these prehistoric people.

The term "Archaic" (or Mesoindian) is used in the sense of a cultural-social-technological stage, of prehistoric people who were adept at living entirely on wild resources in a highly demanding variety of settings and conditions. Forbis' (1992) preference for Mesoindian as a referent for the archeology of post-Paleoindian occupation in the Plains and pre-late prehistoric or (Neoindian) cultures has a certain appeal, if for no other reason than it avoids some of the connotations of "archaicness" in reference to these Holocene hunter-gatherers. His argument against the use of Archaic in the Northern Plains is based on his belief that the term does not reflect the same kind of adaptation or cultural stage as it does in the Eastern Woodlands. This position merits consideration.

Willey and Phillips (1958:107,120-121) have provided the most commonly used definition of the Archaic, one which is at the core of most recent definitions and which is built on the initial usage of Ritchie and the expanded applications of Webb for midden sites in Kentucky, Tennessee, and Alabama (e.g., Webb 1946).

Forbis recognizes incongruence between the Northern Plains post-Paleoindian archeological record and Willey and Phillips' Archaic definition, as he interprets it. Hunter-gatherers who relied at least in part on bison as a key component of their economy simply do not fit the traditional view of "Archaic" as representing broad-spectrum localized foragers.

Willey and Phillips (1958:107) define the Archaic as

> the stage of migratory hunting and gathering cultures continuing into environmental conditions approximating those of the present....there is now a dependence on smaller and perhaps more varied fauna. There is also an apparent increase in gathering...sites begin to yield large numbers of stone implements and utensils that are assumed to be connected with the preparation of wild vegetable foods.

Willey and Phillips, however, also recognized some potential problems in the application of their definition of the Archaic stage concept to the archeological record of the Plains.

> Classification of Archaic stage cultures is even more difficult in the Plains than in the East, owing to...a long persistence of ancient hunting traditions .... Practically all Plains Archaic cultures show a mixed Lithic-Archaic typology, and in some cases the specific Archaic relationships are with the later "typical" Archaic cultures in the East. Nevertheless, ...the general configuration of these cultures...is closer to our concept of Lithic. For example, Signal Butte I and II in western Nebraska....A bison-hunting economy is indicated, and there can be little doubt that the culture reflects a strong continuity from the ancient Lithic stage cultures of the area.
>
> The same general observations apply to the Frontier complex found at the Medicine Creek (Allen) site in south-central Nebraska....we have here a significant instance of temporal overlap of Lithic and Archaic stages in the same area. (Willey and Phillips 1958:120-121)

Willey and Phillips continue their discussion of problems in application of the Archaic stage concept in the Plains region with other examples, but these comments illustrate the nature of the problem. Their discussion (1958:80) is limited not only by the nature of the available evidence at the time but also by assumptions concerning the Lithic stage, which was thought to be essentially (primarily) big game hunters throughout North America, and by their attempt to provide a relatively simple and dramatic contrast with the diversified economies of Archaic hunter-gatherers. This position has been seriously questioned (e.g., Bamforth 1991a; Kornfeld 1988; Meltzer and Smith 1986; Meltzer 1988), and evidence for economic diversity during the Paleoindian (Lithic) period on the Plains has continued to increase (e.g., E. Johnson 1987; Davis and Greiser 1992; Frison 1991d; Bamforth 1991a; Greiser 1985). In fact, the distinctiveness of the Lithic and Archaic stages as defined by Willey and Phillips have become less distinctive rather than reaffirmed, especially between 8,000 and 6,000 years ago, as the result of continued research.

Archeological unit concepts for prehistoric Plains hunter-gatherers are useful tools to aid discussion and comparison, but we must be mindful that such concepts do not constrain or predetermine the results of our comparative studies (or dictate what is or can be compared). Ultimately, understanding the social and economic operation of past cultural groups will not come from classification of archeological assemblages but from gaining an understanding of the operation of past cultural systems through documentation of variability and through comparative studies (e.g., Simms 1988). Our taxonomies should not limit the interpretation of the archeological record or compel us to construe it inappropriately into preconceived frameworks.

These issues are, I believe, at the heart of Forbis' concern with the concept of Archaic in the Northern Plains region. It is also a concern which is appropriately echoed for the Central Plains region.

It has been common, at least since Willey and Phillips' discussion, for archeologists to recognize at least two kinds of Archaic in the Plains region. This perspective has resulted from an awareness of apparent continuity between some late Pleistocene and Holocene Plains hunter-gatherers in terms of technology and economy, and from an awareness of relatively dramatic environmental changes which resulted in extinctions, extirpations, and a continuing reorganization of available resources. It is interesting, however, that the diversity of Plains Archaic has been summarized quite differently by different researchers. These differences probably reflect the fact that the Plains Archaic can be, or at least appears to be, radically different depending upon which sites, which site types, which time periods, and which regions are the topics of discussion. The following examples serve to indicate that the Plains Archaic has been perceived and presented in quite contrastive forms.

> "the Middle Prehistoric period comprised small-game hunting and generalized gathering, with little use of bison, is now regarded as applicable primarily to the Big Horn and Wyoming Basins....Elsewhere in the northwestern Plains...relatively simple subsistence groups [were] relying heavily on bison..." (Wedel 1978:196)
>
> The Western Plains Archaic...continues to emphasize the earlier Paleo-Indian pattern of big-game hunting, while the Eastern Plains Archaic, known from sites in and along the river valleys, manifests an eastern United States Archaic-like pattern of deer hunting, fishing, and nut and seed collection. (Johnson and Wood 1980:38)
>
> In the extreme western Plains, the Archaic peoples carried out a true foraging existence similar to the Desert Culture to the south, where people depended heavily on seeds, nuts, roots, and other

> such food....Some suggest that the Archaic peoples of the more eastern prairie were still predominantly big game hunters because the climate there was still favorable for the herds....Archaic existence was usually not much different from the lifeway of the big game hunting peoples. (Zimmerman 1985:59-60).

Relationships between eastern and western Plains hunter-gatherers during the Holocene, or between Plains and Mountain-Foothills groups are key issues in Central Plains archeology. Are there two kinds of subsistence patterns or types of Holocene hunter-gatherers using the Plains during the Holocene? Those that focus on bison hunting and those that are more general foragers? If so, should both be considered under the same broad taxonomic classification? Or, are these economic options simply alternatives used during different seasons or different years by the same groups? This is again at the heart of Forbis' frustration with the term "Archaic" in reference to Holocene bison hunters on the Plains. During the middle Holocene, 8,000 to 4,000 years ago, bison hunting and utilization is well documented at a number of sites on the eastern and western Plains. These include sites in Iowa, Minnesota, Nebraska, Colorado, Montana, Wyoming, and elsewhere (Anderson and Semken 1980; Davis and Wilson 1978; Forbis 1985; Frison 1991b; Frison et al. 1976; Grange 1980; Kivett 1962; Metcalf 1974:125; Miller 1985; Morris et al. 1985; Reher et al. 1985; Shay 1971). Hunting of mountain sheep, mule deer, and other species is also evident at Holocene sites on the western Plains margin and in the Rocky Mountains but not to the total exclusion of bison (e.g., Metcalf and Black 1991; Gooding 1981).

These recognized differences between east and west, Mountain-Foothills and Plains, when viewed from a chronological perspective which incorporates paleo-environmental change, point to diversity in the archeological record of Holocene hunter-gatherers which remains unexplained or poorly understood. One of the reasons for this is the scale of analyses within which many archeological investigations have been conducted. They have commonly been site specific or delimited by "natural areas." How do we set the limits on the proper and appropriate size of regions for investigating questions about the economy, organization, land use, technology, and variability within specific Holocene hunter-gatherer systems or cultural traditions? This can not be done a priori, although contemporary hunter-gatherer land use studies provide an important framework for comparison (Binford 1983, 1991; Hitchcock 1982; Hall et al. 1985; R. L. Kelly 1983; O'Connell et al. 1992).

Metcalf (1985:187) and others have suggested that our understanding of the McKean archeological record, and by implication other complexes, has been limited in part due to parochial perspectives. If we interpret McKean subsistence and technology on the bases of single sites or small regions, we will very likely miss significant elements of and variability within the system. Further, if we define specific hunter-gatherer complexes primarily on the basis of specific economic orientations (e.g., big game hunters vs. broad spectrum foragers, Mountain-Foothills vs. Plains hunters), then we may simply reaffirm the distinct prehistoric cultural systems which may not have existed. The seasonal, yearly, and long-term variability of technologies, economies, and organizations within specific cultural systems or traditions have generally not been the focus of research, and as a result such variability is poorly understood.

If we consider the distribution and variability in the McKean and Early Side-Notched (Logan Creek) technocomplexes, for example, it is evident that the records can be and have been explained in a variety of ways. If we find McKean artifacts with bison remains, such as at Signal Butte, Cordero Mine, or Dipper Gap, does this mean they were bison hunting specialists to the exclusion of other economic pursuits? Apparently not, if we accept the evidence from Mummy Cave and Dead Indian Creek (Frison and Walker 1984; McCracken 1978). Variability in McKean technology, settlement, economy, and organization can be expected to occur as a result of seasonal, yearly, and long-term variation in resource availability, competition, elevation, ecological diversity, information exchange, and local or regional variation in all these. Some sites have structural remains, some have bonebeds, some have hearths, roasting pits, overlooks, or rockshelters. This is certainly true for the McKean and Early Side-Notched materials in the Plains and Rocky Mountains region and we should expect it of other technocomplexes as well. We do not expect that all McKean sites should have bison remains or pit houses, but in certain settings and seasons we can predict that occupations will be associated with such features. The range of movement, size of economic territories, composition of social groups, and duration of site occupations should all be expected to vary widely through seasons and generations.

There are, however, grounds for making predictions about the nature of such variability, and there are effective ways to use the archeological record to evaluate or test and further develop these models. We need explicit holistic models for evaluation of Mesoindian occupation in the Plains-Mountain region which have detailed and realistic test implications to be assessed in further study of the archeological record.

Osborn (1993) has presented an important model concerning seasonal variation in land use and hunting patterns for hunter-gatherers and farmers in the Southwest, in relation to elevation, ungulate ecology, nutritional requirements, and foraging theory. This model for winter hunting of large ungulates, when they are forced down from the highest elevations by deep snow and up from dryer or harsher open environments to protected "moisture islands" or areas of reliable and productive forage, provides a theoretically sound reason for people to occupy mid-elevation mountain sites during the winter. If the protein, fat, and hides of large ungulates were critical resources, then some mountain settings in winter would have provided the greatest ungulate density and highly predictable behavior of these key economic species. Technologically sophisticated Mesoindian groups may have sought these winter wildlife refugia as key components in a potentially wide-ranging diversified economic and settlement system. Widespread discoveries of middle elevation structures used during the winter by Mesoindians make sense within this framework, not because they were tied to specific localities and had to eke out a living there through all seasons, but because they identified these locations as productive and predictable resource patches important to their foraging and hunting way of life. We might expect hunter-gatherers with such knowledge of ecology and prey behavior to make equally predictable or patterned use of other key species in other habitats in other seasons. Limber pine nuts, plums, sego lilies, and bison were among the resources which were apparently incorporated into the seasonal schedule of foraging. Brush shelters, tipis, rockshelters, and pithouses might be used during the course of a single year by a single human group. We must remain as flexible in our classifications of the archeological record as prehistoric people had to be to live by foraging in the Plains-Mountain region during the Holocene.

The widespread occurrence of early and middle Holocene hunter-gatherer houses, from Illinois and Texas through the Rockies to Nevada, is no longer surprising or especially remarkable in and of itself (Larson and Francis 1996; Lintz et al. 1995; Brown and Vierra 1983). Much remains to be learned, however, concerning the position of these structural sites within the overall economy, ideology, and lifeways of the peoples who constructed and used them. It will become increasingly feasible to predict the kinds of settings in which Mesoindian pit house structures should occur. This is important not so we can congratulate ourselves for guessing correctly but in order to identify counter instances and further evaluate and refine models of Mesoindian lifeways and assemblage relationships. Why do some upland hunting-processing camps have pit houses while others do not? The answer is probably complex but certainly tied to season of use. The summer to early fall activity at the Helen Lookingbill site (at over 2,600 m), for example, was apparently conducted without need of permanent shelters (Frison 1983; Larson 1991; Rapson 1994). But, why was the site not used in winter? Site attributes such as exposure, snow depth, and alternative resources were also important in selection of occupation sites.

This widespread occurrence of permanent seasonal or semipermanent structures during the middle Holocene is one of the single most important archeological facts to impact our perception and understanding of Mesoindian archeology in the Plains-Mountain region. Pit houses and other elements of technology and economy serve to link Mesoindians with both earlier and later archeological complexes. Bison hunting continued during Mesoindian time and was particularly important in some regions, during some periods, and some seasons. This change then was not absolute but one of emphasis. Certainly Paleoindian groups, especially evident in the Mountain-Foothills region, often or periodically utilized smaller animal species and plants. Grinding stones, usually implicated as circumstantial evidence for plant food processing, become more common in the archeological record through the middle Holocene. Some of these stones, however, possess evidence that they were used for grinding pigments (e.g., Grange 1980) as was common during Paleoindian times. Also, Frison (1991b:333) indicates that grinding stones for processing pine nuts and perhaps other vegetal foods were in common use by late Paleoindian time in the Mountain-Foothills region.

Storage and food processing technology also developed or changed significantly during the Mesoindian period. Some elements of food storage and processing which are first developed during this period become central or key components of late prehistoric adaptations (cf., Wolley and Osborn 1991). One Mesoindian development was the making of pemmican for storage and transport (Reeves 1990; Fawcett 1985), but this apparently happened relatively late. It is only after about 4000 B.P. that features representing intensive fat production from bone are found in the archeological record. Such fat was an essential ingredient for pemmican. What were the factors which selected for this intensive and distinctive method of utilizing bison resources? Was it tied to seasonal sedentism in areas with few fat and protein sources? What was the role of competition, demographic changes, environmental change, and bison herd availability? Is there a concomitant change in settlement systems and other elements of technology?

Tracking hunter-gatherers across the landscape is enhanced by seasonal determinations of site occupations, as has been possible for some bison kill and pit house occupations. Linking multiple Mesoindian sites, however, will require use of lithic assemblages and study of artifact function, style, and technology in relation to lithic resource types and availability (Ingbar 1985; Keyser and Fagan 1993; Larson 1990; Francis 1991). Knowledge of the natural distribution of lithic materials and the ability to source them accurately is an important first step in the study of group mobility and organization through lithic studies.

Are the similarities within the range of Paleoindian or Mesoindian assemblages always greater than the differences between Paleoindian and Mesoindian assemblages? The answer is, not surprisingly, no. Simms (1988) and others (Frison 1992; Forbis 1992; Kornfeld 1988; Michlovic 1986; and Bamforth 1991a) have argued for elements of continuity between Paleoindian and Mesoindian. If we approach the study of the hunter-gatherer archeological record in terms of its diversity as reflected in artifacts, structures, site patterning, and resource use, and monitor changes in this diversity through time which resulted from the operation of numerous selective forces, including environmental change, demographic growth, competition, and effectiveness of social and information systems, we will open the exciting possibility of learning about what the past was like and how changes came about rather than simply classifying sites and assemblages into static archeological formulations.

The Mesoindian or Archaic period in the Central Plains and Foothills-Mountain region must be understood if we are to understand the archeological records which preceded and developed from it. The Mesoindian period holds important keys to understanding hunting and gathering peoples who occupied the Plains-Mountain region from the first settlement of the New World until the historic period. The primary factors influencing the human groups who lived in the Central Plains region during the Holocene from 8,000 to about 1,500 years ago include the highly seasonal climate, changing climatic conditions, reduced effective moisture and productivity of the Plains region compared to the late Pleistocene, and increased regional human population (measured in terms of site frequency or artifact frequency by period). It is profitable to contrast the Archaic and the Paleoindian archeological records in the Central Plains not in terms of radical differences but in terms of changing emphasis in economy, technology, organization, and land use strategies.

Summary of Central Plains Mesoindian Archeology

A number of Archaic archeological complexes have been recognized in the Central Plains region. The primary taxonomic units defined by archeologists are summarized here with selected information provided for key sites. Location of selected Mesoindian sites is shown in Figure 33.

Logan Creek Complex

The Logan Creek complex was first recognized through research at the Logan Creek site, 25BT3, in Burt County, northeastern Nebraska (Kivett 1958, 1962; Witty 1957, Mandel 1995; Thies and Witty 1992; Grange 1980:45-47; Anderson et al. 1980:263; Bozell 1994). This complex is characterized by side-notched projectile points, usually with straight to concave bases which are often ground. Point length ranges from 3 to 5 cm, but reworking of blades is common. Unnotched lanceolate points of similar form also occur at several sites. Side-notched points with tips reworked to form hafted endscrapers are also considered diagnostic (Thies and Witty 1992:Figure 2). These artifacts appear to be projectile points which were reworked into hafted scrapers, perhaps after the tips had broken. Whether the scrapers were ever reworked back into points is unclear and would probably depend on need and length of the specimen. Grinding stones and a variety of other stone tools are documented. Some grinding stones have evidence of red ochre (Grange 1980:45), so they do not all necessarily reflect plant food processing. Lithic materials often include some exotic materials from distant sources (e.g., Anderson et al. 1980:Table 9.9). Available radiocarbon dates indicate a time from about 6,000 to 7,500 years ago. Faunal remains are dominated by bison in all reported sites, but a variety of smaller animals are well represented, most notably dog (or other canids), deer, antelope, rabbit, fish, birds, and mussels. Bison is the primary fauna at sites where bones have been studied. Sites referred to the Logan Creek complex have been reported from western Iowa through western Nebraska and Kansas.

Early Holocene side-notched projectile points occur in sites and complexes throughout the western Plains and portions of the Rocky Mountains. Early side-notched or Early Plains Archaic evidence comes from locations such as Hawkin (Frison et al.

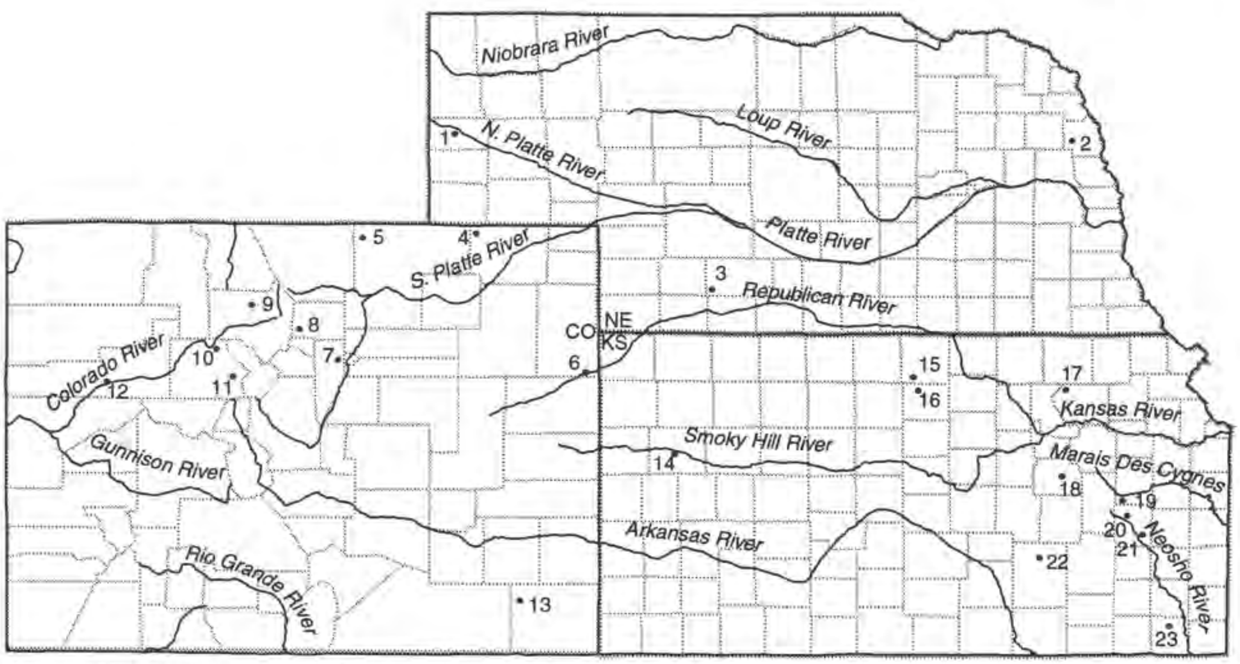


Figure 33. Location of selected Mesoindian sites in the Central Plains. Nebraska: 1. Signal Butte; 2. Logan Creek; 3. Spring Creek; Colorado: 4. Dipper Gap; 5. Wilber Thomas; 6. Hutton-Pinkham; 7. Magic Mountain, LoDaiska; 8. Albion Boardinghouse, Hungry Whistler; 9. Granby, Hill Horn; 10. Yarmony; 11. Vail Pass; 12. Kew Claw; 13. McEndree Ranch; Kansas: 14. 14LO8; 15. Matter Mound; 16. Range Mound; 17. Coffey; 18. William Young; 19. Cow Killer; 20. Williamson; 21. Colvin; 22. Faulconer and Snyder; 23. Stigenwalt

1976), Laddie Creek (Larson 1990), Mummy Cave (Wedel et al. 1968; McCracken 1978), Medicine Lodge Creek (Frison 1976, 1991b), Helen Lookingbill (Frison 1983; Larson 1991), and elsewhere in Wyoming and Colorado (Cassells 1983; Lischka et al. 1983; Lintz and Anderson 1989).

On the Northern Plains the Gowen (or Mummy Cave) complex, represented by sites such as the Gowen site near Saskatoon (E.G. Walker 1988) and the lowest level at Head-Smashed-In bison jump (Reeves 1978), is characterized by side-notched projectile points dating before 5,500 years ago and is approximately contemporary with Logan Creek (Forbis 1992). To the far west in Idaho and into Montana, the Bitteroot complex and notably the Bitteroot point type has been recognized as comparable to Logan Creek (Frison 1991b; Forbis 1992; Lahren 1976).

Central Plains Logan Creek Sites

Several excavated sites in western Iowa have components referable to the Logan Creek complex. These include Cherokee Sewer (Cultural Horizons I and II), Simonsen, Hill, Turin, Lungren, Pisgah, and Ocheyedan (Anderson et al. 1980). These sites include bison kills, camps, and burials. Zone 7 at the Simonsen site represents a bison kill which yielded three projectile points. This stratum is about 5 m below the surface (Agogino and Frankforter 1960; Frankforter and Agogino 1960), and a single radiocarbon date of 8430 ± 520 B.P. is reported. This is currently the earliest date which might be attributed to the Logan Creek complex. Campsites are represented by the Hill and Lungren sites near Glenwood on Pony Creek. At the Hill site (Anderson et al. 1980:262; Frankforter 1959) the primary cultural level was about 5.7 m below the surface and contained a hearth, five side-notched points, an unnotched point, notched and unnotched endscrapers, and remains of bison, deer, turtle, and bird bone. A radiocarbon date of 7250 ± 400 B.P. is reported. Lungren (Brown 1967) is another camp which was minimally investigated and had a single side-notched point and a radiocarbon date of 6280 ± 120 B.P. (Reeves 1973:1238). Turin, near the town of the same name, yielded evidence of four burials about 6 m deep in a loess deposit (Anderson et al. 1980). An adult male, an adolescent, a child and an infant are represented. The adolescent was buried with shell beads and red ochre in a flexed position. A side-notched projectile point was found with the burials or in the same stratum. Radiocarbon dates on bone indicate a minimum age of 4720 ± 250 B.P. and bison bone from below the burials is dated to 6080 ± 300 B.P. The Lansing burial in a loess deposit in northeastern Kansas has also yielded radiocarbon dates which are of comparable age (Table 23). Logan Creek artifacts are shown in Figure 34.

Cherokee Sewer Site. One of the more important and well-documented Logan Creek sites is the stratified Cherokee Sewer site (Anderson and Semken 1980). Cultural levels I and II yielded side-notched projectile points in association with bison remains in what are interpreted to represent processing and camp areas associated with nearby kills. The relatively narrow side-notched points from Cultural Level I are associated with radiocarbon dates of 5950 ± 80 B.P. and 6300 ± 90 B.P. The broader side-notched points in Cultural level II are dated to 7370 ± 100 and 7480 ± 100 B.P. and a number of unnotched points occur in this level as well. Endscrapers are common especially in Cultural Level II, and a variety of other chipped stone, bone, and ground stone artifacts are reported. These Archaic levels are from 3 to 7 m below the surface. The paleoecological record from Cherokee Sewer makes it one of the more important middle Holocene records in the region (Anderson and Semken 1980).

Logan Creek Site. The Logan Creek site is located south of Oakland in Burt County, Nebraska and was investigated during the late 1950s and early 1960s by Kivett with support from the National Science Foundation. This stratified site had eight distinct horizons designated A through H from top to bottom which were initially interpreted as units contained in an alluvial terrace. A series of radiocarbon dates were derived from charcoal ranging from about 6,600 to 7,300 years ago, but these were not in stratigraphic order. The extensive excavations at this deeply buried site have never been fully reported (Bozell 1994:97), but evidence of hearths, pits, and several possible postmolds were found. Faunal remains were dominated by bison bone (Snyder and Bozell 1983), but a variety of other species are represented including deer and fish. The faunal assemblage has never been adequately studied and reported. This important tool assemblage has not been fully documented, but the projectile points are triangular with side notches (usually deep) and slightly to deeply concave bases. Notched endscrapers made from recycled or broken points are also common (Thies and Witty 1992), as are other scrapers, bifaces, drills, and ground stone artifacts. Bone and antler tools as well as a fishhook were recovered.

Reinvestigation of the site context and stratigraphy in 1992 provided important new perspectives on the site's depositional history and age. Six new radiocarbon dates and a revised interpretation of the site formation add to an understanding of Logan Creek (Bozell 1994; Mandel 1995). The site is located on an alluvial fan on the eastern edge of the Logan Creek valley and formed as a result of sediments washing downslope and accumulating in the valley floor. The new radiocarbon dates are in good stratigraphic order and indicate that the upper six Archaic components date from 7,350 to 6,020 years ago.

Spring Creek Site. Archeological salvage work in Frontier County, Nebraska, along Red Willow Creek in 1961 were focused in part on the Spring Creek site, 25FT31 (Grange 1980). Spring Creek was initially recorded during a 1948 survey on the second terrace above Red Willow and Spring creeks near the confluence of the latter. The deeply buried Archaic component was exposed during borrow pit excavation and dam construction and was heavily impacted prior to archeological work and eventually destroyed by borrow operations (Grange 1980:12, 21-47). The Archaic component was about 3 to 4 m below the surface and only a portion of the original occupation area could be studied. Use of heavy equipment to remove overburden enabled the small field crew to excavate a significant sample of the site. A grid of 5 foot squares was used for horizontal reference in Area

Table 23. Mesoindian Radiocarbon Dates from the Central Plains.

Site/Location	Complex	Date	δ	Lab#	Mat.	Ref.
Colorado						
Hungry Whistler	Mt Alb.	5300	130	I-4418	ch	
5BL67	Mt. Alb.	5520	190	I-9434	ch	
	Mt. Alb.	5730	130	I3817	ch	
	Mt. Alb.	5800	125	I-3267	ch	
5BL70	Mt. Alb.	5300	130	I-4419	ch	
	Mt. Alb.	5650	145	I-3023	ch	
5BL73 Albion bh	Mt. Alb.	5730	145	I-5020	ch	
Fourth of July	Mt. Alb.	5880	120	I-6544	ch	
5BL120	Mt. Alb.	6045	120	I-6545	ch	
Ptarmigan	Mt. Alb.	6450	110	I-7458	ch	1
5BL170		6205	170	I-10976	ch	
		4620	95	I-8562	ch	
		4700	95	I-8563	ch	
		4745	95	I-8280	ch	
Yarmony		4790	70	Beta-28131	ch	2
5EA799		6030	100	Beta-25076	ch	
		6080	100	Beta-25079	ch	
		6290	150	Beta-23788	ch	
		6290	70	Beta-25077	ch	
		6320	90	Beta-21197	ch	
		6330	100	Beta-25075	ch	
		7050	200	Beta-25078	ch	
Vail Pass	Mt. Alb.	5055	100	I-9388	ch	3
5ST85		6750	120	WSU-1752	ch	
		6885	115	UGa-1148	ch	
		7320	160	WSU-1754	ch	
		4690	120	WSU-1755		
		4510	120	WSU-1750		
Granby		7170	200	Beta-2976		4
		4665	140	Beta-4945		5
		5250	70	Beta-4704		
		6100	125	Beta-4948		
		6120	140	Beta-4944		
		7190	280	Beta-5132		
Hill Horn		4400	70	Beta-3569		4
		4820	80	Beta-3568		5
		5960	90	Beta-3565		
		4960	80	Beta-3567		
		5870	100	Beta-3566		
		6220	110	Beta-3422		
		6860	100	Dic-2328		
		7960	140	Beta-3192		
Pontiac Pit		4710	120	Beta-6882		6
Cherry Gulch		5730	220	UGa-1230	ch	
5JF63		3460	75	UGa-1069		4
Helmer Ranch		5780	160	W-272	ch	
Magic Mtn	Magic Mtn	4930	250	W8/70-71		
LoDaisKa	E.Archaic	4840	250	M-1009		4
Hutton-Pinkham		4310	200	Beta-35336	csoil	
Dipper Gap	McKean	3180	90	UGa-456		
	McKean	3410	90	UGa-435		
	McKean	3520	85	UGa-455		
Phoebe Shelter	McKean	3570	60	Beta-3869		
5LR161	McKean	3890	60	Beta-3870		
Spring Gulch	McKean	2830	135	UGa-671		
5LR252	McKean	3095	75	UGa-672		
	McKean	3855	350	UGa-1048		
	McKean	3700	105	UGa-1047		
Pack Rat Shltr	McKean?	2440	80	Beta-2285		
5LR170	McKean?	2480	90	Beta-2288		
	McKean?	2760	100	Beta-2286		
Kinney Spring	McKean	3110	130	Beta-7330		
5LR144c	McKean	3250	80	Beta-6847		
	McKean	3800	70	Beta-7333		
Blue Lake V		3215	90	I-8281	ch	
5BL141 Draper Cave		3520	70	UGa-736		
5CR1		3480	65	UGa-737		
Lindenmeier	Archaic	5015			ch	7
Willowbrook		2215	75		ch	8
5JF6						
5JF10	Mag Mtn	2140	250			9
Kewclaw	L.Archaic	2770	60	Beta-3840		4
McEndree Ranch	L.Archaic	2170	65	Dic-1258		4
		2350	55	Dic-1254		
5AH6 Witkin Burial		3190	80	BXO-725	bn	10
	L. Archaic	2900	60	Beta-3339		
Site/Location	Complex	Date	Sigma	Lab#	Mat.	Ref.
Nebraska						
Signal Butte	McKean	4550	220	L-385B		
	McKean	4170	250	L-385D		
Logan Creek	Logan Cr	6633	300	M-837	ch	
25BT3		7250	300	M-1018	ch	
		6900	280	I-803	ch	
25FT31 Spring Creek	Logan Cr	5680	160	M-1364	ch	3
Allen		5256	350	C-65	ch	11
25FT50 Walker	Gilmore	6090	500	M-1130	ch	
25CC28						
Kansas						
Lansing 14LV315		7825	105	GX-586	bn	12
		6970	200	SI-360	bn	
		6700	250	M-1890	bn	
		4610	200	SI-360-R	bn	
William Young	Munkers	5340	160	GaK-297	ch	
14MO304	Munkers	3100	400	GaK-595	ch	
	Munkers	3400	500	GaK-596	ch	
	Munkers	7300	2000	GaK-1735	ch	
14OS347 Cow Killer	Munkers	4980	100	I-12905	ch	
Coffey 14PO1	Munkers	5030	65	WIS-776	ch	
14PO1	Munkers	5080	65	WIS-774	ch	
	Munkers	5070	70	WIS-778	ch	
	Munkers	5125	70	WIS-634	ch	
	Munkers	5140	65	WIS-779	ch	
	Munkers	5155	70	WIS-618	ch	
	Munkers	5160	70	WIS-628	ch	
	Munkers	5170	70	WIS-623	ch	
	Munkers	5240	70	WIS-624	ch	
	Munkers	5255	70	WIS-636	ch	
	Munkers	5285	70	WIS-629	ch	
	Munkers	5355	70	WIS-711	ch	
	Munkers	5505	105	UGa-382	ch	
	Bl.Verm.	4840	95	N-1549	ch	
	Munkers	5680	130	N-1550	ch	
	Munkers	6285	145	WIS-715	ch	
Coffey IV	Walnut	2480	55	DIC-1358	ch	
Coffey IV	Walnut	2320	60	DIC-1357	ch	
Stigenwalt 14LT351		1970	70	TX-5673	hm	13
		2470	60	TX-5674	hm	
		7410	70	TX-5694	ch	
		7590	100	TX-6050	ch	
		8130	130	TX-6048	ch	
		8810	250	TX-6049	ch	
14MM1	Nebo Hill	4020	90	UGa-4085	ch	
14MM1	Nebo Hill	3885	135	UGa-4084	ch	
Burbin 14EL331		5600	110	I-8179	ch	
14LY305	El Dorado	3780	140	GaK-594	ch	
14MY309	El Dorado	3680	180	GaK-598	ch	
Williamson	El Dorado	3600	100	GaK-407	ch	
14CF330	El Dorado	3500	100	GaK-406	ch	
14GR307		3250	140	GaK-775	ch	
De Shazer	Bl.Verm.	5320	790	?	ch	
14MH39	Bl.Verm.	4215	180	?	ch	
14BU50 Falconer	El Dorado	3100	165	N-1552	ch	
Snyder 14BU9	Chelsea	4830	105	N-1279	ch	
14BU9	Chelsea	4600	125	N-1280	ch	
14BU9	El Dorado	3980	100	N-1278	ch	
	El Dorado	3910	160	N-771	ch	
	El Dorado	3650	140	N-770	ch	
	El Dorado	3240	85	N-1277	ch	
14BU9	Chelsea	4150	110	N-1551	ch	
	Walnut	2060	80	N-1276	ch	
	Walnut	1970	110	N-769	ch	
Milbourne 14BU25	Chelsea	4568	100	UGa-2806	ch	
Lewis 14CS301		2850	120	GaK-774	ch	
Bean Hollow 14MH1		2350	250	M-868	ch	

ch=charcoal, bn=bone, sc=solid carbon, csoil=carbonaceous soil, hm=soil humates

References: 1 Benedict 1981; 2. Metcalf and Black 1991; 3. Gooding 1981; 4. Cassells 1983; 5. Wheeler and Martin 1984; 6. Liestman 1984; 7. Haynes et al. 1960; 8. Leach 1966; 9. Nelson 1969; 10. Swedlund 1966; 11. Libby 1955; 12. Brown and Simmons 1987; Thies and Witty 1992; 13. Thies 1990.

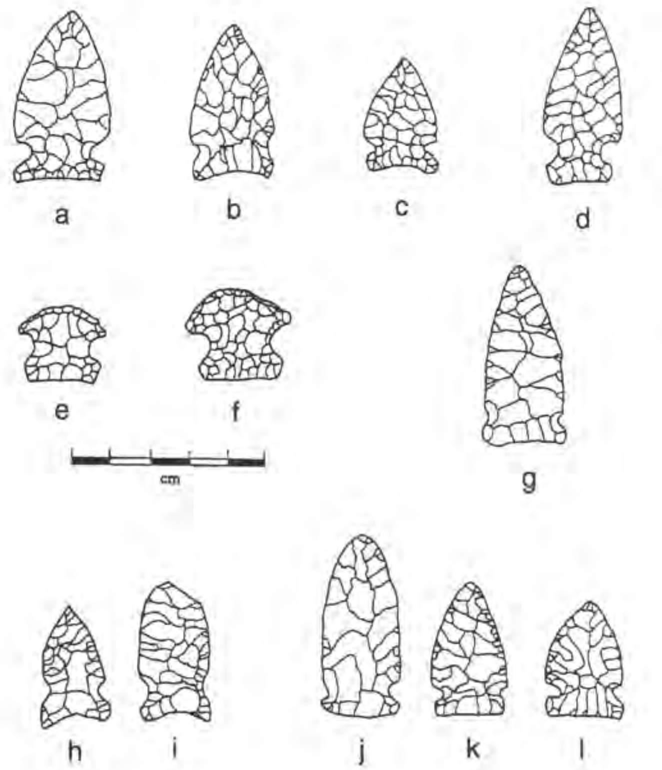


Figure 34. Logan Creek complex artifacts from the Central Plains. a-d. Logan Creek points, Logan Creek site, NE; e-f. Logan Creek scrapers, Logan Creek site, NE; g. Logan Creek point, Cheyenne County, NE; h-i. Logan Creek points, Spring Creek site, NE; j-l. early side-notched points, LoDiaska site, CO (from Bozell 1994; Thies and Witty 1992; Carlson and Jensen 1973; Grange 1980; Greiser 1985).

2 which was the largest excavation. The total area excavated was approximately 160 m^2 and the matrix was not screened. Several features were documented including bone concentrations, charred bone and rock concentrations, shallow basins, shallow pits, and a cluster of three ground stone artifacts with red pigment staining. One bone concentration also included pieces with red stained surfaces. A single radiocarbon date based on charcoal pieces combined from six features resulted in an age of 5680 ± 160 B.P. (M-1364).

Of the 276 stone and bone artifacts recovered were 21 projectile points and fragments including side-notched and unnotched forms comparable to those from Logan Creek (Grange 1980:Figure 8). Endscrapers (unnotched), bifaces, a variety of flake tools, and flake debris were also found. Reported bone artifacts include some probable and some questionable pieces which merit reevaluation given modern awareness of taphonomic processes which can affect bone breakage and surface modifications. A tubular bird bone bead was also recovered as was a single human tooth.

Faunal remains were dominated by bison, represented by 454 of 541 reported pieces and an MNI of 12 (Grange 1980:Table 9; Appendix 1. Tables 1-3.). There may have been as many as 18 bison based on Grange's tabulation in Table 2 which indicates 18 right mandibles. Other species of importance include dog or wolf (NISP=55, MNI=5), rabbit (MNI=2), and gopher (MNI=3), but the later could represent natural background fauna. Other species, each having an MNI of 1, include swift fox, deer, antelope, beaver, prairie dog, vole, duck, goose, and a small bird. Remains of shell fish is also reported from the features. Grange (1980:45) suggests that, "the excavated part of the camp at 25FT31 represents the debris left by a group of between five and ten people for a period of two to four months."

Mount Albion Complex

Research by Benedict and associates since the mid 1960s has focused on several problems of high altitude archeology in the Indian Peaks area of the Rocky Mountains Front Range in north-central Colorado along the continental divide. One target of this research has been the investigation of middle Holocene climatic change on human habitation in the region. Research at the Hungry Whistler and 5BL70 sites was part of this research to study the impact of the Altithermal on human use of the region through the Holocene, and these sites served as the focus for definition of the Mount Albion complex (Benedict and Olson 1978). A number of additional sites and surface collections are documented which contribute to the definition of this high-altitude seasonal game drive complex. Sites are between 2,300 and 3,700 m ASL. Game drive sites were often reused due to preferred or suitable terrain in mountain passes which were funneled routes of animal travel and probably movements of human groups as well. Species, which were the focus of such hunting efforts (along drives), are not well documented from the archeological investigations but are assumed to have included mountain sheep and possibly bison. Deer and elk are also common in the area.

The technology of Mount Albion sites is characterized by corner-notched, corner-removed, or side-notched dart points which exhibit convex bases and are generally heavily ground on the base and stem. Blade forms vary widely reflecting common reworking and heavy use and recycling of points as cutting and scraping tools. Lithic materials are most commonly quartzite, quartz, and argillite. A variety of unifacial cutting and scraping tools and bifacial implements and preforms are reported and many of these were apparently intensively utilized and recycled. Grinding stones are documented which may reflect vegetal food processing, perhaps in conjunction with preparation of winter stores, and red "pigment stones" are common.

Mount Albion Complex Sites.

Hungry Whistler. Excavation at 5BL67 included a total of 73 m^2 using natural levels and 2.5 cm excavation levels with excavation fill screened by .5 m quadrants of each unit. The site has a complex formational history and is in a dynamic periglacial landscape. Detailed study of stratigraphy, lichenometry, geomorphology, freeze-thaw processes, and radiocarbon dating have provided important clues about changing snow, moisture, and frost intensity during the

Holocene (Benedict 1978:31). Several hearths were encountered, with variously dispersed charcoal and these provided samples for five radiocarbon dates primarily between 5000 and 6000 B.P. A number of stone cairns occur in the site area and three of these were excavated and studied in detail. They were stratigraphically associated with the Mount Albion component and had flakes, charcoal, a Mount Albion point, core, and pieces of red ochre in close association.

5BL70. Site 5BL70 is located a distance of about 150 m east of the Hungry Whistler site on the same ridge (Olson 1978).

Magic Mountain Complex

Research at the Magic Mountain site, located in the hogback ridges about 15 km west of Denver in the Rocky Mountains foothills, provided one of the earliest documented well-stratified Holocene archeological records in Colorado (Irwin-Williams and Irwin 1966). Zones F-D, the deepest cultural levels at this open campsite, yielded a radiocarbon date (Zone E) of about 5000 B.P. and a series of notched dart point forms. These materials were designated the Magic Mountain complex and believed to represent a local mountain adaptation. Benedict (Benedict and Olson 1978:127-128) suggests that these materials represent mixed assemblages rather than a single cultural complex. The large corner-notched points are comparable to the Mount Albion complex defined by Benedict. Some materials from the lower levels of the LoDaisKa Rockshelter, about 10 km south of Magic Mountain, are also attributed to the Mount Albion complex (Benedict and Olson 1978).

McKean Complex

The McKean complex was defined based on research at the McKean site at Keyhole Reservoir in northeastern Wyoming where Mulloy (1954; Wheeler 1952, 1954) defined assemblages with distinctive projectile point forms dating to the Middle Prehistoric Period (Mulloy 1958). The Middle Period, or Plains Archaic was very poorly known at the time and research at McKean helped establish a regional chronology for the middle Holocene. The presence of human remains at the McKean site also brought attention to the site. Recent summaries of the McKean complex have been provided by Greiser (1985:91-97), Sundstrom (1989:48-56), Frison (1991b:88-101), Forbis (1992), and a series of key papers in Kornfeld and Todd (1985).

The McKean complex includes a variety of distinctive projectile point types including McKean Lanceolate, straight-stemmed Duncan points, and slightly expanding stemmed Hanna points, and the large triangular side-notched Mallory point type (Greiser 1985:Figure 35; Wheeler 1985; Frison 1991b:Figure 2.52; Lobdell 1974; Benedict and Olsen 1973). Bases are usually deeply concave and the Mallory points usually have a basal notch. Greiser (1985:91) suggests that the Hanna type may be the most recent and date slightly later than the others in the McKean technocomplex. These types occur in collections from the Oklahoma Panhandle, western Kansas, eastern Colorado, and western Nebraska. It is not clear how far east these types occur. Key excavated sites with McKean components in the Central Plains include Signal Butte in western Nebraska, Dipper Gap, Wilber Thomas, Hutton-Pinkham, Magic Mountain, and LoDaisKa in Colorado. Campsites on butte tops, terraces, and in shelters are represented, but kill sites are not yet reported in the area although these occur to the northwest (Brumley 1975, 1978; Fawcett 1985; Lobdell 1973; Reher et al. 1985; Miller 1985; Morris et al. 1985). Examples of McKean artifacts are shown in Figure 35.

In the Colorado Plateau and Great Basin area similar projectile points are generally classified as Pinto and the relationships of those groups using McKean and Pinto points is a topic of some interest (Metcalf and Black 1991; Green 1975; Gooding and Shields 1985). Mallory points are represented at sites studied in the North Park Colorado inventory (Lischka et al. 1983), the Albion Boardinghouse site (Benedict 1975), and elsewhere in Colorado (Lintz and Anderson 1989). These points are generally comparable to the San Rafael Side-Notched in the Colorado Plateau area (e.g., Gooding and Shields 1985).

Whether McKean technology developed in the Rocky Mountains region with McKean lanceolate derived from terminal Paleoindian Foothills-Mountain complexes, such as Lusk and Pryor, remains undemonstrated. The chronologically intermediate early side-notched complexes may reflect multiple technological traditions or a period of economic and technological readjustment. It has also been suggested that the early side-notched, and possibly the McKean tradition as well, is the result of eastern immigrants onto the Plains (Forbis 1992). The nature of any direct relationships between projectile point types and distinctive cultural groups remains an open issue. For the most part it has not been possible to identify specific projectile point types which occur exclusively with specific historically known tribal groups on the Plains, with perhaps a few broadly defined exceptions (cf. Reher and Frison 1980; Fawcett 1980).

In the Northern Plains, the Oxbow complex is approximately coeval with McKean, with the earliest Oxbow dates a few centuries earlier than McKean (Forbis 1992; Morlan 1993, 1994). By 5,000 years ago, McKean and Oxbow assemblages occurred with bison and antelope remains forming important economic components (Forbis 1992). Oxbow projectile points are triangular with deeply concave bases and side notches which often result in a prominent basal "ears."

Economy of the McKean people in the Central Plains region apparently focused on bison, at least during some seasons and periods, and bison bone is common in some assemblages (see papers in Kornfeld and Todd 1985; Frison 1991b; Forbis 1992). In the Rocky Mountains and foothills, mountain sheep and mule deer were also important economic species. Several sites include evidence of antelope utilization or procurement and antelope is occasionally the dominant species (Keyser and Davis 1985; Forbis 1992). Some sites include a wide range of species including numerous small mammals, shellfish, antelope, and deer. Plant foods were probably also of importance but have not been adequately preserved, recovered, or studied, so it is

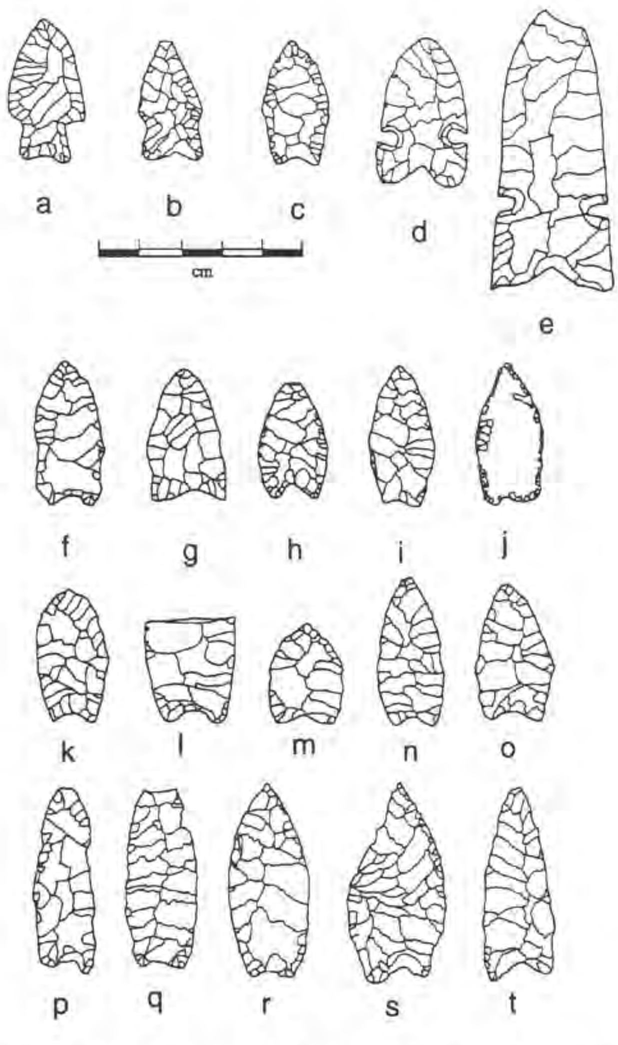


Figure 35. McKean complex artifacts from the Central Plains. a-c. Duncan-Hanna points, Cheyenne County, NE; d-e. Mallory points, Kearny County, KS; f-t. McKean points from Signal Butte, NE (a-c after Carlson and Jensen 1973, f-t after Forbis 1985).

difficult to evaluate the seasonal or long-term significance of these varied resources in the Middle Archaic diets of the region (Keyser 1986; Kornfeld 1985, 1996). The presence of grinding stones at several sites (e.g. Breternitz 1971) also suggests that plant food processing may have played an important role in some seasons or years, but grinding stones were not necessarily always used for plant food processing (Forbis 1992). Technological developments including roasting pits and stone boiling and probably pemmican making, which included bone grease extraction, were well in place by the end of McKean times (Fawcett 1985; Reeves 1990; Forbis 1992).

We should expect some seasonal variability in the economy and habitation and activity site types for McKean in the Central Plains and Mountains. Bison hunting was apparently of some significance in some locations at least during some years, but there may have been significant variability in the availability of bison within specific regions on both a seasonal and long-term basis. Rockshelters, such as Wilber Thomas Shelter, LoDaiska, and Mummy Cave, probably served as important winter occupation sites but also would have been used as short-term camps during logistical forays of task groups. The occurrence of butte-top occupation sites, such as Dipper Gap and Signal Butte, suggest warm season (at least not midwinter) occupation during which ungulate hunting was a primary activity. Butte-top sites provided rapid information gathering (overlooks) and were perhaps also important because of reduced flying insect populations and for communication or signaling. The Dipper Gap site is also close to the Flattop chalcedony lithic source which may have made it a likely gearing-up camp for seasonal bison hunting.

Evidence from several sites suggests that middle Holocene Plains hunter-gatherers were not primarily broad spectrum gatherer/foragers during all seasons. It is also probable that successful bison or antelope hunting would not occur without purposeful gearing up or maintenance of specialized technologies, but this may have been done with seasonal emphasis rather than as a full-time specialization.

Open air sites in unprotected settings which lack pit houses, such as Hutton-Pinkham, were most likely occupied during the milder seasons when a wide range of fruits, tubers, and seeds would have been available which could have served either as primary or supplemental food sources (Latady and Dueholm 1985). Stone circle sites are relatively common on the open Plains and were in use at least by McKean times (Forbis 1992:58; Frison 1991b: 92; Stuart 1990), probably a reflection of relatively mobile seasonal camps.

Pit houses are documented at an increasing number of sites (Larson and Francis 1996) in the Plains and the Mountain-Foothills region, and are generally assumed to reflect winter or cold season occupations (e.g., Metcalf and Black 1991). They occur from the Plains (e.g., Shields 1980; Lintz et al. 1995) to middle elevations (e.g., Gooding 1981). The model proposed by Osborn (1993) for winter season ungulate (mule deer, sheep, bison) hunting in upland settings in the Southwest provides an important model for consideration for the Central Plains and Rocky Mountains region. The relationships of these various site types, open camps, rockshelters, butte tops, and pit houses, in open plains, foothills, and mountain settings remain unresolved or debated. Seasonal and long-term variability in resource availability are assumed to have had a direct influence on the economy, mobility, and land use patterns of middle Holocene people.

Central Plains McKean Complex Sites

Dipper Gap Site. The Dipper Gap site (5LG101) is located about 37 km north of Stoneham, Colorado on a butte top south of "Dipper" valley (Metcalf 1974). Dipper valley was named for its numerous springs, which were probably attractive to prehistoric people, and the Dipper Gap site is named for a gap in the butte forming the southern margin of this valley. This is a short grass region but with a wide variety of plant and animal resources available in the immediate locale (Metcalf 1974:Tables

1-5). The Flattop Butte chalcedony source can been seen in the distance about 19 km east of Dipper Gap, so the location was well situated for exploitation of a variety of resources. Bison remains, however, dominate the fauna from the site.

The principal occupation area was designated Locality I and occurred in a large jagged crack about 29 x 5 m in size which had formed in the caprock of the butte. The 1972 excavation exposed an area of about 95 m^2 in the crack or Locality I and excavation was primarily within the top 1 m of deposit and rarely extended more than 1.5 m below the surface. Previous excavations had occurred at the site (J. J. Wood 1967), and the 1972 work began by cleaning out these old units. Excavations were controlled by 2 m squares with 20 cm levels, and fill was screened through .25 inch mesh. Locality II on the butte top, was excavated in 1 m units, and the small trench (1 x 4 m) was excavated in Locality III under a small overhang (Metcalf 1974: Figure 3).

A number of features were documented, and charcoal from three of these in the crack area excavation was submitted for radiocarbon dating. The dates (3180 ± 90, UGa-456, Feature 16; 3410 ± 90 B.P., UGa-453, Feature 5; 3520 ± 85 B.P., UGa-455, Feature 10) indicate a range for the McKean occupation at Dipper Gap from 3,100 to 3,600 years ago (uncorrected; Metcalf 1974:36; Morris et al. 1985:Table 3.1). Zone D at Dipper Gap contains the McKean and Mountain complex middle Holocene deposits. The features included 21 hearths, several of which were superimposed over other hearths indicating redundant use of the site by McKean people. Hearths of several types were recognized including basins with fire-cracked rock and shallow charcoal concentrations which appear to have been surface fires.

The chipped-stone artifact assemblage from Dipper Gap includes 708 items representing nine categories, plus 70,039 pieces of chipped stone debitage from the controlled excavation. The collection from the crack includes 73 projectile points and fragments, 79 bifaces, 50 endscrapers, 52 side scrapers, 47 retouched flakes, 23 drills and perforators, 13 spokeshaves, a composite tool, and 29 core/choppers. Lithic materials are dominated by Flattop chalcedony (97% of the debitage and 84% of the tools). Other cherts and quartzites are also represented. Ground stone artifacts from the crack include 23 handstones and fragments, 21 grinding slabs and pieces, and three abraders. Numerous pieces of hematite and limonite were also recovered, especially in the lowest levels. Bone artifacts include three awls, three scraping tools, one bird-bone bead, and six incised discs (most of the latter were from near a feature in Locality II on top of the butte). This range of artifacts suggests a variety of maintenance, processing, and extractive activities which probably involved a significant cross section if not the total social group. Hunting, hide processing, vegetal food processing, and manufacture of tools, equipment, containers, garments, etc., are all indicated.

Faunal remains are dominated by bison, with a minimum of seven animals represented, and butchering marks common. Additional species include rabbit, ground squirrel, marmot, dog or coyote, antelope, deer, turtle, and duck. Evidence for butchering also occurs on some canid elements. Metcalf (1974:174) offers this speculative model of how the Dipper Gap site might fit into the overall settlement system of middle Holocene foragers in the region.

> During the spring and early summer, the Plains are better watered than at other times of the year. One possible pattern of seasonal migration could be: fall banding together for communal hunts, winters spent in sheltered sites nearby, spring and early summer spent foraging on the Plains, summers spent in the high mountains, and a return to the foothills and Plains for fall hunting.

As noted by Metcalf, this speculative model can serve as a target for further evaluation.

Signal Butte Site. The Signal Butte site is located on a prominent mesa about 34 km southeast of Scottsbluff, in Scottsbluff County, Nebraska overlooking Kiowa Creek, and south of the North Platte river. The site was brought to the attention of William Duncan Strong in 1931, who visited the site that summer and followed that with intensive excavations during June and July of 1932 (Strong 1935:224-239). The lowest cultural horizon was designated Level I and occurred above alluvial gravels which capped the Butte. This level was covered with as much as 8 feet of loess which contained at least two distinct later components separated from Level I by 1.5 feet of sterile deposits. Excavations were conducted using 5 foot squares and natural levels with all fill screened (mesh size not indicated). The butte top is approximately the size of three tennis courts, of which approximately half of the archeological deposit was excavated by Strong (Strong 1935; Forbis 1985). The total excavation was at least 20 (east-west) by 65 (north-south) feet (Strong 1935) or about 117 m^2. Over much of this area, Level I was at a depth of 1-2 m.

The historical significance of the Signal Butte site extends well beyond the specific cultural complexes represented by the stratified deposits (Strong 1935; Forbis 1985; Wheeler 1985). Signal Butte has served as a pivotal site, bolstered by subsequent investigations at sites such as Ash Hollow Cave (Champe 1946) and Mummy Cave (Wedel et al. 1968), in demonstrating a long occupation sequence in the Plains region contrary to popular anthropological notions during the early decades of this century (e.g., Kroeber 1939).

The Signal Butte assemblage is one of the larger McKean assemblages documented, with 1,119 chipped stone artifacts reported by Strong (1935), who also noted a mass of retouch pieces, flakes, and cores from the site which he considered a workshop as well as habitation site. This includes 674 points with types now recognized as McKean lanceolate, Hanna, Duncan, and Mallory points all well represented (Mallory points being the least common). Other tool forms include 445 bifacial ovoid "side scrapers" (bifacial preforms), 491 endscrapers, 217 unifacial side scrapers, 277 flake knives, 124 drills and gravers, and a variety of other artifacts including spokeshaves (Strong 1935:234). Bone and antler artifacts from Level I totaled 72 specimens including 15 knapping tools, 36 awls, five large bone scrapers, 12 incised bone fragments, four bird bone beads, and numerous worked or split bone pieces. A possible shell (freshwater mussel) pendent with two closely spaced notches on one edge is interpreted as a pendant. The bone assemblage from the site is dominated by bison, but antelope and birds are also represented. Features included common hearths, some with stones, and small "pot-shaped" storage pits. Other artifacts include common pieces of ground hematite and limonite, hammerstones, grooved abraders, a possible grooved axe, and numerous grinding stones and fragments.

The variety of evidence from Signal Butte argues for a habitation site or intensively and repeatedly utilized hunting and processing camp. Forbis (1985:27-29) offers some comments on how the site may have fit into the McKean subsistence-settlement system. The prominent and relatively inaccessible nature of the butte makes it a poor candidate for occupation in severe weather and it probably was not a winter occupation site. There is no wood or water at the butte, so most critical resources would have had to be carried up to the butte top. The butte offers several potentially attractive features including protection from predators, usually a steady breeze or wind which would reduce insect pests, and excellent visibility. From the Signal Butte many thousands of km can be viewed and monitored for game. Also, the Wildcat Hills with their steep cliffs are located south of the butte. Hunters could have monitored the locations and movements of bison, antelope, elk, and other species from the butte and planned and organized their hunting efforts based on quality information. This latter aspect of occupying Signal Butte, the greatly increased potential for information gathering, was probably a key reason for intensive and redundant occupation of the site. Individuals who remained at the camp and were not hunting could continue to monitor the movements of prey species and enhance the overall success of hunting in the area.

Wilber Thomas Shelter. Wilber Thomas shelter (5WL45) is located southwest of Carr, in northwestern Weld County, Colorado (Breternitz et al. 1971). The site was investigated by Nelson in 1968 and by students from the University of Colorado under the direction of David Breternitz during 1969. Excavation units were primarily 2 m² and all fill was screened through .25 inch mesh. The materials from both periods of excavation have been documented and come from a total excavation of about 43 m², which represents no more than a fourth of the total shelter area and includes some excavations in front of the drip line as well. The shelter has a southwest facing exposure. Maximum depth of the excavations was just over 1 m at which point bedrock was encountered. Twenty-eight features were documented during the 1969 excavation including rock-lined and unlined hearths, rock-lined pits, concentrations of fire-cracked rock, and shallow basins. No radiocarbon dates are available as samples submitted were inadequate for dating.

The base of a Scottsbluff point and a flake tool were found just above bedrock, about 1.3 m below the surface. Mountain complex (comparable to the Logan Creek complex) notched points were recovered from levels 3 and 4, 0.6-1.25 m below the surface, and McKean and Duncan-Hanna points were found in levels 2 and 3, from 0.3 to 0.8 m below the surface. Woodland and late prehistoric artifacts were recovered from levels 1 through 3. Several grinding stones (manos) were found in the McKean levels, but no grinding basins were recovered. Chipped stone artifacts include 10 McKean or Duncan-Hanna projectile points, endscrapers, scrapers, gravers, bifaces, perforators, and a chopper.

Hutton-Pinkham Site. The Hutton-Pinkham site is located in southeastern Yuma County, Colorado just a few kilometers from the Kansas border (Larson et al. 1992). The site is contained within the Pleistocene and Holocene alluvium of Bonny Creek near its confluence with the South Fork of the Republican River. Although one or more late Pleistocene levels contains faunal remains and possible artifacts, the primary evidence from Hutton-Pinkham dates to the middle Holocene, with a single radiocarbon date of 4310 ± 200 B.P. (Beta-35336) on carbonaceous soil from a hearth. This is considered a minimum age for the hearth. The primary occupation occurs at a depth of 2.2 to 2.6 m below the surface in a buried soil. Excavation in 1977 included nine 2 m² units which focused on the buried soil. Excavations in 1988 and 1989 were concerned with stratigraphic evaluation of the site, collection of paleoecological samples for pollen and soil analyses, and a reassessment of the cultural component. During this latter work several profiles were cleaned and studied, and eight additional units were excavated.

Artifacts include 29 chipped stone tools, ground stone, fire-cracked rock, charcoal, worked and unworked bone, and a single hearth (Larson et al. 1992). Two projectile points fall within the McKean technocomplex and additional tools include eight endscrapers, six cores, two gravers, one drill, three biface preforms, three biface tools, one sidescraper, and two flake tools. Debitage included 597 pieces of chipped stone mostly representing small tertiary flakes. Lithic material types represented by the artifacts include stone from the Hartville Uplift, Dakota and Morrison formations, and fossilized wood. The latter material is argued to be of local origin due to some gravel cortex. The overall small size and poor quality of the artifacts is, however, attributed to limited availability of raw materials. Ground stone artifacts include eight pieces: two manos, four slab fragments, and two hammerstones. Two bone awls and two tubular bone beads were also recovered. Unmodified bone includes predominantly pieces of bison, but deer, antelope, rabbit, squirrel, and various birds are represented. The majority of bone, from at least some units, was burned. Investigation and further analysis of sites such as Hutton-Pinkham, especially interdisciplinary work such as initiated at this site, including study of soils, pollen, and invertebrates, will add significantly to our understanding of the middle Holocene occupation of the Central Plains region.

Albion Boardinghouse Site. The Albion Boardinghouse site (5BL73) is located in western Boulder County at an elevation of 3,260 m, below timberline in the North Boulder Creek drainage (Benedict 1975). The lithic and faunal assemblage from the site indicate that it was a camp associated with high elevation hunting, butchering, and tool repair and maintenance.

The distinctive projectile point assemblage consists primarily of Mallory points, also well represented at sites like Scoggin in Wyoming (Lobdell 1974), Spring Gulch (Kainer 1974) in Colorado, and Signal Butte in Nebraska (Strong 1935). The site assemblage includes 23 Mallory points and fragments and three other notched points. The predominance of point bases suggests retooling activities were common. Also, three preforms, numerous biface fragments, two endscrapers, and 2,278 flakes were collected. The flakes indicate that relatively more tool maintenance than tool manufacture occurred at the site. A fragmentary grinding stone and milling slab were also documented. Many of the artifacts and flakes were burned. Bone occurred as small unidentifiable fragments in the upper charcoal-rich level. The two available radiocarbon dates are divergent and bracket McKean dates from elsewhere. The ages are 2420 ± 220 B.P. and 5730 ± 145 B.P., and it is difficult to resolve which if either can appropriately be associated with the Mallory assemblage. The Albion Boardinghouse site provides some support for Osborn's (1993) model of seasonal high elevation hunting by foragers who utilized the diverse environments of the central Rocky Mountains and Plains.

McKean Sites in Northeastern Colorado. Additional sites with McKean components located in northeastern Colorado have been reported by Morris et al. (1985) and include several that have yielded radiocarbon dates based on charcoal and some sites known only through surface collections. Although these sites have not been published in detail, they provide significant supportive information concerning the distribution of McKean complex assemblages in the Central Plains region. In addition to Dipper Gap, radiocarbon-dated McKean components are reported from Phoebe Rock Shelter (5LR161), Spring Gulch (5LR252) (Kainer 1974), Pack Rat Rock Shelter (5LR170), and Kinney Spring (5LR144c). Collectively, these sites provide some information pertaining to the variety of fauna in McKean assemblages, and to the co-occurrence of various McKean technocomplex projectile point types. Ten additional sites, lacking radiocarbon dates but with McKean complex points, have been documented in the foothills and short grass plains of Larimer and Weld counties. Most of these sites are located on south or southeast facing slopes overlooking springs or creeks (Morris et al. 1985:17).

Key McKean Sites on the Northern and Northwestern Plains. A number of McKean sites outside the immediate area of concern to this overview have yielded key evidence concerning technology, economy, age, distribution, and variability in the McKean archeological record. Research with assemblages from the Lightning Spring and Red Fox sites (Keyser and Davis 1985; Keyser and Fagan 1993) has provided important insights into McKean lithic technology and biface reduction systems, following up on research by Green (1975). Several sites with biface caches are also documented (e.g., Davis 1976), and the distribution of components based on projectile point occurrences is fairly well defined (Tratebas 1986; Keyser and Fagan 1993; Kornfeld and Todd 1985). Bison kills are documented in Wyoming at Cordero Mine (Reher et al. 1985; Nevin and Hill 1995) and Scoggin (Lobdell 1973, 1974), and in Alberta at Head-Smashed-In and Cactus Flower (Brumley 1975; Reeves 1978). Structural evidence in the form of pit houses are documented at McKean and Dead Indian Creek in Wyoming (Frison 1991b; Frison and Walker 1984; Kornfeld and Frison 1985). The Kolterman site located in the Angostura area of southwestern South Dakota was investigated with several other middle Holocene sites by Wheeler (1985:8) and has yielded two radiocarbon dates attributed to McKean. These dates 4231 ± 350 B.P. and 3631 ± 350 B.P., may represent early McKean ages.

Deluge Shelter. Located in Dinosaur National Monument in the Green River Basin near the Utah-Colorado border, Deluge Shelter is a multicomponent site with an important middle Archaic deposit (Leach 1970). Three radiocarbon dates from Level 12 (Leach 1970:225) have been attributed to the McKean complex, and although they have been inconsistently reported (Metcalf 1974:36; Barnes 1985), the range is between 3200 and 3900 B.P. A Scottsbluff point was found below the McKean level, and Fremont materials occur in the upper deposits. Fauna is dominated by mule deer and rabbit with elk, beaver, and muskrat also represented (Leach 1970:224).

Apex Complex

The Apex complex was also based on work at Magic Mountain and is characterized by the presence of McKean technocomplex points and is dated to the period between 3000 and 5000 B.P. (Irwin-Williams and Irwin 1966). This complex compares favorably with Complex C and Complex D at LoDaisKa shelter (Irwin and Irwin 1959). A variety of stemmed and notched dart points occur with the McKean, Duncan, Hanna, and Mallory points in this complex, and these other forms may represent local variants (Greiser 1985:94). The Apex complex is of importance because it represents part of an early attempt to organize and classify the Holocene archeological record in the eastern Colorado area. The relatively well-dated and stratified sequence at Magic Mountain has provided an important key used to help decipher the chronological position of other assemblages in the central and eastern Colorado area. The Apex complex, or a significant part of the three components attributed to this complex (which includes potentially mixed assemblages), can be considered a regional expression of McKean. Artifacts of other groups or non-McKean materials are apparently represented as well. An evaluation is needed as to the potential relationships with sites in the Plains region. One must consider the possibility that some of the differences between Apex and McKean are primarily seasonal or functional rather than cultural.

Munkers Creek Phase

Discussions of the Munkers Creek phase are found in Witty (1982a), Schmits (1976, 1978), Reynolds (1982a), and Thies and Witty (1992). This phase dates to approximately 5500 to 5000 B.P. and was defined by Witty (1982a:202-205, 218-228). Components of this phase are located in northeastern and east-central Kansas. Excavated and reported sites include William Young in the Council Grove Lake area in Morris County (Witty

1982a), Cow-Killer (Area 741) in the Melvern Lake area, Osage County (Reynolds 1982a), and the Coffey site on Tuttle Creek Lake in Pottawatomie County (Schmits 1978). It should be noted that the Coffey site components originally assigned to the Munkers Creek phase were later used by Schmits in defining the Black Vermillion phase. The primary documented sites are located in alluvial terrace settings on primary rivers and tributaries. Age of the Munkers Creek phase is based on a series of radiocarbon dates from the William Young and Coffey sites and these indicate that the phase dates to the mid-Holocene Hypsithermal.

Economy of the Munkers Creek people was apparently based on hunting and foraging, with deer and small mammals the primary animal species utilized. Bison are also represented in the fauna at some sites. Distinctive artifacts include Munkers Creek gouges, some of which are made from Munkers Creek knives (Figure 36). Munkers Creek knives are typically large, often sickle-shaped pieces which exhibit gloss on the surfaces of the concave edge. This polish apparently resulted from cutting wild grasses or similar plants (Witty 1982a:152-157). Other important artifact types include chipped double-bitted axes and lanceolate dart points of the Munkers Creek type which have poorly defined shoulders. Interesting ceramic figurines or fired clay heads were found at the William Young site. No other ceramic technology is known except for a ceramic bead from the Coffey site, and this is the earliest evidence for ceramic technology documented for the region. A number of sites in eastern Kansas are assigned to this phase by Witty (1982a:202-205), but more research is needed as the variety of site types, settlement systems, economy and other issues.

Munkers Creek Sites in Kansas.

William Young Site. The William Young site (14MO304) was tested in 1961 with primary excavations conducted in 1962 and 1964. The site is located on Munkers Creek at Council Grove Lake. Three primary stratigraphic and cultural levels were recognized and it is the lowest, Zone III (ranging from 2 to 5 feet below the surface) which is of primary interest here. A series of sequential occupation surfaces are apparently represented which include hearths, pits, postmolds, charcoal concentrations, debitage concentrations, and mud dauber nests. A rich lithic assemblage includes a large and diverse collection of debitage suggesting a full range of lithic extraction, reduction, and maintenance activities (Reynolds 1982b). A good source of Permian Flint Hills Florence chert is available within a few hundred meters of the site. A considerable amount of early and intermediate stage biface reduction occurred at the site.

The Zone III excavation included 3,800 feet^2 (about 38 10 x 10 foot units) which was conducted in 6 inch levels. The lack of screening is assumed to account for the underrepresentation of very small flakes in the debitage assemblage (Reynolds 1982b:240). The Zone III occupations and collections occurred through a vertical thickness of about 5 feet (Witty 1982a:13). Features included 15 hearths, some small with few stones but others large with numerous burned limestone rocks, six

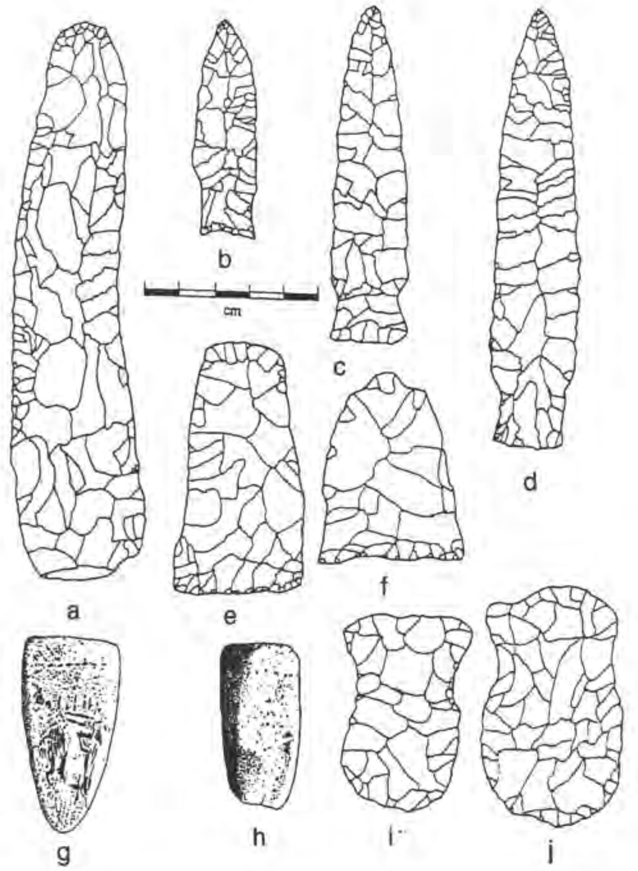


Figure 36. Munkers Creek complex artifacts from the William Young site, Kansas. a. Munkers Creek knife; b-d. Munkers Creek projectile points; e-f. Munkers Creek gouges; g-h. Munkers Creek ceramic figurines; i-j. Munkers Creek axes at 50% reduced scale (redrawn from Witty 1982).

generally shallow pits, four postmolds, and numerous concentrations of charcoal and lithic debitage.

Among the more remarkable artifacts from the William Young site are two fired clay human "effigy" heads. Both ceramic items are triangular in outline and flat in section and measure about 5 cm in length. The elements of the faces are executed with punctations and minimal molding. These represent the earliest known ceramic objects (made by use of controlled fire) in the Plains region and perhaps in the entire United States.

A number of distinctive chipped stone artifact types occur at William Young which are characteristic of the Munkers Creek phase. These include Munkers Creek axes which are thick chert bifaces with a sharp cutting edge on one end opposite a blunt or squared poll end, and broad shallow side notches for hafting the handle near the poll end. Munkers Creek knives are also distinctive and are bifacial implements 10 to 15 cm long with a rounded or blunt point on one end and a squared base which often exhibits a cortex remnant. These knives were made from biface blanks rather than from large flakes and have parallel or asymmetrical blade edges. The overall form is usually crescent shaped or with one concave edge and the opposite one convex or straight. The concave edge is typically highly polished (e.g., sickle gloss) apparently reflecting the function of these tools in cutting grasses. The type of grass being cut and the purpose to which it was put remain unclear. Grass seeds may have been collected as a food resource, stems may have served as thatch or padding, and there are other possibilities such as the creation of mastic from grass resin. The presence of some grinding stones may suggest vegetal food (grass seed?) processing, but at least one of these artifacts was used in association with pigment grinding or preparation (Witty 1982a:179). Munkers Creek knives are a distinctive middle Holocene artifact type and have been recorded, also made of Florence chert, as distant as Caddo County in west-central Oklahoma.

Munkers Creek gouges are another distinctive element in the Munkers Creek phase. These bifacial tools appear to be recycled from broken bifaces, late stage preforms, or broken Munkers Creek knives and are characterized by a steep unifacial bevel on the broad end. These artifacts compare closely to bifacial varieties of the Clear Fork Gouge found commonly in the Southern Plains (Ray 1941; Hester et al. 1973; Hofman 1977, 1978; Hughes 1980; Turner and Hester 1993). These tools exhibit nibbling and crushing on the working edge which suggests heavy-duty work on wood or other resistent material. These gouges are from 6 to 9 cm long and compare in thickness with the Munkers Creek knives, 10 to 17 mm.

Munkers Creek points are also distinctive with a slight stem and lanceolate blade. The shoulders are generally weak and slope toward the base which is straight, or slightly concave or convex. The stem is parallel sided or slightly expanding. Variety 2 points are generally smaller with very slight shoulders and may represent points with substantially reworked blades. A few side-notched or expanding stemmed points are also in the assemblage.

Faunal material is fairly diverse with 10 species of mammals as well as box turtles represented. Notable by its absence in the fauna is bison. Both antelope and deer are represented along with small species including large canid, beaver, rabbit, cottontail, squirrel, mustelid, badger, and fox (Witty 1982a:Table 31).

The thickness of the Zone III deposits at William Young was as much as 5 feet, so some consideration was given to the problem of artifacts associations and assemblage definition based on what is obviously a deposit which accrued over an extended period (Witty 1982a:Figure 17). Notably, the hearths and "immobile" features of Zone III range from 2.2 to 7 feet below the surface. During the period of Munkers Creek phase occupation, it is argued that there was rapid aggradation of the terrace surface. Refitting of a number of artifacts demonstrated that there has also been some homogenization of the deposits, probably by a variety of biogenic and physiogenic processes (Butzer 1982; Hofman 1986a), with segments of the same artifact vertically displaced more than a foot in at least some cases. This is an expectable and "typical" amount of vertical movement in terrace deposits of this age (Hofman 1986a).

Cow-Killer Site. The Cow-Killer site (14OS347) is located on the Marais de Cygnes just below the Melvern Lake Dam, about 45 miles east of the William Young site, and was discovered during excavations related to construction activities. Excavations under the direction of John Reynolds were conducted during 1974 and 1975. The work in 1975 was primarily concerned with the early ceramic Greenwood phase component at the site. In 1974, excavation focused on Area 741 which was excavated using 5 x 5 foot horizontal units and 6 inch or 3 inch levels. An area of 350 foot^2 (ca. 17.5 x 20 feet) was excavated, and the matrix was not screened. Area 741 was the deepest portion of the site and produced Munkers Creek materials including points, knives, and gouges (Reynolds 1982a: Plate 10). Stone hearths, shallow pits, and postmolds were documented as were concentrations of debitage and burned floral material (Reynolds 1982a:Figure 8). A grinding stone and several pieces of hematite were also recovered. Faunal material included more than 1,000 specimens of which about 90 were identifiable to species. Deer elements were most common, followed by bison and beaver. Turtle carapace segments and fish vertebrae were also recovered. The full extent of the site remains unknown due to destruction during construction activities that first exposed the site.

Coffey Site. The Coffey site (14PO1) is located on the Big Blue River near the northern end of Tuttle Creek Reservoir about 40 km north of Manhattan (Schmits 1978, 1980a). The primary buried Archaic cultural levels in Locality I, levels III-5, III-7, and III-8, occur 2.4 to 3 m below the surface. These components have been attributed to the Munkers Creek phase (Witty 1982, Reynolds 1982a) and subsequently to the Black Vermillion phase primarily because of the diversity of projectile point types represented at the Coffey site as compared to the William Young site (Schmits 1978, 1981). The majority of radiocarbon dates frame these occupations between 5000 and 5500 years B.P. (Table 29). Excavations were conducted from 1972 through 1975 and covered an area of about 148 m^2 for level III-5 and somewhat less for levels III-7 and III-8 (about 132 and 120 m^2, respectively). Methodology included use of 1 x 1 m excavation units, 10 cm levels, screening, and flotation. As a result of the extensive excavation and deligent recovery, the Coffey site investigations serve as a key for comparison and interpretation of middle Holocene sites in the region (e.g., Wedel 1986).

Features include shallow basin pits, burned rock concentrations, hearths, and at least one postmold. Charred botanical remains were recovered through flotation and include evidence of smartweed *(Polygonum)*, hackberry, bulrush *(Scirpus)*, and grape. A variety of plant species which might be expected were not recovered. The diverse faunal and floral inventory provides an important complement to that derived from most other Archaic sites in the region. The contribution of naturally occurring or "background fauna" to this inventory has not been adequately assessed.

The lithic assemblage includes a variety of projectile points including Munkers Creek and basal and corner-notched points, gouges, axes, Munkers Creek knives, and ground stone artifacts. An apparent ceramic bead was also recovered. Reported were 27,754 artifacts and ecofacts (Schmits 1978:Table 2) dominated by pieces of unworked bone (11,022), flake debris (10,726), charred seeds (4,209), unworked stone (704), burned earth or daub (226), and charcoal fragments (551). The remaining specimens include 205 chipped stone tools, 49 ground stone tools, 11 bone tools, 12 ornamental artifacts, and 39 cores. The chipped stone inventory includes 18 projectile points mostly with straight to expanding stems and basal or corner notches. Bifacial drills (N=3), preforms (N=26), and bifacial knives (N=51) are also described. Ten of the knives are comparable to the Munkers Creek knives from the William Young site and generally exhibit high polish or gloss on a concave edge. The remaining knives are ovate and variable. Three chipped stone axes, two bifacial gouges, two bifacial choppers, and 19 biface fragments are reported with the remaining chipped stone tools consisting of 31 scrapers and 36 retouched flakes. The majority of the chipped stone artifacts and debris are Flint Hills Permian cherts available in the locality. The 49 ground stone artifacts and fragments include grinding slabs (N=7), manos (15), hammerstones (10), a spheroid, a ground stone grooved axe, and ground stone fragments. Bone tools include three antler tine flakers, three bird bone tubes, two punches, one awl and two pieces of modified bone. The tubular fired clay bead made of untempered clay represents an unusual element in Archaic assemblages and complements the occurrence of fired clay beads from the William Young site (Witty 1982a). Pieces of hematite and limonite were recovered from the three levels at Coffey, and a quartzite cobble was covered with ochre and traces of ochre were found on a few tools. In the three levels, 19 hearths, and one postmold were identified.

A variety of activity sets were identified and compared between the three primary levels. There was notable variation in the relative proportion of tools related to activities such as hunting, heavy cutting, hide working, woodworking, chert working, and seed grinding. Whether this variation is due to seasonal differences, random variation, or sampling is unclear. It is evident that the site served as a multiple diverse activity base camp rather than a special purpose or limited activity site, although there is no evidence of permanent structures. Schmits suggests that the most likely seasons of use would have been summer through winter when the site was less vulnerable to flooding. The apparent lack of structural evidence, however, suggests that winter occupation would have been temporary rather than permanent.

A variety of animal resources were apparently used with bison, deer, small mammals, reptiles and amphibians, birds, and fish represented. Mammals include bison, deer, raccoon, dog or coyote, skunk, squirrel, mole, cottontail, gopher, and woodrat. Birds include ducks, geese, and hawk. Several turtles were also found. A large number of fish are represented in each of the three levels, dominated by catfish, with gar, drum, chub, sucker, and minnow present. Overall, a diffuse economy is indicted, but with catfish forming a significant portion of the diet. The size of the catfish varies considerably with more than 160 individuals. The size variation may indicate use of nets or poisons which would result in a relatively nonselective capture. Such techniques may have been effectively employed in shallow backwater areas. Use of plant resources included seeds and berries with *Chenopodium* a dominant plant food as shown by the more than 4,000 charred seeds. This is a disturbance plant which would also occur commonly along the margins of backwater lakes. Schmits argues for a dryer climate and more xeric floral community in the region around Coffey during the middle Holocene, based on the floral and faunal evidence from the site.

Other Munkers Creek Phase Sites. Witty (1982a:204-205) provides a brief discussion of several additional Munkers Creek sites in eastern Kansas. These include Elliott (14GE303), Roniger (14CS375), Hyde in the upper end of Melvern Lake, three sites in the John Redmond Lake area (14LY328, 14LY329, and 14CF1310), and four sites in the Council Grove Lake area (including 14MO306, 14MO316, 14MO320). Evidence from these sites is based primarily upon surface collections which contain some combination of diagnostic Munkers Creek artifacts such as gouges, knives, axes, or points.

Sedalia Phase

The late Archaic Sedalia phase was known initially from surface-collected sites in west-central Missouri along the Lamine River in the vicinity of Sedalia between the Missouri and Osage rivers (Seelen 1961; Turner 1965). This distribution is expanded considerably by Chapman (1975), but Reid (1984:72) and Kay (1983) suggests that the complex as a distinctive assemblage type is more limited. The most definitive research to date has been at the Phillips Springs site and Rodgers Shelter in the Truman Reservoir area in the middle Osage River drainage (Kay 1983). The Phillips Spring site assemblage is particularly noteworthy because of the numerous preserved remains of native cultigens, especially squash and gourds (Chomko 1978; Kay 1982, 1983; Kay et al. 1980). This abundance of evidence for domesticates in the late Archaic of west-central Missouri holds important implications for this time period in eastern Nebraska and Kansas. A suite of radiocarbon dates from Phillips Spring, Rodgers Shelter, and several other sites indicate the time frame for the Sedalia phase to be from about 2600 to 4300 B.P. (Kay 1983). Sedalia components in Unit E at Phillips Spring include hearths, midden deposits, burned rock concentrations, and storage pits. The site is interpreted as a relatively permanent encampment or base camp occupied from spring through fall. Additional components include that at Rodgers Shelter Horizon 3 where three primary flexed Sedalia phase burials are documented at what is interpreted as a short-term hunting-butchering camp (Kay 1983). An important mortuary site is the Holbert Bridge Mound where a secondary bundle burial with associated Afton points was contained in a rock and earth mound. Upland sites between the Osage and Missouri rivers are common, but most consist on lithic scatters (Kay 1983). The Geiger site is an example of an upland site with several discrete midden concentrations which could represent prior house locations (Kay 1983:51).

The characteristic projectile point-knives are Sedalia Lanceolate and the less frequent Etley Stemmed and Stone Square Stemmed, Smith, Afton and occasionally other types.

Other artifacts include gouges, drills, ground stone axes, chipped adzes "Sedalia Diggers," ground stone manos and metates, hammerstones, and choppers. The complex is apparently contemporary with the Nebo Hill phase in the Kansas City area.

Chelsea Phase

In the southern Flint Hills of Kansas, the Chelsea phase has been dated to about 4100-4900 B.P. (Grosser 1977). The phase was first defined by Grosser based on research at the Snyder site and additional information is available on a component at the Milbourne site (Root 1981). Both sites are located in the Walnut River Valley in Butler County. The Chelsea phase is later than Munkers Creek but predates the El Dorado phase, which is recognized over a broader geographical area. A Chelsea phase radiocarbon date from Snyder is 4830 ± 105 B.P. (N-1279). Diagnostic artifacts include short shallow side-notched and long shallow corner-notched dart point/knives. There is evidence of bison, deer, antelope, rabbit, and other small vertebrates in the diet. Food plants are unknown, but grinding stones do occur. Grosser (1977) attributes the change from Chelsea to El Dorado phase as being a result of more generalized foraging or utilization of a larger variety of resources.

El Dorado Phase

The El Dorado phase has been defined based on research at the Snyder site (Grosser 1973, 1977) on Walnut Creek in Butler County and the Williamson site in the John Redmond Lake area in Coffey County (Schmits 1980b, 1987b), and some less intensively studied components at other east-central Kansas sites (Schmits 1987b:169-170; Witty 1982a:225-226). The complex is believed to date between about 4100 and 3300 B.P. based on radiocarbon dates from four sites; Williamson, Snyder, 14LY305 and 14MY309 (Table 27). Components are documented throughout the eastern third of Kansas in tall and mixed grass prairie and savanna country. Two burial mounds in north-central Kansas, Matter Mound and Range Mound in Jewell and Mitchell counties, respectively, have been attributed to the phase (Schmits 1987b; Thies and Witty 1992). These stone mound complexes are poorly documented but provide important clues to mortuary complexity during the Late Archaic in the Central Plains. Secondary burials, a few primary burials, and cremations are represented at these mound sites in north-central Kansas. Ornamental artifacts, including numerous shell items are reported from Matter Mound where the remains of at least 23 individuals were documented (Finnegan 1981). Several individuals and some shell beads were also found at Range Mound. These round rock mound features are about 10 and 20 m in diameter, respectively, and about 1 m in height. Two primary flexed human burials, both females, and a dog burial were documented at the Williamson site. Both burials were associated with possible rock features or concentrations which may have been part of the grave covering. Artifacts diagnostic of the El Dorado phase include Table Rock stemmed, Sedalia lanceolate and especially Dustin side-notched projectile points. Tubular bone beads are also documented.

Economic pursuits are best reported from the Williamson site where the artifact inventory suggests emphases on hunting and butchering, hideworking, and chipped stone tool manufacture with minimal evidence for plant food processing (Schmits 1987b:Table 4). The Williamson site is interpreted as having been used during the fall as a "residential extractive camp." Faunal remains indicate that bison was an important component of the diet with deer, antelope, beaver, and a variety of lesser species filling out the recovered bones. Plant food remains were not found at the site. Remains of shellfish processing is seen at the El Dorado phase component at the Faulconer site (Bradley 1973), indicating that such lesser species seasonally contributed to the subsistence of these Archaic people. The presence of bison in the faunal assemblage helps document the post-Hypsothermal range of this species.

El Dorado Phase Sites in Kansas

Williamson Site. The Williamson site (14CF330) is located on Eagle Creek near its confluence with the Grand or Neosho River in the John Redmond Lake area in east-central Kansas (Schmits 1980b; 1987b). Excavation was conducted using a grid of 10 x 10 foot units and 6 inch levels and covered an area of about 1200 feet^2. Stratigraphic Unit II was the primary cultural stratum and was from 1.2 to 1.5 m in thickness. Vertical distribution of artifacts suggests at least two distinct occupational periods. The lowermost of these yielded charcoal which provided two radiocarbon dates of 3500 and 3600 B.P. (Table 29). Features included burned rock concentrations and two burials. The individuals were both females between 20 and 40 years old buried in flexed positions, one seated and one on her back. One was buried with a projectile point and one with a biface knife. A dog burial was also documented at the site. Unit II yielded 123 chipped stone tools, eight ground stone tools, three bone tools, 18 cores, four pieces of limonite, and 326 pieces of animal bone. Projectile points are primarily stemmed with side notches and convex bases and referred to as Dustin. Other types include lanceolate points and Table Rock stemmed. Fauna from Unit II includes a variety of species with bison and deer well represented and badger, beaver, rabbit, canid, turtle, bird, and fish also in evidence.

William Young Site. William Young is primarily known as a Munker's Creek phase occupation, but Zone II (from .5 to 2.0 feet below the surface) at the site yielded an assemblage assigned by Witty to the El Dorado phase (1982a:113). William Young is located in Council Grove Lake in the Flint Hills of east-central Kansas. This component has projectile points of the Table Rock and Motley types, some grinding equipment, bone tools, bison bone remains, and three hearths. The presence of one or more structures may be implicated by fragments of mud dauber wasp nests.

Matter and Range Mounds. Two mound sites in the vicinity of Glen Elder and Waconda Lake in north-central Kansas have yielded limited but tantalizing information pertaining to late

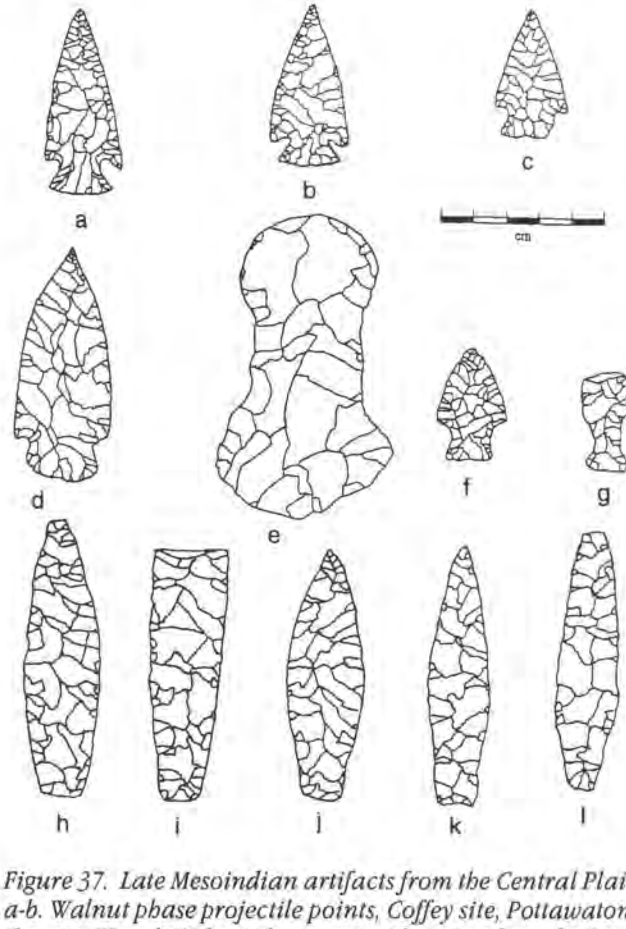


Figure 37. Late Mesoindian artifacts from the Central Plains. a-b. Walnut phase projectile points, Coffey site, Pottawatomie County, KS; c-d. Walnut phase projectile points from the Snyder site, Butler County, KS; e. El Dorado phase ax from the Snyder site, Butler County, KS; f-g. El Dorado phase points from the Coffey site, Pottawatomie County, KS; h-l. Nebo Hill points from the Sohn site, Jackson County, MO (from Grosser 1977; Redder 1980; Schmits 1980a).

Archaic mortuary practices in the region (Finnegan 1981; Schmits 1987b; Thies and Witty 1992:159). The Matter Mound site, 14JW303, and Range Mound, 14ML307, have yielded preliminary information on probable El Dorado phase burial practices. The sites are known primarily through bank erosion and the results of vandalism. The presence of Table Rock and Dustin or Lamoka point types suggest affiliation with the El Dorado phase (Reynolds 1977; Schmits 1987b; Thies and Witty 1992). The Range Mound contained burned rock and was about 20 m in diameter and 1 m in height. Disarticulated and fragmented remains of several adults are represented (Finnegan 1981), and artifacts include several points and 25 marine and freshwater shell beads. Matter Mound was some 10 to 13 m in diameter and about 1 m high. Remains of at least 23 individuals were present including primary, secondary, and cremation interments. Artifacts include Dustin points, numerous beads, and geometrically shaped shell artifacts (Thies and Witty 1992; Reynolds 1977). Whether the variation in mortuary treatments indicates status differentiation or situational factors relating to the time, location, and season of death remain unknown (Schmits 1987b; Hofman 1986b).

Faulconer Site. This dated site in the Walnut River valley gains significance through the faunal study and radiocarbon dated stratigraphic sequence (Bradley 1973). The diverse fauna from Zone B, radiocarbon dated to 3100 ± 167 B.P. (N-1552), includes coyote, prairie dog, pocket gopher, deer, fox, and turkey. Additional species from the site include jack rabbit, cottontail, and box turtle. Mussels are also abundant below Zone A and are dominated by *Amblema* (Crenondonta) with some *Quadrula* and *Ligumia* represented. The vertebrate fauna is assumed to have been culturally introduced, but the rodents could represent background fauna. Grosser (1977) suggests that Faulconer Zone B may belong to the Walnut phase, but Leaf (1979) suggests an El Dorado phase connection based on projectile points.

Snyder Site. Excavations at the Snyder site, 14BU9, by the University of Kansas during the 1968 through 1971 seasons (Grosser 1970, 1973, 1977) yielded substantial information on Holocene occupations assigned primarily to the Walnut and El Dorado phases. The site is situated on a terrace above the Walnut River near the El Dorado Reservoir area in the southern Flint Hills. Most of the cultural materials of significance are derived from Zone C which is from 90 to 130 cm thick and contains El Dorado, Walnut, and Chelsea phase components. The El Dorado phase component occurred between 80 and 140 cm below the surface, underlying the Walnut phase materials and above the limited Chelsea phase assemblage. Zone C excavations were in 2 m squares (usually divided into four 1 m quadrants) and 15 cm levels, with tools and bones plotted individually. Some of the deposit was dry screened through 1/4 inch mesh and selected samples were waterscreened as well. Total excavated area at Snyder was extensive, but much of the excavation did not extend below Zone B. About 280 m^2 were excavated through Zone C (estimated from Grosser 1977:Figure 4).

Daub provided clues to the location of a probable structure in addition to hearths, pits, burned limestone concentrations, and a burial in the El Dorado component (Grosser 1977:124-129). Most of the pits were shallow and contained burned limestone, but one containing refuse may have originally been a storage facility. In addition four postmolds were documented, though there were no structural patterns evident. Feature 22 appears to represent a structure of indeterminate form or size which is indicated by daub with grass impressions, fired earth, and mud dauber's nests. A second area of burned earth, charcoal, daub, and mud dauber's nests suggest a possible second structure.

A burial was encountered at the Snyder site during stratigraphic testing (Klepinger 1972). The individual was an adult female estimated to have been 24-29 years old and about 4 feet 11 inches in height. She had been placed in a flexed position with a few possible associations including a biface fragment and large notched projectile point. Sediment from within the burial deposit contained hackberry and chenopod (lambsquarter) seeds. The deposit with the burial is estimated to be more than 3,900 years old.

Radiocarbon dates from Snyder include four for the El Dorado phase. These are 3240 ± 85 B.P. (N-1277), 3650 ± 140 B.P. (N-770), 3910 ± 155 B.P. (N-771), and 3980 ± 100 B.P. (N-1278), suggesting a time frame from about 3,200 to 4,000 years ago for the El Dorado occupations (Grosser 1977:Table 34).

Faunal remains from Snyder include a substantial species list of vertebrates, with bison being the single most important animal in terms of weight or mass contribution. A few lesser species, however, occur in higher frequency. The El Dorado phase fauna includes white-tailed deer, bison, antelope, cottontail, beaver, badger, raccoon, muskrat, river otter, ferret, coyote, jack rabbit, prairie dog, gopher, mouse, moles, and voles in the mammal list. Turtle, rattlesnake, toad, owl, catfish, and mussels are also represented. Plant remains identified to species from the El Dorado phase include hackberry, pigweed, and lambsquarter (Grosser 1977:Table 33). In addition, black walnut was found in the earlier Chelsea component at the site.

The El Dorado phase lithic assemblage from Snyder includes 189 artifacts with projectile points (N=33, 25%), knives (49, 37%), choppers (16,12%), grinding stones (30, 22%), and miscellaneous tool fragments (55) dominating the assemblage. Scrapers, hammerstones, and drills are rare. The later Walnut phase occupation at the site shows a marked increase in scrapers and rare choppers and grinding stones (Grosser 1977:Table 22). A few bone beads and bone tools are documented and chipped stone axes and large bifaces are also common in the assemblage. Projectile points are large, broad bladed, and stemmed or notched. A variety of types are present including Dustin, Table Rock, and corner-removed and corner-notched forms.

Coffey Site. The Coffey site in the northern part of Tuttle Creek Lake on the Big Blue River in Pottawatomie County, Kansas is primarily known for its buried components (Schmits 1978a, 1980a), but an extensive surface collection yielded numerous Dustin and Table Rock projectile points which are derived from an El Dorado phase occupation (Schmits 1987b:169). The density of material and size of the surface scatter suggest intensive or repeated used of the site by El Dorado phase people.

Nebo Hill Phase

The Nebo Hill phase (Reid 1980, 1983, 1984; Reeder 1980) represents a distinctive late Archaic occupation in the Kansas City area which dates to approximately 3000 to 4500 B.P. The phase is particularly important to the issue of agricultural development in the region because it represents an early period of tropical cultigen usage, notably squash, by hunter-gatherers in the region. Other native cultigens are also indicated at some Nebo Hill components (Adair 1988). Nebo Hill is a key cultural complex in the study of processes leading to an agricultural economic lifeway in the Central Plains region.

Nebo Hill people are interpreted by Reid (1980, 1983, 1984; Reeder 1980) to have had a cyclical pattern of mobility and organizational flexibility. The growing seasons were spent in nucleated settlements on upland divides or high terraces overlooking major streams. During winters the social groups dispersed and lived in protected lowland settings along lesser streams and tributaries. The material culture of these people is distinctive and includes large, though often resharpened, lanceolate projectile point/knives, bifacial gouges, bifacial hoes ("diggers"), adzes, ground stone axes, grinding stones, and fiber-tempered pottery (Figure 37). Other than fragmentary ceramic vessels which may have been used for storage, there is little evidence of systematic or intensive storage. The complex is believed to be a precursor of Woodland developments in the region, which were due to a series of demographic and economic changes. Although settlement of Nebo Hill people is believed to have been seasonally permanent, evidence for structural remains is limited. Possible structure areas are identified at the Nebo Hill site (Reid 1984:Figure 23) and a possible pole structure is reported from site 14MM27 in Miami County, Kansas (Blakeslee and Rohn 1982). Limited information pertaining to mortuary practices indicates that ridgetop cemeteries were used.

Nebo Hill Sites

Nebo Hill Site. The type site, 23CL11, is located on a high river bluff at the north edge of Kansas City, Missouri (Shippee 1948). Surface collections from this and several nearby sites in Clay and Jackson counties, Missouri were used by Shippee to define the Nebo Hill complex. The variety and distribution of Nebo Hill sites is discussed by Reid (1983, 1984). Sites occur in southwestern Iowa, northwestern Missouri, and northeastern Kansas, and Reid (1983:19-20) suggests that geologic and geomorphic factors may be controling the limited east-west distribution of recognized and reported sites which include, camps, lithic quarries, burials, and limited activity sites. Few Kansas sites have been studied in detail, but a site is reported in Miami County (14MM27) in the Hillsdale Reservoir on the Marais des Cygnes (Blakeslee and Rohn 1982). The upper Osage River Basin is as far south as well-documented Nebo Hill components are reported.

Walnut Phase

The Walnut phase, ca. 3000-2000 B.P., is represented by sites in the Flint Hills province (Grosser 1970, 1977). There is a Walnut phase component at Snyder in the uppermost part of Zone C, 40-80 cm below the surface. The component yielded 107 stone tools dominated by projectile points (N=17, 20%), knives (41, 49%), scrapers (22, 26%), and miscellaneous fragments (N=23). Other rare tools forms include choppers and a hammerstone. Fauna includes bison, white-tailed deer, mole, and vole. Two Walnut phase radiocarbon dates from Snyder are 1970 ± 110 B.P. (N-769) and 2060 ± 80 B.P. (N-1276). Other components include a dated occupation at the Coffey site (Schmits 1978b, 1981) and other Butler County sites. Small projectile points named "Walnut Valley Corner Notched" (Grosser 1977) may represent an early arrow point type in the Plains region. No evidence of pottery is reported and subsistence data is limited to faunal remains. Bison, deer, and small mammals are represented. Similar early dates for arrow points are known from further south in Oklahoma (Taylor 1987; Hartley 1974).

Colvin Phase

This poorly known complex was created based on work at the Colvin site in the Wolf Creek Reservoir area of the Neosho River valley in Coffey County, east-central Kansas (Rohn et al. 1977). No radiocarbon dates are available but the phase is estimated to date between 3500 and 2500 B.P. based on typology of the projectile points. Concentrations of fire-reddened limestone and sandstone apparently reflect cooking or food processing activities. As the distinctiveness of this phase has not been well documented, use of this archeological construct should be dependent upon further study and more complete information concerning the original materials.

Stigenwalt Complex

The Stigenwalt complex was named by Thies (1990) following investigation of the Stigenwalt site, 14LT351, in Labette County and on Big Hill Creek near Big Hill Lake in the Verdigris River valley. The investigations were conducted in 1986 and 1987 along both sides of Big Hill Creek where a new man-made channel had exposed deeply buried paleosols and cultural materials. An extensive deposit containing burned rock and artifacts extended for some 60 m along the creek margins. Numerous features containing burned rock were defined and three of these yielded charcoal used for radiocarbon dating. In addition, two radiocarbon ages were determined on soil humates from an overlying and somewhat younger paleosol.

The rock feature dates range from about 7,300 to 9,000 years ago (7410 ± 70 B.P., TX-5694; 7590 ± 100 B.P., TX-6050; 8130 ± 130 B.P., TX-6048; and 8810 ± 250 B.P., TX-6049) (Thies 1990:109). The projectile points found in association with these features and dates vary considerably in form and have been compared to a variety of named types. Thies (1990:116) describes them as follows: "one point has a lanceolate shape, one is basally notched, four are either side notched or corner notched, and ten are stemmed, or corner removed....10 of the 16...are stemmed..[and]...can be characterized... as being corner-removed specimens with straight stems." Other artifacts include a grooved ground stone axe, bifaces, unifacial tools, flake tools, cores, debitage, grinding stones and slab metates. Bone artifacts include two awls and a bird bone bead. Nine pieces of human skeletal material were found in association with one rock concentration and represent at least two individuals, one adult and young adult. There is no information on burial form and no indication of burning. One of the elements was found in a second rock feature and whether this represents part of the above individuals or a third individual is unknown.

Plant remains include numerous pieces of onion or garlic *(Allium)* which were apparently collected and roasted at the site. Faunal remains include deer, coyote, mink, beaver, badger, raccoon, squirrel, jackrabbit, cottontail, gopher, vole, mice, hawk, prairie chicken, owl, snakes, and frogs. The MNI for all species is low with two deer, three cottontails, and two coyotes represented.

Overall, the stratigraphic and paleoecological information from Stigenwalt site is as significant as the archeological remains. The site will serve as a key reference point in the development of an early Holocene archeological and paleoecological record in southeastern Kansas.

Frontier Complex

Salvage excavations in Medicine Creek Reservoir at the Allen site led to definition of the Frontier complex which was attributed to the Plains Archaic period (Holder and Wike 1949:260-266). Initial radiocarbon dates from the site were less than satisfactory (Libby 1955) and included two ages from the lower occupation level, about 8300 and 10,500 B.P. with large sigmas and a mixed sample from both occupation levels of about 5200 (Table 29). Recent reanalysis of the collections from Allen by Bamforth (1991a) includes new radiocarbon dates based on charcoal which show the two occupation levels at Allen to be of Paleoindian age. The lower level dates to more than 10,000 years ago and the upper level (Occupation Level II) has one date of about 8700 B.P. The Allen site is discussed above with the Paleoindian complexes. The lower level yielded two points classified by Bamforth (1991a:361) as Agate Basin, and parallel-oblique flaked points from the site may belong with the younger component. Wedel (1986:70), suggests the points from Occupation Level I are concave based and "reminiscent of the Angostura type." Importantly, distinctive artifacts including "trapezoidal scrapers" were found at Allen, and these compare closely to Munkers Creek gouges in Kansas Archaic assemblages (Witty 1982a).

Other Archaic Evidence

In western Kansas, relatively little early to middle Holocene archeological evidence has been reported. One documented site from Logan County, 14LO8, was reported by Schock (1965) which was a limited activity camp on the Smoky Hill River. Limited testing yielded evidence of a campfire, three fragmentary dart points, and large (bison?) bone fragments. Numerous other accounts of preceramic occupations in Kansas occur (e.g., Rogers 1984), and inspection of numerous collections made by avocational archeologists indicate a wide range of Archaic materials in western Kansas including projectile points of the Logan Creek, McKean, Mallory, and later types. Holocene hunter-gatherer sites in Nebraska are becoming better known, but most remain incompletely studied (Carlson 1994). The Dry Lake and Gering sites are among those needing more complete study (Breternitz and Wood 1965; Carlson 1994; Carlson and Steinacher 1978; Thies and Witty 1992).

Awareness of the complexity of Archaic or Mesoindian lifeways is increasing and the importance of Mesoindian archeology to the understanding of cultural variation before and after this period is acknowledged. The commonly deeply buried position of many middle Holocene sites is now widely recognized, and as a result archeologists are increasingly better equipped to identify and investigate such sites which have usually gone unrecognized on typical pedestrian surveys.

Holocene Hunter-Gatherer Variability in Evolutionary Perspective

Many of the comments included at the close of the Paleoindian section are appropriate here as well. Research problems include the need for documentation of local and regional geomorphology in order to explain patterning in site distributions and site formation. Holocene land surface changes have a dramatic impact in many regions on recognition of settlement patterns (site distributions), site burial, and visibility. Surface stability is a key factor in assemblage formation and study of site formational histories. There have been relatively few extensive excavations of Mesoindian sites in the Central Plains region. This may be the result of, or the cause for, limited concern with intrasite spatial studies or discussion of domestic space use at Mesoindian sites.

Interdisciplinary research focused on a wide range of evidence is needed at a diverse range of Mesoindian sites in a variety of settings. Archeologists, however, must work to investigate and define the paleoecology of study areas without being limited to site-specific inquiry or studies limited only to those materials found at archeological sites (e.g., Butzer 1982; Pearsall 1989). The relationships among recognized archeological complexes, precise dating of assemblages, lithic technological studies, investigation of trade, lithic source studies, evaluation of demographic changes, documentation of technological changes and developments, variation within and between groups in economy and organization, the relationships and processes in the Paleoindian-Mesoindian and the Mesoindian-Woodland transitions, the utility of foraging models for understanding economies and economic changes, and the relationships between mobility, storage, housing, organization and technology are some of the broad areas of interest in need of further investigation.

Beyond these general concerns, several important research issues are specifically evident when we consider Mesoindian archeology in the Central Plains. Between 8,000 and 2,500 years ago substantial and far-reaching changes occurred in hunter-gatherer lifeways in the Plains region. This was a period of climatic and ecological variation and one of cultural, economic, and technological variation as well. We should expect that the adaptations represented by Holocene hunter-gatherers span the range of variation from that found in standard stereotypical views of both Paleoindian and Woodland prehistoric societies. Archaic or Mesoindian lifeways do not represent a single economic or social condition, but a highly diverse range of cultural groups who occupied a wide range of settings and were dynamic in their adaptations during a period of significant environmental changes.

Views on Mesoindian lifeways have changed substantially in the past 15 years, due to numerous field investigations which have documented pit houses, micro-scale economic evidence, technological diversity, and which included improved identification and documentation of sites and assemblages through geomorphic and site formation studies. Of equal importance, however, is the improved understanding and awareness of hunter-gatherer variability and diversity on a global scale, and the use of sound ecological models as a framework for comparison and evaluation of forager behavior (Bettinger 1991; Binford 1980, 1983; Kelly 1995; Smith and Winterhalder 1992). Critical to development of realistic interpretations concerning Paleoindian-Mesoindian and Mesoindian-Woodland relationships is the use of analytical approaches which include diversity and variation as key components in the study of culture change. If comparative studies and explanations are limited to typological assessments, then the potential to learn about diversity and the processes of change will be seriously impaired.

Economies of Mesoindian groups ranged from those which were, at least seasonally heavily dependant upon hunting bison and other large game to those geared toward intensive use of lower ranked (smaller and requiring more collection/processing time) plant and animal resources. The use of domesticated varieties of squash was well established during the middle Holocene by Mesoindian groups in the Midwest and southeast (Smith 1992). Current evidence for Mesoindian domesticates, other than dogs, is limited in the Plains and Rocky Mountains regions. More systematic sampling and recovery of paleobotanical remains from archeological excavations should help clarify the significance of wild, domesticatable, and domesticated plant foods in the Mesoindian economy. It is now generally accepted that native cultigens may well have been in relatively wide use before Woodland times. It was not the knowledge of cultigens alone which sparked the developments witnessed in the Woodland and late prehistoric periods, but some combination of factors probably including demographics, social organizational changes, environmental change, and technology, which were part of this long-term process.

The hunting technology during the Mesoindian period is assumed to have been dominated by the use of spear throwers, snares, traps, throwing sticks, and nets. The timing and impact of bow and arrow usage remains poorly understood, but the history of its development and use in the New World may have been different on the Plains than in other regions. Individual, cooperative, and communal hunting seem all to have been practiced on the Plains since very early times. The development of communal hunting as a central part of the economies and social organizations of Plains groups is an important research issue, but we cannot simply assume that a large number of bison necessarily implies communal (multigroup) activity (Hofman 1994a). The economic needs, bone technology, shelter, clothing, and food, which were often derived from bison by Plains hunter-gatherers, are needs which could also have been met through use of other resources. The flexibility of bison and nonbison resource use in the economy and technology of Plains societies would directly impact the organization, mobility, land use patterns, and interactions of groups. Investigation of these factors in Mesoindian archeology must be conducted with the realization that the same group may engage in distinctly different economic patterns from season to season, year to year, or through the lifetime of individuals. It is also important to recognize that some significant resources may be minimally represented at some sites or in some archeological contexts. In some situations, people may have relied heavily upon bison resources such as meat, fat, and robes which leave little evidence in the archeological record. If stored bison products are being supplemented with local small game, our view of the economy may be significantly skewed.

The documentation of structural remains at numerous Mesoindian sites in the Plains and Rocky Mountains region in recent years (e.g., Larson and Francis 1996) has helped open new insights and perspectives on Holocene hunter-gatherer lifeways. Substantial winter structures imply a seasonal collector and logistical mobility strategy for some (Metcalf and Black 1991), and this may have been linked in some cases to predictable high density resource areas (Osborn 1993). It is clear that not all Plains Mesoindians lived in highly mobile, minimal technology, foraging groups subsisting heavily on plant resources.

Ceramic technology is something generally associated with Woodland and later occupations in the Plains. The discovery of small fired ceramic (clay) decorated humanoid heads in the Munkers Creek component at the William Young site (Witty 1982a) offers evidence that ceramics were being used, at least for special purposes, well before the Woodland period. There remains, however, no evidence for use or development of ceramic vessels in the Plains region prior to the introduction of Woodland ceramics, which stylistically and technologically appear to be derived from the Woodland cultures of the midcontinent. Mesoindian vessels for transport, storage, and cooking remains largely unknown in the Plains. Baskets and bags were highly functional and more durable in situations of frequent or seasonally frequent mobility.

Storage technology has not received detailed study, but the development of pemmican as a stored food source is again important (Reeves 1990). It is suggested that a fundamental change in mobility, technological organization, and resource use occurred with the beginning of pemmican usage by Plains bison hunters. Evidence of below-ground storage and bulk processing activities focused on storable or transportable resources is likely to be found in the archeological record. Pit features are relatively common on some Mesoindian occupation sites, but effectively distinguishing storage, trash, and processing features has not been a priority concern. It is likely that much of the storage, processing, and transport technologies which were critical or became critical in Woodland and late prehistoric times were developed during Mesoindian times.

Information pertaining to ideology, ritual, social organization, art, trade, and division of labor can potentially be gained from the archeological record. Progress along these avenues has been limited in part by the minimal focus most studies have placed on these aspects of prehistoric Mesoindian life (Kornfeld 1991). Theoretically, such information is no more out of reach or abstract than information on many aspects of economy or technology which are more commonly the focus of archeological effort. Burials, use of domestic space, spatial arrangements of activities, elaborations in material culture, attributes of style, use of paints and designs, exotic materials, and child care and training are all things which may leave their patterns in the archeological record.

Our uses of the archeological record will be limited in part by the questions we ask of it, but asking appropriate questions will depend in large part on an understanding of what the archeological record does and does not represent. The archeological record is generally less well suited to doing primitive ethnography than to the study of long-term cultural change (Jochim 1991). But regardless of the scale of analysis or goals of research, it is important to recognize that significance of the archeological record is generally derived from the questions which are asked of it and how it is studied, rather than from some inherent quality that makes some materials or sites more important than others.

5 Woodland Complexes in the Central Great Plains, by Mary J. Adair

Throughout the Central Plains, beginning around 500 B.C., prehistoric cultural groups experienced varying degrees of technological, social, and perhaps political changes. The material consequences of these changes resulted in the recognition among archeologists of a new adaptation to the Central Great Plains. Labeled the Woodland period, this term not only provided a distinction from the earlier Archaic, but also suggested the existence of a formative stage for later agricultural Village period occupations. Archeologically, the changes are noted by the appearance of ceramics, corner-notched points adapted for either the atlatl or the bow and arrow, elaborate burial practices, the appearance of introduced and indigenous crop plants, and the arrangement of human groups within a hamlet or household structure. While these characteristics do not appear in all of the Central Great Plains Woodland complexes at the same time or intensity, they are often used to characterize the entire period, which is temporally placed from 500 B.C. to A.D. 1000 (Cassells 1983; Benn 1990; Johnson n.d.; Wedel 1961a, 1986).

On the basis of temporal arrangements and cultural similarities, researchers have suggested that the Woodland period of the Great Plains originated from contact with populations to the east, specifically the Mississippi and Illinois River valleys (Johnson 1979; Wedel 1961a; Willey 1966). This assumed eastern etiology resulted in the prefix "Plains" being added to the term Woodland to distinguish cultural complexes of the east from those on the Plains. However, as more archeological investigations are being conducted on Plains Archaic complexes, the recognition of indigenous cultural innovations as being responsible for the development of the Woodland period has been suggested on several occasions (Johnson n.d.; Reid 1983; Schmits 1981). As Johnson states "even the traditional Plains Woodland diagnostics have become blurred as we have gained an understanding of later Plains Archaic developments" (Johnson n.d.:2).

For example, ceramic vessels, which are widespread in association with Woodland complexes, first appear in limited quantities in Late Archaic Nebo Hill, Munkers Creek and Black Vermillion complexes of eastern Kansas and western Missouri (Reid 1983; Witty 1982a; Schmits 1981). The association of both indigenous and tropical cultigens with Plains Woodland contexts is evident from the archeobotanical record, and while such a record is not evident in the preceding Archaic period, the prevailing arguments suggest that the extensive use of certain weedy annuals (i.e., *Chenopodium berlandieri*) during the Archaic period is an indication of the process of use and cultivation of these plants which resulted in their eventual domestication. The fact that cultivated cucurbits have been recovered from Archaic contexts in proximity to the Plains (Chomko and Crawford 1978; Kay 1986; King 1985) further heightens the possibility of an association of cultigens with Plains Archaic populations. Increasing sedentism during the Woodland period, suggestive of social and demographic changes, is likewise evident during the Archaic period with the recognition of temporary structures at Late Archaic sites (Blakeslee 1979). Some of the smaller corner-notched points commonly associated with the Woodland period also are recovered from Archaic sites, suggesting overlapping technologies. In short, similarities in certain technologies and adaptive strategies between the Late Archaic and Plains Woodland complexes argue for continuity and suggest that the origin of the Plains Woodland period lies in part with the preceding Archaic.

In the western part of the Central Plains, commonly referred to as the Central High Plains, the distinction between the Archaic and Woodland is even less obvious, perhaps as the eastern influence became more attenuated (Gunnerson 1987:63). Butler (1986, 1988) summarizes the Woodland as very different from contemporary complexes to the east, arguing that the "classic" view of Woodland does not apply to the High Plains. While ceramics and small projectile points indicative of the bow and arrow are present, elaborate burial practices are absent and settlements do not conform to a hamlet setting. Sites tend to be in shelters or open air locations away from major drainages. The archeobotanical record is limited, and suggests in particular that horticultural crops were never economically important. This is based on too few samples, however, and does not address the potential for the importance of wild plants. Also, as will be discussed in greater detail below, the recognition of the economic importance of a specific plant cannot be measured solely by the quantity of remains recovered. While the evidence for horticulture in the High Plains is restricted to the appearance of maize, its presence does indicate a transition from a strictly hunting and gathering lifeway to one in which the growing of or trading for plant foods provided a part of the diet. Equally important is the recognition of the variety or type of maize recovered from the archeological contexts, as this information is useful in addressing the direction from which maize entered the Central Great Plains.

Currently there are 17 Plains Woodland cultural phases or complexes recognized in the Central Great Plains. Temporally, the eastern phases (i.e. those located in the prairies or prairie-bordered regions) can be divided into a tripartite classification scheme of Early (500 B.C.-A.D.1), Middle (A.D. 1-A.D.500), and Late (A.D. 500-A.D.1000). Recognized complexes include the Early Woodland Bowlin Bridge phase, the three phases of the Middle Woodland Kansas City Hopewell, and the transitional Middle Woodland to Late Woodland Boyer phase. The Valley focus and Cuesta phase are also included in a Middle Woodland cultural context. Late Plains Woodland complexes, which date from ca. A.D. 500-1000, include Schultz, Hertha, Keith, Grasshopper Falls, Wakarusa, Deer Creek, Greenwood, Parker, Loseke Creek, Sterns Creek, South Platte, and Ash Hollow.

Figure 38. Distribution of Early Woodland (italic) and Late Plains Woodland complexes in the Central Great Plains.

Several of these complexes share characteristics with earlier Middle Woodland complexes and are perhaps more appropriately defined within the context of an Early Ceramic period. As noted earlier, the culture sequence in the High Plains is defined according to this nomenclature. Spatial distributions for each of these complexes is featured in Figure 38. Key sites and radiocarbon dates (Table 24) are also presented for each of these phases.

In presenting these various cultural complexes, it is important to note that different taxonomic systems have been used in designating recognized manifestations of the Plains Woodland. The literature contains descriptions of complexes assigned to either the Midwest Taxonomic System (McKern 1939) or the Cultural-Historical Integration System (Willey and Phillips 1958). The latter is the more recent and widely used system. Many times, however, a specific cultural expression designated as a "phase" does not properly describe the observed, and sometimes extensive, temporal and spatial parameters. It has been suggested, therefore, that the term "variant" be adopted since it appears to be better suited for the organization of various Plains Woodland taxa (Krause 1969; Lehmer 1971; Johnson n.d.). Plains Woodland complexes, however, are distributed throughout both the eastern prairies and western plains and therefore display variations in the adaptation to the environment, as well as influences from adjacent cultural groups. Consequently, not all Plains Woodland complexes have been organized in the same manner. For example, the tripartite division of the Woodland period, which works well for the eastern prairie-bordered groups, is not applicable for the Woodland groups on the High Plains (Butler 1988).

For the eastern Woodland cultures, Benn (1983, 1990) has suggested the concept of the Mid-America Woodland tradition (MWT) to highlight cultural continuities within the Middle and Late Woodland periods, within the time frame of 200 B.C. to A.D. 1000, and between the eastern prairies and the western prairie peninsula. Variants assigned to this tradition include the Middle Woodland taxa of Valley, Sonota, and Rowe; the early Late Woodland Boyer phase; and the Late Woodland Loseke Creek complex. Haas (1983) extended the tradition to include several complexes of the central and western portion of the Plains by adding all of the Kansas City Hopewell phases, and the later Plains Woodland complexes such as Keith, Parker, Sterns Creek, Grasshopper Falls, Greenwood, Hertha, and any other Woodland complex defined in Kansas. The division into regional complexes is often based on subtle variations in ceramic decoration or temper and temporal ranges which lack adequate chronometric ages. Although major gaps persist in our ability to organize all Woodland taxa into a single system, there remain underlying similarities which serve to distinguish all complexes as "Woodland." The taxonomic nomenclature used in this chapter does not conform entirely to any of the defined systems, but rather attempts to use whatever designation was originally applied for a specific complex. Therefore, the eastern prairie complexes will be arranged into the early, middle, late sequence while the western cultures, as well as complexes located between the two areas, will be presented as part of the broader Central Great Plains Woodland adaptation.

As will be discussed below for the various Woodland complexes, there is a notable difference in the cultural expression of these groups as one moves from the eastern prairies to the western plains, with greater artifact variety and concentration found in the eastern complexes. Some of this variation is often explained as an adaptation to different, and perhaps richer, environments and the proximity of the eastern prairie or prairie-bordered cultures to the Eastern Woodlands. While the association of Plains Woodland complexes to Eastern Woodland complexes is a repeated research focus, there is an inherent danger in assuming that cultural complexity or cultural expression is directly related to the environment, or any constraints the environment might impose.

In Plains archeological research, however, this assumption has often dictated excavation techniques and cultural reconstruction. This is particularly true for the development of agriculture during the Woodland period. Drawing on modern day scenarios, it is often stated that dry corn farming during the prehistoric past was not possible west of the 100th meridian, since rainfall amounts are too infrequent and insufficient to sustain a crop today. Consequently, the western Woodland complexes are described as exhibiting a heavier reliance on hunting, particularly big game hunting. Identified faunal remains, especially from several Keith complex sites, have indicated instead a more varied strategy (see discussion below) while a lack of flotation, phytolith, or pollen studies makes a discussion of plant resource use impossible. Variations in adaptation between the eastern prairies and the western plains may be very real situations, but the research into this must be concluded from recovered data rather than from assumptions of environmental and technological constraints and modern day analogies.

Table 24. Central Great Plains Woodland Complexes, Major Sites and Radiocarbon Dates.

Taxonomic Unit Key Sites	Uncalibrated Radiocarbon Dates		Reference
Early Woodland			
Traff, 23JA159	395±70 B.C.	UGa-2535	Wright 1980
	505±80 B.C.	UGa-2404	
23JA36	450±85 B.C.	UGa-1873	Ziegler 1981b
23JA40	350±100 B.C.	UGa-2351	Ziegler 1981a
14JO46	400±60 B.C.	Beta-38587	Logan and Hedden 1990
14BN26			Johnson 1992
Middle Woodland			
Kansas City Hopewell			
Quarry Creek, 14LV401	A.D.170±60	Beta-47830	Logan 1993
	A.D. 300±80	Beta-47828	
	A.D. 360±90	Beta-47827	
	A.D. 370±80	Beta-47829	
McPherson, 14LV357			Wagner et al. 1989
Trowbridge, 14WY1	A.D.130+150	N-971	Johnson 1979
	A.D.260±100	N-972	
	A.D.320±100	N-970	
	A.D. 360±125	N-973	
	A.D. 400±105	N-974	
Renner, 23PL1	A.D. 8±250	M-572	
	A.D. 100±90	GaK-1166	
	A.D. 108±200	M-571	
	A.D.438±200	M-573	
	A.D. 687±250	M-454	
Young, 23PL4	40±110 B.C.	N-1197	
	A.D.610±60-75	CWR-180	
Valley			
MAD, 13CF101/102	A.D.20±80	Beta-1579	Benn 1981
	A.D.40±65	Beta-1580	
Rainbow, 13PM91	A.D.485±181	GX-6209	Benn 1990
	A.D.255±175	GX-6210	
	A.D.190±125	GX-6211	
Taylor Mound, 14DP3	A.D.10±140	M-2343	O'Brien 1971
	A.D.290±140	M-2344	
	A.D.10±140	M-2345	
Wallace, 25GO2	A.D.500±60	Beta-28990	Winfrey 1991
	A.D.350±50	Beta-28991	
Schultz, 25VY1	1880±300 B.C.	M-182	Kivett 1952
South Platte			
25MO86	A.D.980±70	WIS-1795	Bozell and Winfrey 1994
25SX405	A.D.1200±90	NWU-61	
39JK68	A.D.750±130		
48LA277	A.D.800±80	Beta-10722	Connor 1993
	A.D.980±70	Beta-10723	
	A.D.560±150	Beta-49836	
LoDaisKa, 5JF142	A.D.690±150	M-1002	Irwin and Irwin 1959
	A.D.800±150	M-1005	
	A.D.800±150	M-1008	
	A.D.980±150	M-1003	
Uhl, 5WL32	A.D.740±150	GX-0324	Wood 1967
	A.D.195±95	GX-0319	
Bayou Gulch, 5DA265	A.D.510±55	DIC-1502	Butler 1986
	A.D.280±55	DIC-1469	
	A.D.430±50	DIC-1504	
	A.D.600±65	DIC-1505	
	A.D.680±95	DIC-1439	
	A.D.900±55	W-1438	
	A.D.1000±60	DIC-1440	
	A.D.1080±55	DIC-1507	
	A.D.1150±50	DIC-1503	
Spring Gulch, 5LR252	A.D.465±70	UGa-1049	Kainer 1976
	A.D.245±70	UGa-673	
	A.D.635±135	UGa-675	
	A.D.875±135	UGa-664	
	A.D.1015±140	UGa-1050	
	A.D.1070±180	UGa-1051	
Michaud A, 5AH2	A.D.150±110	GX-0529	Wood 1967
Ash Hollow			
Kelso 25HO23	A.D.800±200	M-637	Kivett 1952
Ash Hollow, Lens D 25GD2			Champe 1946
Agate Bluff			Irwin and Irwin 1957
Hatch, 5WL38			Wood 1967
Loseke Creek			
Arp, 39BR101			
Lawson, 25PT12			
25DO12	A.D.1040±75	WIS-2315	Bozell, pers. comm.
Grasshopper Falls			
Anderson, 14JF331	A.D.760±90	GaK-1735	Reynolds 1979b
Avoca, 14JN332	A.D.780±50	Beta-33220	Baugh 1991
14JN349	A.D.420±170	TX-6483	
14AT2	A.D.920±60	Beta-10120	
14JF350	A.D.950±95	I-11371	
14AT2	A.D.600±60		Williams 1986
Senn's Hill, 14JF414	A.D.750±60		Logan 1989; Logan (ed.) 1990
Greenwood			
Cow Killer, 14OS347	A.D.650±100	Beta 12906	Reynolds 1984a
Stiles, 14MM13	A.D.155±145	UGa-4088	
	A.D.725±75	UGa-4091	Blakeslee and Rohn 1982
	615±195 B.C.	UGa-4089	
Deer Creek			
Richland, 14SH101	A.D.820±60	Beta-18609	Logan 1990b
	A.D.490±100	Beta-18610	
	A.D.550±100	Tx-5667	
Keith			
25FT14			
25FT18	A.D.370±110	SI-126	
	A.D.820±200	M-841	
25FT70	A.D.690±80	SI-197	
	A.D.880±70	SI-50	
Massacre Canyon	122±250 B.C.	M-181	Kivett 1953
Doyle, 25RW28	A.D.76±80	UM-470	Grange 1980
	A.D.520±45	SI-68	
	A.D.84±70	UM-549	
	A.D.580±100	UM-466	
Woodruff, 14PH4	A.D.607±240	C-928	Kivett 1953
Coal Oil Canyon			Bowman 1960
Pottorff, 14LA1			Wedel 1959
Young, 14SC2			Wedel 1959
25HN12	A.D.700±110	UGa-5478	Adair and Brown 1987
	A.D.900±70	UGa-5482	
	A.D.730±55	DIC-3325	
Hertha			
William Sherwood	A.D.755±70	14MM509	Blakeslee and Rohn 1982
14MM26	A.D.841±105	N-1060	Artz et al. 1975
Sterns Creek			
White Swan Mound	A.D.525±110	I-110	Haas 1983
Walker Gilmore	A.D.920±150	M-1129	

Woodland as a Formative Period

The concept of the Woodland as a formative period for the following agriculturally oriented village period focuses on the increased use of wild and agricultural plants as well as the presence of wattle and daub structures. Greater attention in this chapter will therefore be given to the identified plants and their morphological characteristics, their context within the site, the recovery methods utilized during excavation, and the distribution of the species throughout the Woodland period. House structures and their manner of manufacture are also highlighted.

A summation of the archeobotanical record for the Plains Woodland complexes discussed in the text is presented in Table 25. Also included is the repository(ies) for archeobotanical remains discussed in text. Attention is given to the mode of recovery of the botanical remains, and includes techniques such as hand collected, water-screened, or flotation methods. Variation in the latter mode is further defined by the identification of the specific flotation technique. For example, the "Apple Creek" flotation method, originally designed in the late 1960s (Struever 1968), called for a screen-bottomed wash tub to be agitated as two archeologists stood knee-deep in a creek. The heavy fraction matrix was trapped in the bottom screen while a cheesecloth-covered tea strainer was used to catch the light fraction. Although revolutionary for the 1960s, this was a time consuming and physically tiring recovery method. Consequently, large amounts of soil could not be processed during a regular field season. In addition, personal recollections of its use in the Plains did not include the use of cheesecloth over the tea strainer, thereby reducing the potential recovery of small seeds. The more mechanized SMAP barrel, developed for the Shell Mound Archaeological Project, enabled significantly larger amounts of soil to be floated (Watson 1976) over less time and with less physical energy. Again, personal recollections of its use on the El Dorado project enabled approximately 12% of the 120 sq. m of excavated area at the Two Deer site to be floated. Although the barrel method remains as the most common flotation method currently used in the Plains, several major problems, in particular, heavy clay content, continue to affect our ability to retrieve the small sized charcoal remains.

Major advances have been made in the field of paleoethnobotany throughout North America within the last few decades. Most have focused on the origins of agriculture and have encompassed changes in both methods of recovery and middle range theory. Included are (1) the concept of agriculture as a dynamic evolutionary process, requiring significant changes over a considerable amount of time in both human behavior and plant physiology; (2) the view of agriculture as a complex form of plant management, requiring a close interaction and development with other aspects of the society; (3) the recognition that indigenous weedy plants were of equal, or perhaps even greater, importance than the tropical cultigens in prehistoric subsistence strategies; and (4) the ability to go beyond the reconstruction of past subsistence strategies by asking why and how things changed over time. Within the Great Plains however, we have not fully embraced these advances. Historically, the assumption existed for many years, and may continue to exist in some measure, that Plains subsistence was dominated by the exploitation of the bison. Recent studies (Bozell 1995), however, indicate that the use of the bison in the Central Plains varied considerably through time and space.

During the Woodland period of A.D. 1-1000, bison use increased from east to west, with deer and various smaller mammals dominating the faunal assemblages in the east. Historically, agriculture has been viewed as late coming and partially if not totally abandoned after the introduction of the horse. While the importance of agriculture to the northern protohistoric and historic Plains tribes was well documented at an early time (Will and Hyde 1917; Wilson 1917; Gilmore 1913, 1919), the long time depth of this subsistence strategy was not recognized. Further, the contemporary view of agricultural development as a process involving social, residential, and technological cultural arrangements, was inconsistent with the belief that fully domesticated crops were merely introduced onto the Plains. Consequently, little attention has been given to the role of plants in the diet of Plains people and we have not fully addressed the dynamics involved in the development or regional diversity of Plains agriculture. While there is no reason to argue that the Plains was another universal location for the development of agriculture, there is every reason to argue that the environmental and cultural diversity of the Plains offered prehistoric inhabitants a variety of plants which could be, and probably were, used for food, fuel, shelter, and clothing. Within the context of well developed and well adjusted plant gathering strategies, cultivation was merely an extension. Although certain domesticated plants were probably introduced into the Plains, their initial acceptance was based on the existence of subsistence and social strategies capable of maintaining their use. The following intensification of certain plant use was more than likely determined by the cultures of which they were a part, rather than by any external influence.

Another misconception of Plains subsistence that is also entrenched in the literature is the tendency to equate horticulture and agriculture with the plant trio of corn, beans, and squash. Extensive research in the Southwest and the Eastern Woodlands is providing convincing evidence that the three tropical cultigens arrived in North America at separate times and were of varying importance to the indigenous populations (Smith 1992; Adams 1994). Of even greater significance, however, is the overwhelming evidence that indigenous weedy annuals, such as goosefoot *(Chenopodium berlandieri)*, marshelder *(Iva annua)*, sunflower *(Helianthus annuus)*, and little barley *(Hordeum pusillum)* were important subsistence resources in the Eastern Woodlands before the development of maize agriculture. Current data from Plains sites suggest that corn and squash may have been present by Middle Woodland times but were added to cultivated marshelder, an indigenous plant recognized as a domesticate

Table 25. Archeobotanical Remains from Central Great Plains Woodland Sites.

Site	Complex	Archeobotanical Remains	Mode of Recovery	Repository	Reference
Traff 23JA159	Early Woodland	goosefoot *(Chenopodium* sp.), pigweed *(Amaranthus* sp.), black walnut *(Juglans nigra)*, hickory *(Carya* sp.), marshelder *(Iva annua var. macrocarpa)*, black walnut *(Juglans nigra)*, hickory *(Carya* sp.), marshelder *(Iva annua var. macrocarpa)*	barrel flotation	KUMA	Adair, 1980, 1990
23JA36	Early Woodland	pigweed *(Amaranthus* sp.), hickory *(Carya* sp.)	barrel flotation	KUMA	Ziegler 1981b
23JA40	Early Woodland	knotweed *(Polygonum* sp.), spurge *(Euphorbia* sp.)	barrel flotation	KUMA	Ziegler 1981a
Young, 23PL4	KC Hopewell	goosefoot *(Chenopodium* sp.), pigweed *(Amaranthus* sp.), knotweed *(Polygonum* sp.) marshelder *(Iva annua)*, grape *(Vitis* sp.), spurge *(Euphorbia* sp.), sunflower *(Helianthus annuus)*, plum *(Prunus* sp.), blackberry *(Rubus* sp.), black walnut *(Juglans nigra)*, hickory *(Carya* sp.), hazelnut *(Corylus americana)*	barrel flotation	KUMA	Adair 1977
Trowbridge, 14WY1	KC Hopewell	pigweed *(Amaranthus* sp.), marshelder *(Iva annua var. macrocarpa)*, grape *(Vitis* sp.), ragweed *(Ambrosia trifida)*, pawpaw *(Diospyros virginiana)*, persimmon *(Asimina triloba)*, squash *(Cucurbita pepo)*, maize *(Zea mays)*, black walnut *(Juglans nigra)*, hickory *(Carya* sp.), hazelnut *(Corylus americana)*, oak *(Quercus* sp.)	hand collected some flotation (Apple Creek)	KUMA	E. Johnson 1975 Adair 1988
Quarry Creek, 14LV401	KC Hopewell	goosefoot *(Chenopodium* sp.), maize *(Zea mays)*, grape *(Vitis* sp.), plum *(Prunus* sp.), purslane *(Portulaca* sp.), bulrush *(Scirpus* sp.), dock *(Rumex* sp.), grass (gramineae), black walnut *(Juglans nigra)*, hickory *(Carya* sp.), hazelnut *(Corylus americana)*, hackberry *(Celtis occidentalis)*	flotation	KUMA	Adair 1994
McPherson, 14LV357	KC Hopewell	knotweed *(Polygonum* sp.), maize *(Zea mays)*, panic grass *(Panicum* sp.), grape *(Vitis* sp.), hickory *(Carya* sp.), hazelnut *(Corylus americana)*, black walnut *(Juglans nigra)*, oak *(Quercus* sp.)	barrel flotation	Ft Leav.	Wagner et al. 1989
Yeo, 23CL199	KC Hopewell	goosefoot *(Chenopodium* sp.), knotweed *(Polygonum* sp.), marshelder *(Iva annua var. macrocarpa)*, black walnut *(Juglans nigra)*, hickory *(Carya* sp.), hazelnut *(Corylus americana)*	flotation	KSU	King 1982
Wallace, 25GO2	Middle Woodland	sedge *(Carex* sp.), bulrush *(Scirpus* sp.), goosefoot *(Chenopodium* sp.)	barrel flotation	NPS	Adair, n.d.
Elliott, 14GE312	Schultz Mid.Woodland	marshelder *(Iva annua var. macrocarpa)*	?	KSU	Adair 1988
14LT304	Cuesta	sunflower *(Helianthus annuus)*, plum *(Prunus* sp.), maize *(Zea mays)*, squash *(Cucurbita* sp.), hickory *(Carya* sp.)	hand collected	KSHS	Brogan 1981 Adair, n.d.
14LT316	Cuesta	hickory *(Carya* sp.)	hand collected	KSHS	
Infinity, 14MY305	Cuesta	acorn *(Quercus* sp.)	hand collected	KSHS	
Stiles, 14MM13	Greenwood	goosefoot *(Chenopodium* sp.), pigweed *(Amaranthus* sp.), blackberry *(Rubus* sp.), vetch *(Vicia* sp.), maize *(Zea mays)*, black walnut *(Juglans nigra)*, hickory *(Carya* sp.), hazelnut *(Corylus americana)*	limited flotation	WSU	Blakeslee and Rohn 1982
Cow-Killer, 14OS347	Greenwood	black walnut *(Juglans nigra)*, "small seeds"	water screened	KSHS	Reynolds 1984a
Avoca	Grasshopper Falls	goosefoot *(Chenopodium* sp.), violet *(Viola* sp.), spurge *(Euphorbia* sp.), grass *(gramineae)*, grape *(Vitis* sp.), maize *(Zea mays)*, hickory *(Carya* sp.), black walnut *(Juglans nigra)*, sunflower *(Helianthus annuus var. macrocarpa)*, marshelder *(Iva annua var. macrocarpa)*	flotation	KSHS	Adair 1991
14JN349	Grasshopper F	maize *(Zea mays)*	flotation	KSHS	Adair 1991
Senn'sHill,	Grasshopper F	black walnut *(Juglans nigra)*, hickory *(Carya* sp)	barrel flotation	KUMA	Adair 1990
14AT2	Grasshopper F Falls	goosefoot *(Chenopodium* sp.), pigweed *(Amaranthus* sp.), bulrush *(Scirpus* sp.), purslane *(Portulaca* sp.), black walnut *(Juglans nigra)*	flotation	KSHS	Williams 1986
Richland, 14SH101	Deer Creek	goosefoot *(Chenopodium* sp.), black walnut *(juglans nigra)*	barrel flotation	KUMA	Adair 1987
William Sherwood, 14MM509	Hertha	pigweed *(Amaranthus* sp), hickory *(Carya* sp.), black walnut *(Juglans nigra)*,	flotation	WSU	Blakeslee and Rohn 1982
25DO12	Loseke Creek	goosefoot *(Chenopodium* sp.), maize *(Zea mays)*	flotation	NSHS	Adair n.d.
Lawson, 25PT12	Loseke Creek	maize *(Zea mays)*	hand collected	NSHS	Kivett 1953
LoDiasKa, 5JF142	South Platte	goosefoot *(Chenopodium* sp.), plum *(Prunus* sp.), wild bean *(Lupinus perennis)*, dock *(Carex* sp.), paspalum *(Paspalum* spp.), hawthorn *(Crataegus* sp.), acorn *(Quercus* sp.), onion or garlic *(Allium* sp.), grass *(gramineae)*, maize *(Zea mays)*	hand collected	Colorado?	Irwin and Irwin 1959

during the Early Woodland period (Adair 1990). While corn became a dominant crop in Village period complexes, it was only one of several cultigens used by both Plains Woodland and Plains Village populations. To determine the pathway of importance for both tropical and indigenous cultigens, each domesticate should be evaluated according to context, quantity, and frequency from its first appearance in an archeological context.

With a current emphasis on agricultural origins dominating paleoethnobotanical research in geographical areas adjacent to the Plains, there is certainly a tendency to orient Plains research in the same direction. Although important, elucidating argicultural crops tends to ignore the importance of wild plants. Plains Woodland ethnobotanical research must include a determination of the quantity and quality of the various wild plant species to the overall diet. It is clear from the information presented in Table 25 that wild species, including both weedy annuals and nuts, contributed to the caloric intake of Plains Woodland populations at the same time that the consumption of domesticates was increasing. The actual ratio of wild vs. domesticate plant use cannot be stated with any absolute certainty with the data provided; however, with greater attention to archeobotanical recovery and analysis, this type of research could prosper.

Aside from the theoretical issues, one of the biggest methodological stumbling blocks in Plains paleoethnobotanical research is the recovery method used during excavation. Without archeobotanical remains, it is impossible to document, or even convincingly argue, the importance of plants or the presence of early domesticates. However, that is exactly what is often done. Most pre-Village period Plains subsistence strategies are described as "hunting and gathering," a conclusion often based on the identification of numerous faunal elements representing various animal species and the inferred used of plants, a conclusion based on the presence of grinding slabs and, if lucky, a few *Chenopodium* seeds. The recovery and identification of maize, even one kernel fragment, is frequently described as evidence of "limited horticulture" or "incipient agriculture" or even "experimental horticulture." To adequately discuss the importance of both wild and domesticated plants, recovery techniques must be extensive, systematic, and consistent. Macrobotanical remains, phytoliths, and pollen are all valuable sources of information, and research designs which propose to reconstruct past subsistence strategies should address each source. Further, CRM projects which outline field and laboratory techniques should specifically describe the type of flotation technique used and the sampling procedure followed. Adequate funds should also be available to complete every step in the recovery, identification, quantification, analysis, and curation.

In this chapter, which focuses heavily on an overview of the plant subsistence strategies used in the Central Great Plains during the Woodland period, it is impossible to overlook the lack of, or limited amount of, botanical data from several of the complexes. By comparison, however, archeobotanical remains have been recovered in sufficient quantities from other Woodland complexes (i.e., Grasshopper Falls phase) which allow for a more in-depth discussion of past subsistence. Rather than attempting to generalize from what is known by applying the information to those complexes from which limited archeobotanical remains are available, this chapter concludes with suggestions for further research.

Early Woodland

Spanning a period of roughly 500 years, from 500 B.C. to A.D. 1 and located along the eastern margin of the Great Plains, are a series of sites that provide the earliest evidence of the Woodland pattern. Immediately adjacent to the boundaries of this study, five Early Woodland occupations are recognized from recent investigations along the Little Blue River in extreme western Jackson County, Missouri (Johnson 1992; Peterson 1982; Schmits and Bailey 1986; Wright 1980; Ziegler 1981a, 1981b). They are 23JA159 (Traff), 23JA40, 23JA36, 23JA38 (Bowlin Bridge), and 23JA243 (McPherson). Directly within the current project boundaries, two contemporary sites in eastern Kansas, 14BN26 and 14JO46, were identified from surveys and limited excavations (Logan and Hedden 1990; Johnson 1992). In northwestern Iowa, the Rainbow and MAD sites provide some of the best information on the developmental sequence of the Woodland period (Benn 1990), while to the north in southwestern Minnesota, Early Woodland sites are attributed to the Fox Lake phase (Anfinson 1982).

Gregg (1990) also describes an Early Woodland occupation at the Naze site in southeastern South Dakota. While variations exist in the occupations from these different geographical areas, the primary characteristics which distinguish them as Early Woodland are the presence of thick, stone-tempered ceramics with cordmarked exteriors occasionally overlain in the rim area with incised geometric designs in association with bifacial knives conforming to the type Mason Contracting Stem of the Belknap type series (Montet-White 1968; Farnsworth and Asch 1986). The type of ceramic described closely resembles the Black Sand-Incised and Spring Hollow-Incised ceramics of the Midwest, now grouped in the Liverpool type series (Griffin 1952; Logan 1976; Farnsworth and Asch 1986; Farnsworth and Emerson 1986). Based on work in the Kansas City vicinity, Schmits and Bailey (1986:231-232) defined the Early Woodland Bowlin phase, a taxonomic distinction which may not be applicable to the more western occupations (Johnson 1992).

Several sites, located within the Flint Hills region of central Kansas and previously identified as Late Archaic, may be a part of the Early Woodland manifestation. Excavations of the Walnut phase occupation at the Snyder site (14BU9) in south-central Kansas and the Coffey site (14PO1) in north-central Kansas have produced radiocarbon dates ranging from 530 B.C. to 20 B.C. (Grosser 1973; Schmits 1981). Triangular corner-notched projectile points recovered from these two sites are morphologically similar to those associated with the Early Woodland occupation at the Traff site (Schmits 1981:203). The designation of the Walnut phase as Late Archaic is due in large part to the radiocarbon dates and the absence of ceramics, although the material culture remains and adaptation type appear to be very similar to that identified for the prairie-bordered Early Woodland complex.

In general, the quantity, type, and extent of cultural debris from these sites indicate a seasonal or temporary occupation of perhaps family related bands, not too different from that recognized from the preceding Late Archaic. Cultural debris tends to cover a relatively small area, with cooking hearth-workshop areas, lithic tool production areas, and pit features identified at several sites. Recovered floral and faunal remains suggest that the subsistence pattern also varied little, with the notable exception of the appearance of cultigens. Along with numerous goosefoot *(Chenopodium* sp.), pigweed *(Amaranthus* sp.), hickory *(Carya ovata),* and black walnut *(Juglans nigra),* indigenous crops are represented by domesticated achenes of marshelder *(Iva annua var. macrocarpa)* from the Traff site (Adair 1980).

Marshelder, or sumpweed (Figure 39), is a weedy annual dispersed throughout the Eastern Woodlands and Plains where it is frequently found in moist settings disturbed by annual flooding (Asch and Asch 1978; Jackson 1960; Yarnell 1972). Asch and Asch's (1978) study of the nutritional content of the *Iva* seed (or achene, as the seed and pericarp combined are more properly called) indicates that it is a good source of food energy, high in protein and fat content and several essential vitamins and minerals. Smith (1992) provides a summary of the prehistoric use of this plant in the Eastern Woodlands, noting the early evidence for its domestication during the second millennium B.C. Like many indigenous plant species, the morphological effect of domestication on the marshelder plant is a significant increase in seed size. Collections of modern *Iva annua* seeds from the Illinois River valley area (Asch and Asch 1978), the eastern portion of the Central Plains (Adair 1988), and the central and western regions of Oklahoma (Drass 1995), indicate that achene size does not exceed 4.5 mm in length. Domesticated *Iva annua var. macrocarpa* achenes from archeological contexts range from approximately 4.8 to 10.0 mm in length, a size significantly larger than that produced by any wild plant today. As Yarnell argued over 20 years ago (1972, 1977), the evidence of aboriginal domestication of *Iva* is entirely dependent upon archeological data.

At the Traff site, four *Iva* achenes and seeds were recovered from two contexts. Size reconstruction is often necessary due to charring and loss of the pericarp (Asch and Asch 1985; Yarnell 1978). The Traff achenes measure 4.5-6.4 mm in length and 3.4-5.7 mm in width (Figure 40). Their average size of 5.4 x 4.2 mm (Adair 1990) provides the first convincing evidence for the presence of any domesticate in the Central Great Plains. The presence of domesticated *Iva* suggests that the Early Woodland inhabitants of the Traff site had more than a casual reliance on plants, but were instead deliberately planting and cultivating at least one native species. Recently (Adair 1993b), an examination of the morphological characteristics of the goosefoot (*Chenopodium* sp.) seeds recovered from the Traff site was made to determine the potential for the domestication of this weedy annual. Seed margin morphology, seed coat

Figure 39. Marshelder or Iva annua var. macrocarpa *and Sunflower or* Helianthus annuus.

characteristics, and pericarp thickness were analyzed on several of the small seeds. No characteristics associated with the domesticated variety (Smith 1992) were observed, and one must conclude that the wild *Chenopodium* plant was the variety used by the prehistoric inhabitants of the Traff site.

Many of the archeobotanical remains from the Traff site were recovered from a large hearth complex; the possibility exists, therefore, for some of the small seeds to represent accidental charring and inclusions into the archeobotanical record. For plants such as goosefoot and pigweed, which tend to grow in disturbed ground around habitation areas and disperse thousands of mature seeds, it is almost impossible to determine accidental or intentional use unless sufficient flotation samples are taken from locations throughout the site to distinguish areas of concentration from areas of uniform seed rain. At the Traff site, flotation samples taken from every excavation unit and from each level clearly demonstrate the concentration of plant remains within the feature. Test excavations at two other Early Woodland sites, 23JA36 and 23JA40, were not as extensive as the investigations at Traff. The distribution of plant remains at these sites, therefore, cannot be presented in the same manner. At both tested sites, the amount of archeobotanical remains is relatively small, being limited to a few pigweed and knotweed seeds and nut shell remains of hickory (Table 25). Outside the study area, large seeded sunflower achenes *(Helianthus annuus var.*

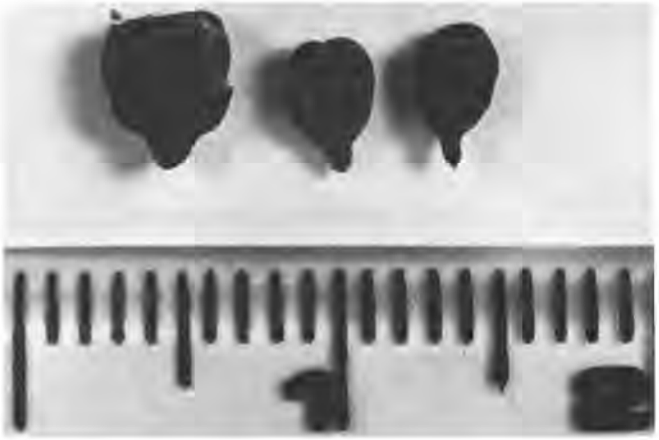


Figure 40. Iva annua, var. macrocarpa *achene (left) and seeds from the Traff site (23JA159).*

macrocarpa) were identified from the Boyer phase occupation of the Rainbow site (Benn 1990:195-200) along with numerous seeds and rind fragments of squash *(Cucurbita pepo)* and several tobacco seeds *(Nicotiana* cf *rustica).*

The appearance of tobacco in the Boyer phase represents the first recognition of this plant on the Plains (Adair n.d.). The extent to which these other cultigens were grown in the area is unknown. To date, squash has not been identified from a pre-Woodland component and although a single marshelder achene was identified from the Late Archaic Nebo Hill site (Root 1979), one cannot argue for its extensive use which culminated in domestication.

Middle Woodland

While the term Middle Woodland is often used in reference to complexes which display Hopewellian traits, other groups were living in the Central Plains during the same time but practiced a lifestyle in stark contrast to the more elaborate Hopewell. Three Middle Woodland complexes identified in the area are the Kansas City Hopewell, located around the confluence of the Missouri and Kansas Rivers (Johnson 1976, 1983; Wedel 1943); the Cuesta phase, recognized in Labette, Montgomery, and Greenwood counties in southeast Kansas (Brogan 1981; Marshall 1972); and the Valley variant, found throughout central Nebraska and westward into the High Plains of Colorado (Hill and Kivett 1940; Kivett 1952; Bozell and Winfrey 1994). The extent to which the more easterly prairie-bordered Hopewell groups influenced the development of, or participated with, the westerly plains Middle Woodland groups is largely unknown. Butler (1988), however, reports on cordmarked ceramics and radiocarbon dates of ca. A.D. 100 from northeastern Colorado, suggesting that some expansion of eastern people or diffusion of ideas occurred during the early part of the Middle Woodland period.

The Cuesta phase is a local complex of the larger Cooper regional variant, originally defined from investigations along the Grand River in northeast Oklahoma (Bell and Baerreis 1951; Vehik 1983) but later expanded to include portions of southeast Kansas, southwest Missouri (Marshall 1972) and northwest Arkansas (Schultz 1969).

To the north throughout central Nebraska and westward into the High Plains of Colorado, Middle Woodland groups are recognized as the Valley variant. Although not well defined in the literature, sites assigned to the Valley variant include small probably temporary occupations, larger/more extensive occupations, and burials and suggest that some relationship existed between Hopewell and Valley.

Kansas City Hopewell

The Middle Woodland Kansas City Hopewell complex was defined by the early work of Mett Shippee (1967) and Waldo Wedel (1938b, 1943) in and around Platte County, Missouri. Across the state line in Wyandotte and Leavenworth counties, Kansas, Harry Trowbridge collected similar artifacts and conducted excavations at several sites, including the Trowbridge site (14WY1). Beginning in the late 1960s, archeologists from the University of Kansas, first under the direction of Robert Squier and later supervised by Alfred Johnson, extensively investigated several Kansas City Hopewell sites, surveyed tributary drainages and recorded the distribution of Hopewell sites, and embarked on in-depth analyses of the recovered cultural remains. This work helped clarify the temporal and spatial extent, cultural variability, settlement and subsistence practices, and the diagnostic artifacts related to the Kansas City Hopewell (Adair 1977; Bell 1976; Brockington 1977; Hefner 1974; A. Johnson 1976, 1979, 1983; E. Johnson 1975; Johnson and Johnson 1975). Although much of this work focused on sites in Platte County, Missouri, recent investigations in Leavenworth County, Kansas (Logan [ed.] 1993; Wagner et al. 1989) have better defined the nature of the Hopewell occupation west of the Missouri River.

Kansas City Hopewell can perhaps best be described as a regional variant of the larger Hopewell cultural complex that existed throughout much of the Eastern Woodlands during the Middle Woodland period. As the westernmost recognized variant, it has been suggested that the Kansas City Hopewell complex originated due to a migration of people from the Lower Illinois Valley area, with comparisons frequently being made to the Bedford, Ogden, and Utica phase of the Middle Woodland, Havana tradition (Wedel 1943; Johnson n.d.). With the recognition of a local Early Woodland occupation in the Kansas City region, there also exists the possibility of an in situ development (Adair 1988; Logan [ed.] 1993). Both alternatives need further research.

Diagnostics of the Kansas City Hopewell include large (approximately 2 to 5 gallons), straight-walled vessels tempered with grit or sand and either decorated on the rims with a variety of designs or left undecorated with smooth surfaces. The most prominent decorations are cross-hatched incisions, rocker-stamping, hemiconoid punctates, embosses, and lip notches (Figure 41). The vessels exhibit a wide mouth and rounded or subconical bases. Distinctive lithic artifacts include broad-bladed, corner-notched points (Snyders type) and subtriangular, contracting-stemmed dart points (Gary, Dickson, or Steuben types) (Figure 42). Also highly characteristic of the Kansas City Hopewell complex is the production and utilization of bladelets produced from a prepared core (Reid 1976; Wedel 1943). Other lithic artifacts include blocky endscrapers, drills, gouges, and chipped stone and ground stone axes and celts. Most of the lithics were manufactured from locally available Winterset or Westerville cherts, although Reid (1976) has demonstrated that some exotic cherts were traded into the area from the Big Bend region of central Missouri.

The core area of the Kansas City Hopewell surrounds the confluence of the Kansas and Missouri Rivers. Isolated habitation sites and diagnostic Hopewellian ceramics have been found in all directions from this location. To the north, the Kelley site (14DP11) in Doniphan County, Kansas is perhaps the most northern occupation site known, although Kansas City Hopewell pottery has been collected from sites in Nemaha, Cass, Dakota, Buffalo, Webster, Richardson, and Jefferson counties in Nebraska. Diagnostic cross-hatched, dentate, or rocker-stamped designs on the rims distinguish these ceramics from those assigned to the Valley focus. Evidence of Hopewell contact or influence is seen to the west of the core area at habitation and burial sites in Douglas and Jefferson counties (Logan [ed.] 1993) and around Manhattan, Kansas (Schultz and Spaulding 1948; O'Brien et al. 1979). South of the core area, Hopewellian ceramics are reported from the El Dorado Lake area (Grosser 1973) in Butler County and into the southeast part of the state. The latter evidence may be more appropriately attributed to the Cuesta phase.

The Hopewell Interaction Sphere, a term introduced over 30 years ago (Struever 1964), describes an extensive trade network of the Hopewell people that included much of the eastern Woodlands of North America and reached south to the Gulf of Mexico and across the Great Plains to the Yellowstone region. It has been suggested that the Kansas City Hopewell people were not active participants in this exchange since exotics are relatively rare occurrences in Kansas City sites (Johnson 1979). Sixty-six items, most representing local imitations of trade items, have been recovered from eight sites (Logan [ed.] 1993; Johnson 1979; Wedel 1943). The nonlocal items include one fragment of a helmet shell from the Gulf Coast, three celts, three awls, four fragments of copper, one obsidian flake, and three small pieces of sheet mica (Johnson 1979; Logan [ed.] 1993). Recent analyses of several of the exotic artifacts identified at least one of the celts as copper (Logan 1993 [ed.]:152), which may have been quarried from the Great Lakes region. The source of the obsidian flake recovered from

Figure 41. Middle Woodland Kansas City Hopewell ceramics.

Figure 42. Middle Woodland point styles.

the Trowbridge site was identified as Obsidian Cliff in Yellowstone National Park, northwestern Wyoming (Hughes 1995).

A series of radiocarbon dates along with stylistic changes in the ceramics and bifacial tools was used to suggest three developmental phases for the Kansas City Hopewell. The Trowbridge phase is the earliest (A.D. 1-250) and is characterized by dentate-stamped and punch-and-boss decorations on vessel rims and broad-bladed projectile points resembling the Snyders type. The Kansas City phase of A.D. 250-500 is distinguished by incised cross-hatched lines and punctate designs on vessel rims in association with subtriangular, contracting stemmed or corner-notched projectile points. The final phase, representing the early Late Woodland in the Kansas City vicinity, is the Edwardsville phase (A.D. 500-750). Vessel rims are either undecorated or exhibit lip crenations while projectile point styles include medium sized and smaller Scallorn styled corner-notched varieties.

Several of the large village sites, such as Trowbridge, Young (23PL4) and Renner (23PL1) are believed to have been occupied for the initial 500 years of the Hopewell span, while the Yeo (23CL199) and Miller (14WY8) sites are representative of the terminal phase. With (uncalibrated) radiocarbon dates of A.D. 170 ± 60 to A.D. 370 ± 80 (Table 24), the chronology of the Quarry Creek site (14LV401) suggests occupation(s) from the Late Trowbridge phase to the late Edwardsville phase (Logan [ed.] 1993:184-186). As Logan (1993 [ed.]:187-188) discusses, however, recent radiocarbon dates from several Late Plains Woodland sites in northeast Kansas suggest occupation of this area during the seventh and eighth centuries, which is roughly contemporaneous with the range of the Edwardsville phase of the Kansas City Hopewell. It is interesting then that none of the Plains Woodland sites display any Hopewellian material culture traits, despite the close proximity of the two complexes. Logan states that it "is difficult to imagine that a cultural barrier of some kind prevented the interaction of these cultures in the Lower Kansas River Basin." (Logan 1993 [ed.]:188). The more likely scenario is that the terminal dates for the Edwardsville phase are around A.D. 600-650 and that this period witnessed either the disappearance of the Hopewell culture, as in the Midwest, or its cultural transformation into a Late Plains Woodland adaptation. Such a research issue requires both the recognition of sites that could elucidate such a cultural/technological change as well as sufficient radiocarbon determinations from both late Hopewell and Plains Woodland occupations.

The settlement-subsistence strategies of the Kansas City Hopewell have perhaps received the greatest amount of research (Adair 1977; Bell 1976; Brown 1975; A. Johnson 1976; E. Johnson 1975; Pullen 1976; O'Brien 1982). Current understanding of these strategies indicates that the Kansas City Hopewell were well adapted to the ecological setting provided by the junction of two major rivers, the Kansas and the Missouri and their numerous tributaries. Primary environmental zones exploited were the floodplain forests and upland oak-hickory forests and prairie patches. White-tailed deer *(Odocoieleus virginianus)*, elk *(Cervus canadensis)*, raccoon *(Procoyon lotor)*, turkey *(Meliagris galopova)*, with lesser numbers of bison *(Bison bison)*, were the basic animals hunted, although various fish, amphibians, reptiles, and migratory waterfowl added variety to the resource base. The floral remains exhibit an interesting mix of wild plants and cultigens and are suggestive of an increased reliance on local resources by groups who were becoming more sedentary. Although nuts, particularly hickory and hazel, are present in significant percentages in the archeobotanical record from the Late Archaic to the Kansas City Hopewell, the numbers of small seeded annuals and fruits increases significantly (Table 25). Seeds of goosefoot *(Chenopodium* sp.), pigweed *(Amaranthus* sp.), and knotweed *(Polygonum* sp.), along with plum *(Prunus* sp.), pawpaw *(Asimina triloba)*, and grape *(Vitis* sp.) comprise the majority of identified species from the Trowbridge (14WY1) and Young (23PL4) sites. Various grasses, some identified as panic grass, bulrush *(Scirpus* sp.), dock *(Rumex* sp.), and spurge *(Euphorbia* sp.) have been identified from several Middle Woodland sites in the Central Plains. Also present, but still in fairly low percentages, are the remains of indigenous crops of marshelder and sunflower along with the introduced cultigens squash *(Cucurbita pepo)* and maize *(Zea mays)*.

The association of maize with Middle Woodland populations has been a source of debate for decades. Many archeologists were once convinced that the cultural complexity of the Hopewellian societies (most notably those complexes in the Ohio and Illinois River valleys) of 2000 years ago maintained a high population density, sustained by a productive and dependable subsistence economy based on maize agriculture (Spaulding 1955). Flotation sampling from many sites over the past 40 years, as well as more recent studies of $^{13}C/^{12}C$ isotopic ratios in human bone, have, however, combined to demonstrate that maize was not a staple resource during the Middle Woodland period (Bender et al. 1981; Lynott et al. 1986; Smith 1992). In addition, many maize remains were found to be associated with later components. While the appearance of maize in the river valleys of the Eastern Woodlands is confirmed by direct accelerator dates on maize remains (Chapman and Crites 1987; Ford 1987; Smart and Ford 1983; Riley et al. 1994) from the Holding, Edwin Harness, and Icehouse Bottoms sites, some continue to argue that its economic importance in the Middle Woodland diet is not sufficiently evaluated (Riley et al. 1994)

Maize has been recovered from four Kansas City Hopewell sites: Trowbridge (14WY1) which yielded the largest sample consisting of a nubbin cob and about 90 isolated kernels; Renner (23PL1) which contained two isolated kernels (Wedel 1943); four cupule fragments and one kernel fragment from the McPherson (14LV357) site (Wagner et al. 1989); and three cupules from the Quarry Creek site (14LV401) (Adair 1993b). From a temporally equivalent complex, Benn (1990) identified one maize kernel from the early Late Woodland occupation at the Rainbow site in northwest Iowa. Radiocarbon age determinations were recently made on the maize samples from Trowbridge, McPherson and Quarry Creek sites (Table 26). Previously described as representing an early Chapalote-like variety by several ethnobotanists (Cutler and Blake 1973; Ford 1984), the Trowbridge corn is instead associated with a protohistoric component at the site. The three AMS dates on the Trowbridge corn are 220 ± 50 (UCR-3357), 70 ± 60 (Beta-75015) and 170 ± 60 (Beta-75016) RCYBP (Table 26). The cupule recovered from the McPherson site was direct dated to 900 ± 40 RCYBP (A.D.1050) while the Quarry Creek remain yielded a date of 1880 ± 50 RCYBP (A.D.70). The McPherson site sample clearly reflects an association of the maize with the later Village period occupation at the site, while the Quarry Creek sample, at first glance, seems to confirm a Middle Woodland affiliation. However the $\Delta^{13}C$ value on this sample is -25.6, obviously incorrect for a C_4 plant such as maize, suggesting that the charcoal submitted was not *Zea mays*. While additional maize remains were identified from the Quarry Creek site (Adair 1993a), further direct dating of this cultigen should perhaps await a larger sample from other Middle Woodland sites. In the meantime, however, the potential association of maize with the Middle Woodland Kansas City Hopewell period should not be totally disregarded; but clearly the arrival of this cultigen in the eastern Plains needs further research.

Table 26. Accelerator Dates on *Zea mays* from Kansas City Hopewell Sites.

Site/Provenience	Lab No.	Lab Date	A.D.	1δ	$\Delta^{13}C$
14LV357 Unit 4, level 3 20-26 cm below datum	UCR-3355	900 ± 40	1050	1165	-11
14LV401 Feature 6, 80-90 cm below surface	UCR-3356	1880 ± 50	70	130	26.5
14WY1 Feature 13b, 9" below surface	UCR-3357	220 ± 50	1730	1666	10.7
14WY1 Feature 13b	Beta-75015	310 ± 60	1640	1638	10.5
14WY1 Feature 13b	Beta-75016	400 ± 60	1550	1473	11.0

Another cultigen that continues to be associated with the Kansas City Hopewell complex is the common bean *(Phaseolus vulgaris)*. During excavation at the Renner site (23PL1), a seed "resembling the modern pinto" (Wedel 1943) was recovered. Rumors surrounding this discovery describe the remain as either rapidly disintegrating after excavation, or being crushed beyond identity after being stepped on in the field. Regardless of the rumors, this specimen does not exist in the collections from the Renner site at the Smithsonian, despite a catalog entry for both the corn and the beans. Furthermore, the arrival of the common bean into the American Bottom area is now generally accepted to have occurred after A.D. 1000 (Lopinot 1992, 1994). If beans were recovered from the Renner site, as Wedel describes, then they were probably associated with the later Steed-Kisker occupation. Without the actual specimens, however, there is no way to make a definite identification. The presence of the common bean within a Middle Woodland context has been repeatedly questioned (e.g., Ford 1979; Adair 1988), but somehow, its association with the Kansas City Hopewell complex continues in the literature (Riley et al. 1990).

Based on variation in size, location, artifact density, and function, three classes of Kansas City Hopewell sites are recognized. Large villages, which are frequently located near the mouth of streams tributary to the Missouri and Kansas rivers, often extend over 5-10 acres. Isolated postmold stains and occasional daub fragments hint of the presence of some kind of structure. The most common features at the large sites, however, are the numerous storage pits. Twenty-nine trash filled storage pits were identified during the excavations at the Young site, while 15 such features were identified at the Trowbridge site. These features are frequently large subsurface constructions, filled with village trash consisting of floral and faunal remains; ceramics; lithic, bone, and ground stone tools; and charcoal. Nearby thick midden deposits combine to suggest a fairly extensive occupation. Current thought suggests that the storage pits may have been constructed outside of any habitation structure and perhaps grouped together off to one edge of the site.

Smaller sites, ranging in extent from 2 to 5 acres and originally suggested (Johnson 1976) to be of ancillary support to the larger villages, comprise the second type of Kansas City Hopewell site. These sites are often located on terraces within the valleys of streams tributary to the Missouri and Kansas Rivers. The smaller size of the site, the limited quantity of refuse, and a restricted range in functions as defined by the tools, all combine to indicate a shorter period of occupation. A few radiocarbon dates also indicate that these smaller sites may not have been occupied until later in the Middle Woodland sequence, an interpretation which also led to the suggestion that these sites represent budding-off communities formed by population pressure at the larger village sites (Johnson 1979). Alternatively, they have been suggested to be resource exploitation stations for the maintenance of the larger villages (Johnson 1976, 1979), a suggestion not yet substantiated by the identification of recovered floral and faunal remains.

Burial mounds comprise the third type of Kansas City Hopewell site. Located along the bluff ridges of the Missouri River, most have been destroyed by treasure seekers before any professional excavations were conducted in the area. A few exceptions include the Cochran Mound (23PL86), the Cogan Mounds (23PL125), and others noted in Shippee (1972) and Wedel (1943) (Figure 43). Earthen mounds often cover a central stone vault tomb, although skeletal remains have been recovered from both the tomb and the surrounding fill. Burial types include primary and secondary inhumations and cremation. Burial goods include both utilitarian items and artifacts especially manufactured as grave goods. Burials have also been exposed at several village sites, such as Renner and Aker, where both adults and children were interred into shallow pits within midden areas.

Despite the fairly extensive investigations into the Kansas City Hopewell complex, there remains quite a lot to learn about these people. In terms of the subsistence strategies used, most of the larger sites were excavated before fine screen recovery techniques were routinely used, consequently the floral remains tend to be the larger sized, such as noted in the remains from the Trowbridge site. Although the "Apple Creek" flotation method (Struever 1968, Pearsall 1989) was used at the Young site, the fine screen mesh size used approached 1/4" and many

Figure 43. Waldo Wedel (left) and Mett Shippe (right) during excavations of the Avondale mounds in 1934 and 1935 (Photo courtesy of Joan Shippee Wagner).

small seeds would not have been recovered. In addition, many samples remain unsorted. Although a more mechanized flotation method (a variation of the SMAP barrel) was used during the excavation of the Quarry Creek site (14LV401), many unsorted samples are curated due to lack of funds. Analysis of some of this material may help to address current research questions. Included are: (1) If the smaller sites were settled to exploit resources for the maintenance of the large villages, what plant species were involved in this strategy? (2) Was there a shift in subsistence over time to include the introduction of tropical cultigens, as recognized for the more easterly Middle Woodland? (3) Why are maygrass and little barley, so common in eastern Hopewell sites, not present in the archeobotanical record from the Kansas City region? Is it a different adaptation on the prairie border or are our recovery and identification techniques inadequate? (4) Does the appearance of cultigens imply population pressure (as Johnson 1979 suggests) with crops viewed as a safeguard to resource depletion? Maize has been recovered from several Middle Woodland sites in the Eastern United States (Asch and Green 1992; Smith 1992) in quantities so limited that its importance as a food item has been questioned.

Cuesta Phase

The Cuesta phase of southeast Kansas was initially defined by Marshall (1972) from excavations at the Infinity site (14MY305) in Montgomery County, Kansas. This phase is a local complex of the larger Cooper regional variant, originally defined from investigations along the Grand River in northeast Oklahoma (Bell and Baerreis 1951; Vehik 1983). A series of related sites in the Elk City Lake and Big Hill Lake areas of Kansas, along with diagnostic ceramics, combined to suggest that Cuesta was similar to Hopewell manifestations in Missouri and northeast Oklahoma, although somewhat later than the Kansas City Hopewell. Radiocarbon dates place the Cuesta phase between A.D. 700-1000 while speculation that a migration of Middle Woodland people into the area may have been responsible for its origin has been presented. At present, however, no data have been collected to support this suggestion, although the ceramics clearly exhibit Hopewellian designs, such as dentate stamping, punctates, and stick impressed (Marshall 1972). In large part, the ceramics closely resemble those recovered from Kansas City Hopewell sites as well as the Cooper site in northeast Oklahoma. A preliminary study of the Cooper ceramics indicates significant differences exist between these wares and those of the Kansas City Hopewell (Cook, personal communication 1994). Studies such as this, in addition to a tighter chronology for Cuesta phase sites, may provide the evidence needed to establish the origins of this phase and its relationship with eastern and northern Hopewell groups.

From survey and excavation work in the Big Hill Lake region of southeast Kansas, it has been suggested that variability existed in the Cuesta settlement pattern (Brogan 1981; Thies 1982a, 1985; Jones and Witty 1980). Cuesta settlements include large nucleated villages, while smaller, perhaps functionally oriented, sites are also noted. Brogan (1981) suggested that this settlement arrangement may be related to the carrying capacity of the floodplain resource zone, although significant differences in the floral and faunal remains have not been observed between the large and small occupation sites. Cuesta villages contain from five to 10 houses, defined as either oval structures measuring 8-12 m by 11-15 m or square houses about

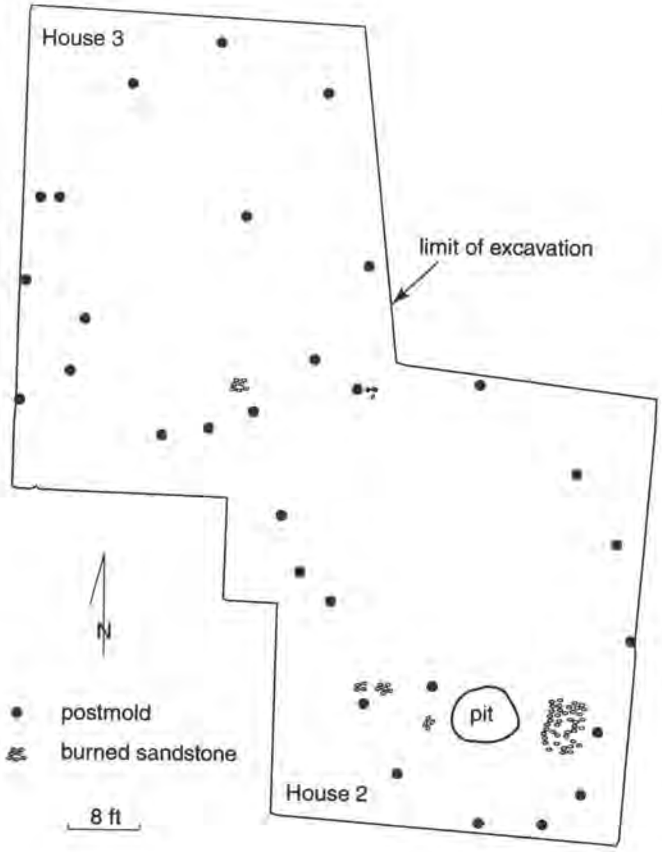


Figure 44. Plan view of House 2 and 3, 14MY305 (from Marshall 1977).

13 feet on each side (Brogan 1981; Marshall 1972; Rowlison 1977) (Figure 44). Interior roof supports, wattle-and-daub wall construction, and interior features (hearths and storage pits) are recorded for both types of houses. Extramural features, such as hearth areas, storage pits, and middens have also been recorded.

While burial mounds have not been recorded for southeast Kansas, several such sites were excavated in northeast Oklahoma (Howard 1970). Two mounds within a group of eight disclosed a shallow burial pit containing fragmentary human remains and a shallow pit dug for a flexed burial. Burials attributed to the Cuesta phase within the Central Plains have been found primarily in the midden deposits of large village sites (Marshall 1972; Weakly 1965). Burial goods were not associated with these interments.

Artifacts recovered from Cuesta sites include a variety of chipped stone tools, ground stone implements, bone tools, and ceramics representing numerous types. Marshall (1972) identified three ceramic wares for the Cuesta phase, each with component types. The Havana ware, comprising about 18% of the ceramics from the Infinity site, can be further identified as Naples Stamped, dentate variety and Neteler Stamped, plain variety. Both types are sand tempered. Cuesta ware can be divided into six different component types: Cuesta Decorated, dentate variety; Cuesta Decorated, punctate variety; Cuesta Decorated, smooth stick impressed variety; Cuesta Decorated, cord-wrapped, stick impressed variety; Cuesta Plain; and Cuesta Plain, decorated lip variety. Cuesta ware is indurated clay tempered and vessel shape is defined as relatively large with an elongated shape and a conoidal or round base. The third ceramic ware is identified as Montgomery cord-roughened and is only minimally represented in the collection from the Infinity site. Brogan (1981) does not offer a description of this ceramic type. Projectile points are described as expanding stem dart points, conforming to the Snyders and Ensor types, contracting stem dart points of the Gary type, and smaller corner-notched Scallorn type arrowpoints. Endscrapers, side scrapers, bifacial knives, modified flakes, and drills are also recovered. Chert types for the various tools are not presented, although it is important to note that three flakes of obsidian were recovered from the Infinity site. The source of this obsidian has not been identified.

Subsistence practices of the Cuesta phase are described as hunting and gathering with evidence of limited horticulture—a similar economic mode as that attributed to the Kansas City Hopewell. Remains of large mammals, such as bison *(Bison bison)* and deer *(Odocoileus* sp.), are associated with faunal elements of turkey *(Meliagris galopova),* raccoon *(Procyon lotor),* beaver *(Castor canadensis),* dog *(Canis* sp.), rabbit *(Sylvilagus* sp.), turtle *(Testudines)*, and various rodents. Floral remains, indicative of the proposed gathering and horticulture activities, can be summarized in one sentence. Two fragments of acorn *(Quercus* sp.) were identified from the Infinity site; one corn kernel, a fragmented sunflower achene, a plum pit *(Prunus* sp.), and a few hickory *(Carya* sp.) shells were recovered from 14LT304; and nutshells, probably also hickory, were also recovered from 14LT316. Although Brogan (1981:70) suggests that these remains indicate a "subsistence base with a reliance on a riverine oak-hickory resource zone," the archeobotanical data are, in reality, insufficient to address issues of either reliance or the exploitation of any particular resource zone. Acorns, hickory nuts, sunflowers, and plums are all consumed by wildlife and single remains could easily be deposited within an archeological context through nonhuman activities.

Additionally, the sunflower can survive in a number of different habitats, including recently disturbed ground surrounding habitation areas. While the corn kernel is more indicative of human activities such as planting and harvesting, this sample could not be relocated during a recent inspection of the 14LT304 collection. However, three isolated corn cupules were identified from a "charcoal" matrix collected from a storage pit at this site (Adair, unpublished notes), reaffirming the association of corn with the Cuesta complex. Without systematic flotation recovery techniques, however, archeobotanical remains cannot be retrieved in the quantities or contexts needed to identify the use of wild or cultivated plants and the gathering strategies simply become assumed rather than demonstrated activities. Ongoing excavations of a

Cuesta occupation in Bourbon County, Kansas (Feagins, personal communication 1995) may help to better define the subsistence base, as systematic flotation sampling is a critical component of the investigations.

Valley Complex/Focus/Variant

Excavations at the Schultz site (25VY1) in west-central Nebraska over 50 years ago disclosed a pre-Village ceramic-making occupation which was used to formally define the first Middle Woodland taxon in the state (Hill and Kivett 1940). Numerous investigations over the next several decades helped to better identify the Valley complex in Nebraska and to distinguish it from Middle Woodland complexes to the south and east (especially the Kansas City Hopewell) as well as later Plains Woodland complexes (Bozell and Winfrey 1994). The spatial and temporal limits of the Valley variant are, however, still not as clearly defined as one would like. Site distribution extends from the Missouri River westward along the Platte, Loup, and Niobrara Rivers to the central and western portions of Nebraska, thus incorporating both the prairie and plains environments. To the south, a Valley burial site have been investigated in Doniphan County, Kansas (O'Brien 1971), while Valley sites have also been reported in the lower Republican and Kansas river drainages around Manhattan, Kansas (O'Brien 1984b). Eastern Valley sites are located primarily along the Missouri River drainage, such as indicated by the Rainbow site in northwestern Iowa (Benn 1990). Valley ceramics are also reported from eastern and central Wyoming (Connor 1993; Miller et al. 1986; Bozell and Winfrey 1994), central South Dakota (Hoffman 1968), northwestern North Dakota (Kivett 1949), and Yuma County, Colorado (Kivett 1949). Radiocarbon dates from four Valley component sites (Table 24) indicate a temporal range from about A.D. 1 to A.D. 600, a span roughly contemporaneous with the Kansas City Hopewell and overlapping the Keith and South Platte complexes.

Bozell and Winfrey (1994) provide the most recent summary of the Valley focus in Nebraska. Of special interest is their list of the approximately 30 Valley complex sites which have been excavated or tested. Most of these sites, located in Knox, Dixon, Platte, and Cedar counties, were investigated between the late 1930s and the mid-1950s by researchers with the University of Nebraska-Lincoln and the Nebraska State Historical Society. Artifacts, primarily the ceramics, recovered from these sites provided the basis for most of the literature dealing with this complex. Valley ceramics are described as thick-walled, conical vessels with designs similar to Middle Woodland Havana ware of the Midwest (Hill and Kivett 1940; Benn 1990). Rim decorations include embosses or punctates, incised lines, dentate stamping, cord-wrapped rod impressions, and lip-notching. Some vessels, especially those from western Valley sites, exhibit undecorated rims and a cord-roughened body. Projectile points are large corner-notched forms with expanding stems similar to the Snyders type, a common Middle Woodland style. Other tools include bifacial knives, scrapers, drills, retouched and utilized flakes, celts, hammerstones, grinding stones, and atlatl weights (Bozell and Winfrey 1994). Bone tools are fairly common and include awls, perforated bison phalanges, flakers, and expedient butchering tools.

Valley variant settlements often contain the remains of one or more circular to oval structures built over an excavated basin or on the unprepared ground surface. Excavations at the Schultz site (25VY1) disclosed ten possible structures ranging in size from 7.3 by 6.1 m to 1.7 by 1.9 m (Hill and Kivett 1940; Bozell and Winfrey 1994). All were constructed over a shallow basin and most contained centrally placed hearths. The superstructures were relatively light, being manufactured with small poles and covered with skins or mats. Some variation is evident, however, with the recovery of daub at the Wallace site, suggesting a wattle and daub covering. Shallow, basin-shaped exterior pits are often associated with Valley structures. As discussed below, Keith variant sites, including Doyle (25RW28) and Massacre Canyon (25HK13), exhibit structures similar to those associated with the Valley variant.

The four sites which provide the radiocarbon determinations for the Valley focus, and yield the most information on settlement and subsistence practices, were excavated during the 1970s and 1980s. Included are the MAD site (13CF101/102) and Rainbow site (13PM91) in northwest Iowa, the Wallace site (25GO2) in Gosper County, Nebraska, and the Taylor Mound burial site (14DP3) in Doniphan County, Kansas. Subsistence evidence suggests a primary dependence on bison *(Bison bison)*, deer *(Odocoieleus* sp.), and antelope *(Antilocapra americana)*, with a lesser reliance on smaller mammals, birds, and mussels (Kivett 1952; Falk and Semken 1990; Winfrey 1991). Bozell and Winfrey (1994) suggest that the reliance on bison may be a function of site location, with a greater use of the animal in the western part of the Valley range. At the Wallace site, over 56% of the identifiable fauna is pronghorn, with bison represented by only 6.2%. Falk lists 29 different species of vertebrates from the Valley variant components at the Rainbow site. Like the Kansas City Hopewell, fish are rare or absent from the faunal remains, despite the extensive use of flotation at several of the sites (Falk and Semken 1990).

Evidence for the use of either wild or cultivated plants as part of the Valley component at the Rainbow site subsistence strategy is not abundant. Botanical remains were not recovered from the western Valley sites, while flotation samples taken from the Wallace site (Adair, unpublished notes) have so far yielded limited quantities of goosefoot (*Chenopodium* sp.), bulrush (*Scirpus* sp.), and sedge (*Carex* sp.) seeds. Cucurbits, goosefoot seeds, and one maize kernel were recovered from Middle Woodland contexts at the Rainbow site (Benn 1990:193-209). Combined, the archeobotanical evidence is much too limited to suggest any characteristic trend in plant use for the Valley variant. The geographical extent of the complex is also too broad to expect a single pattern of wild plant resource use. One research interest, however, could focus on the presence and distribution of the introduced domesticates squash (*Cucurbita pepo*) and corn (*Zea mays*).

Although squash was recovered from earlier components at the Rainbow site, the maize from the Valley component may be the earliest association of this cultigen with a Plains complex. Given the current understanding of the distribution of these cultigens throughout the Woodlands of eastern North America (Smith 1992), it seems likely that both plants were introduced into the Plains from the east. The extent of any diffusion of these plants westward from the prairie edge complexes during the Middle Woodland period is unknown, although the obvious similarities in ceramic designs between the Kansas City Hopewell and the Valley complexes indicates that some westward dispersal of ideas occurred.

The association of Valley cord-roughened and Harlan cord-roughened (representative of the Keith complex) ceramics at the Whalen site in Sherman County, Nebraska, further suggests a temporal overlap of the Middle Woodland and Plains Woodland cultures. Bozell and Winfrey (1994) describe the Keith complex as encompassing both the Middle and Late Woodland expressions. In this context, it is appropriate to note that a scapula tool exhibiting extensive silica polish was recovered from the Keith complex Doyle site (25RW28) in Red Willow County, Nebraska. Artifacts such as this are commonly identified as agricultural tools when associated with Village period sites, so its association with an earlier time period is intriguing. Radiocarbon dates from the Doyle site (Table 24) indicate an occupation during the mid to late sixth century, although the artifacts are more typical of styles associated with the later Late Plains Woodland period. The Keith focus will be described in greater detail below.

Late Plains Woodland

For approximately 500 years, or roughly A.D. 500-1000, prehistoric populations in the Central Great Plains exhibited a lifestyle notably different from the Middle Woodland expression but without the presence of a village orientation. During this time, people tended to group themselves in small, nuclear family-sized houses of wattle and daub construction; reside in one location for at least part of the year; develop a dispersed hunting strategy; increase their consumption of agricultural crops; and create local styles of globular shaped ceramic vessels. The latter characteristic in particular has been used by researchers to distinguish local Woodland complexes. However, as presented below, certain traits assigned to one ceramic style of a particular Woodland taxa tend to also be present in other Woodland complexes, suggesting either the frequent exchange of ideas or styles between Woodland peoples or that the differences between complexes are subtle and may not warrant separate taxonomic designations based on ceramic designs.

Keith Focus/Variant

Extensive archeological investigation in the Republican River basin of Nebraska in the 1930s and 1940s resulted in the recognition of the Keith focus (Kivett 1953). Additional key sites, excavated in the following decades, further identified the temporal and spatial distribution of this complex. Keith complex sites are located throughout southwestern Nebraska, north-central and northwestern Kansas, with some Keith-like materials being recovered from eastern Colorado (Bozell and Winfrey 1994; Kivett 1953; Phillips 1963; Wedel 1959). Originally identified as a focus (Kivett 1953), the taxonomy of this complex changed when Johnson (n.d.) reidentified the focus as a variant, and Wedel (1986) referred to Keith as a phase. Johnson further suggests that Keith may represent temporally and/or spatially distinct adaptive patterns. Radiocarbon dates, however, are not numerous and suggest a broad range from about A.D. 1 to A.D. 800 (Adair and Brown 1987; Grange 1980; Wedel 1986) (Table 24). Several early dates from the Doyle site infer a Middle Woodland association.

The settlement pattern of the Keith complex consists of small hamlets, temporary camps, and burial mounds or ossuaries. Most sites are located on terraces of major rivers (e.g. the Republican and Arkansas rivers), although some temporary camps are found in rockshelters. Major sites assigned to the Keith focus include Woodruff ossuary, 14PH4 (Kivett 1953); West Island, 14PH10 (Witty 1966b); Vohs (Witty 1969), Massacre Canyon, 25HK13 (Kivett 1953); 25FT18 (Kivett 1953, Gunnerson 1987); Cooper (Witty 1968); Doyle, 25RW28 (Grange 1980); Coal Oil Canyon, 14LO401 (Bowman 1960); Young, 14SC1 (Wedel 1959); and 25HN12 (Adair and Brown 1987).

Small villages or hamlets are identified by the remains of structures. Grange (1980) describes these structures as round, basinlike pit houses about 4 to 5.5 m in diameter. They contain interior hearths, concentrations of shell and burned rock, extensive amounts of ceramics, chipped stone tools, and faunal remains. Subfloor burials have also been encountered. Lacking evidence of posts or superstructures, the houses have been interpreted as temporary (perhaps seasonal) shelters that were probably reoccupied. Hearths have also been located outside of the dwellings, such as noted from West Island (Witty 1966b). The size of the structure suggests that small groups (i.e. nuclear families) were the likely residents. Whether they lived in the structures on a temporary or permanent basis remains to be researched, although the amount of cultural detritus might suggest that the period of occupation was fairly lengthy.

The recovered faunal remains indicate a diverse exploitation strategy and may represent more than one season of hunting. Identified species are dominated by the remains of deer *(Odocoileus* sp.) and antelope *(Antilocarpa americana)*, but also include beaver *(Castor canadensis)*, raccoon *(Procyon lotor)*, badger *(Taxidea taxus)*, coyote *(Canis* sp.), jackrabbit *(Lepus californicus)*, prairie dog *(Cynomys* sp.), cottontail *(Sylvilagus floridanus)*, various rodents, migratory birds (e.g., Canada goose, mallard), owl *(Otus* sp.), hawk *(Accipitridea)*, turkey *(Meliagris galopova)*, prairie chicken *(Tympanuchus* sp.), turtle, and frog. The bison is represented by only a few elements, suggesting to Bozell and Winfrey (1994) that the use of the bison was reduced significantly during the Middle Woodland period (keeping in mind that the Keith focus is viewed as overlapping the Middle and Late Woodland periods).

Unfortunately, no floral remains have been recovered from Keith complex sites, a situation best explained by the lack of appropriate fine-scale paleobotanical recovery techniques. The contents of a single feature from site 25HN12 were floated using a version of a SMAP barrel, although only wood charcoal fragments were identified (Adair and Brown 1987). The extensive numbers of milling and grinding stones in Keith sites suggests, however, that plants may have retained a fairly significant level of importance (Adair and Estep 1991). As mentioned above, the recovery of a scapula digging tool suggests that plants, such as possibly the prairie turnip, were important resources to the Keith folks.

Ceramics from Keith focus sites are identified as Harlan Cord-Roughened. Vessels of this ware are vertically cord roughened, frequently tempered with crushed calcite, and almost always lack decoration. Other characteristics include wide orifices, thick walls, and flattened lips (Kivett 1953). Krause (1995) has recently suggested a continuity in ceramic production sequences between the Keith and Upper Republican wares. If true, this suggests not only a fairly lengthy time span for Keith, but a regional transition from the Woodland to the Central Plains tradition.

Projectile point styles represented at the earlier component sites, such as the Walter site (14LA2), are similar to those found in Valley complex sites and are predominantly large corner-notched forms with expanding stems. The smaller corner-notched forms (Scallorn-like), assumed to be associated with the bow and arrow, occur at later component sites, including the Vohs (14OB401), West Island (14PH10), and Coal-Oil Canyon (14LO401) sites . The bone artifact industry includes awls, beads, perforated bison phalanges, flakers, scapula cutting or digging tools, and rib shaft wrenches. Modified shell artifacts are abundant, from both burials and habitation sites. Included are pendants, gorgets, and beads manufactured from local mussel shell, although a few species of *Olivella* and *Marginella*, presumably acquired through trade, also occur. The size of the habitation sites and the number of adjacent burial sites suggested to Kivett (1970) that Keith people may have been bound by communal burial sites. Burial sites such as the Woodruff ossuary (14PH4), perhaps the best known western Plains Woodland burial location, attest to the skills and combined effort of a number of individuals in the construction of the burial pit.

Greenwood Phase

The Greenwood phase, formally defined by Witty in 1982 (1982a:207-213), identifies Plains Woodland components in the central part of the Flint Hills and the western part of the Osage Cuesta which existed between A.D. 400 to A.D. 1000. Several Greenwood phase sites were excavated in the early 1960s and include the type sites of Two Dog (14MO301) and Cow-Killer (14OS347). Like many of the other Late Plains Woodland manifestations, the Greenwood phase is believed to have developed from an indigenous Woodland and/or Late Archaic culture (Brown and Simmons 1987) and many have been influenced by the contemporaneous Cuesta, Grasshopper Falls, Butler, or Keith complexes which surround the geographical extent of the Greenwood phase. So similar are some of the characteristics to other Woodland taxa that O'Brien and Rager (1983) suggested that Greenwood and Butler phases probably represent the same cultural group. One major distinction, however, is the presence of later Pomona-like ceramics in Greenwood phase sites, suggesting both a long temporal span for the Greenwood complex and a possible development of the Greenwood into the Village period Pomona variant (Witty 1978).

Characteristics of the Greenwood phase include long to oval shaped houses, similar to those defined for the Cuesta phase, with central hearths and evidence of wattle and daub construction (Blakeslee and Rohn 1982). Both interior and exterior pits occur, features which suggest the storage of artifacts or food stuff for longer periods of preservation. Ceramics consist of two types that were defined by Calabrese (1967c). These are the Verdigris and Greenwood types. The Verdigris type includes straight walled, conical shaped vessels with cord-roughened exteriors and smoothed surfaced, conical-shaped vessels with slightly thicker walls. The temper is predominantly crushed limestone, although small amounts of clay or crushed bone have also been recorded. Greenwood ceramics are globular shaped with sloping shoulders and constricted orifices. Exteriors are cord-roughened and vessel walls are noticeably thinner than the Verdigris type, a characteristic which may reflect a use of the pot for long-term simmering of foods (cf. Braun 1981). Thinner, more compact ceramic vessels distribute heat more evenly.

A variety of faunal remains recovered from excavations of the Cow-Killer (14OS347) and Curry (14GR301) sites are representative of at least 26 taxa, including deer *(Odocoileus* sp.), wapiti *(Cervus canadensis)*, bison *(Bison bison)*, raccoon *(Procyon lotor)*, cottontail *(Sylvilagus floridanus)*, beaver *(Castor canadensis)*, coyote *(Canis* sp.), bobcat *(Lynx rufus)*, prairie dog *(Cynomys* sp.), gopher, woodrat and other rodents, turkey *(Meliagris galopava)*, prairie chicken *(Tympanuchus* sp.), various migratory birds, turtle, and snake, and attest to a diffuse hunting strategy, a characteristic shared by other Plains Woodland complexes. Floral remains are not abundant from Greenwood phase sites due to absence of flotation recovery techniques. Black walnut shells *(Juglans nigra)* and unidentified "small seeds" were recovered from the Cow Killer site (Reynolds 1984a), although the low frequency of these remains does not argue for their use as food by the prehistoric inhabitants. An exception to this is the Stiles site (14MM13), where Blakeslee and Rohn (1982) report on the recovery of goosefoot *(Chenopodium* sp.), pigweed *(Amaranthus* sp.), blackberry *(Rubus* sp.), vetch *(Vicia* sp.), black walnut *(Juglans nigra)*, hickory *(Carya* sp.), hazelnut *(Corylus americana)*, and a single fragment of maize *(Zea mays)*. While the presence of the corn does little to help define the subsistence mode of the Greenwood phase, its association with a Plains Woodland component adds another account to the growing evidence for the distribution of this cultigen throughout the eastern portion of the Central Great Plains prior to A.D. 900. One only wonders what might have been recovered from Greenwood phase sites if flotation had become a standard recovery technique in the 1950s instead of 20 years later.

Grasshopper Falls Phase

The Grasshopper Falls phase was initially defined by Reynolds (1979b) on the basis of information provided by surface and excavation remains from over 100 sites in Jefferson, Atchinson, Shawnee, Jackson, and Osage counties, Kansas. Sites share similarities in terms of structural remains, settlement patterns, and artifact content. As Baugh (1991) emphasizes, perhaps the most consistent attribute of the excavated sites is the presence of one or two oval patterns of postmolds. Based on this characteristic, Grasshopper Falls phase sites have been described as representing nuclear or individual family households who resided in semipermanent structures located along river drainages of the Dissected Till Plains of northeast Kansas. Radiocarbon dates from several sites indicate a temporal span of A.D. 700-1000 (Table 24).

In addition to the habitation structures, architectural features include internal and external storage pits, and internal and external hearths (Figure 45). The latter feature is not always present within the house area, suggesting perhaps a warm weather occupation. Pits are described as exhibiting a circular orifice and extending to a depth of 8 to 40 cm below surface, with little to no variation between internal and external characteristics. The depth of some of the larger pits may well suggest a need for storage (Baugh 1991:54-55). Excavations at the Avoca site (14JN332) in Jackson County disclosed a house which appeared to have been rebuilt at least once, and perhaps twice (Baugh 1991). The structure was a relatively large (132.98 m^2), elliptical house with approximately 39 perimeter posts and possibly six interior posts. Following an interpretation of re-use, however, some of the perimeter posts may actually represent interior posts of the remodeled structure. Other Grasshopper Falls phase structures range in size from 10.58 m^2 (14JF307) to 41.22 m^2 (14JF350, House 1) to 91.10 m^2 (14SH322, House 2). The variations in house size are suggested to be a function of length of occupation or group size.

The presence of daub scatters and thick concentrations of daub, such as identified from the Reichart site (14JF448) and Avoca (14JN332) sites, provides good information on the mode of construction (Baugh 1991; Logan 1990b). Reynolds (1987a) has suggested that although daub may have been an important construction material, it was not entirely necessary to spread mud over the entire structure. The primary covering may have been grass thatch with mud "plastered selectively on these covers where the structures were most vulnerable to the elements" (Reynolds 1987a:178). The most vulnerable locations are interpreted to be along the lower portions of the structures. Baugh (1991:46) challenges this idea, noting that most of the daub from Grasshopper Falls phase structures is associated with roof fall.

Ceramics, labeled Grasshopper Falls ware, are angular grit tempered (quartz, feldspar) or less frequently, sand tempered vessels. Exterior surfaces are cordmarked, smoothed over

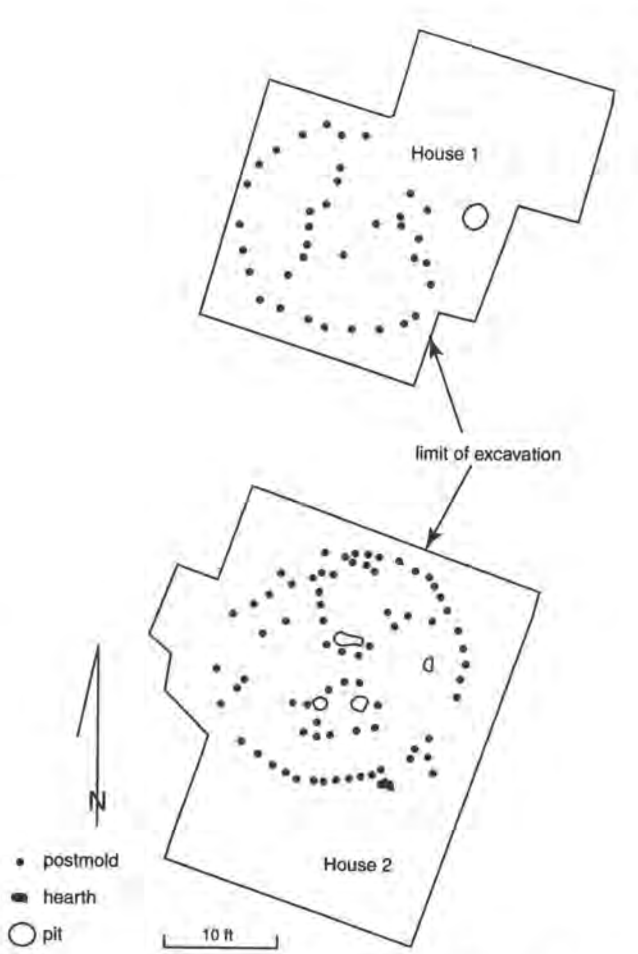


Figure 45. Plan view of House 1 and 2, 14JF307 (from Reynolds 1979b).

cordmarked, smoothed, brushed, or polished. There is little to no decoration. Termed a utilitarian ware (Reynolds 1981:88), it is most commonly in the form of medium to large conical-based pots with straight to slightly bulging sides.

Chipped and ground stone tools are typical of other Plains Woodland complexes. Projectile points include both medium to large corner-notched points with expanding stems and small corner-notched varieties, and mark the transition from the use of the atlatl to the bow and arrow. Other tool categories include celts, drills, gouges, thin bifaces, endscrapers, hafted scrapers, and side scrapers. Mullers, celts, grinding slabs, hammerstones, and abraders comprise the ground stone category.

Direct information on the subsistence practices of Grasshopper Falls phase people is restricted to floral and faunal remains recovered from a few sites. In particular, excavations at the Avoca site (14JN332) recovered numerous bison *(Bison bison)*, white-tailed deer *(Odocoieleus virginianus)*, dog/coyote *(Canis* sp.), cottontail *(Sylvilagus floridanus)*, turtle, and fish elements and suggest an exploitation of the adjacent floodplain prairies and forests. Floral remains recovered from several of the features provide some of the first good evidence for the use of plants during the Late Plains Woodland period and shed light on the developing agricultural strategies. Wild plants and nuts are represented by goosefoot *(Chenopodium* sp.), grape *(Vitis* sp.), spurge *(Euphorbia* sp.), violet *(Viola* sp.), hickory *(Carya* sp.), and black walnut *(Juglans nigra)*. Although there has been no attempt to analyze the goosefoot seeds for the presence of morphological characteristics due to domestication (Smith 1992), recovered marshelder *(Iva annua)* and sunflower *(Helianthus annuus)* seeds and achenes clearly exhibit the large size due to domestication (Adair 1991). The 12 *Iva annua* achenes and seeds recovered from the Avoca site range in size from 4.9-7.2 mm (length) to 2.6-5.5 mm (width) and average at 5.8 x 3.6 mm. In addition, 10 fragments of corn (from both cob and kernel) were identified. The three domesticated plants accounted for 44% of the total archeobotanical seed assemblage and indicate an importance not previously recognized for the Plains Woodland period.

Although a fragment of a large sized sunflower achene was reported from the Cuesta occupation at site 14LT304 (Adair 1988), the first good evidence of domesticated sunflower in the area comes from the Late Plains Woodland period. A common plant throughout the Plains (Figure 39), the sunflower is the only plant of New World origin that was domesticated prehistorically and became an important crop in modern times. Like the marshelder, domestication status of the common sunflower is determined by the size of the seed. A single sunflower achene was recovered from Hearth 1 at the Avoca site and was size reconstructed to measure 6.9 x 2.8 mm. (In order to make measurements on archeological specimens comparable with those from modern collections, one must make correction for loss of pericarp and/or shrinkage due to carbonization. The most commonly used formula is that suggested by Yarnell (1978) in which achene lengths and widths are increased by 11% and 27% respectively, and kernel lengths and widths are increased by 30% and 45%, respectively.

The lengths of wild achenes (kernels in their shell) of *Helianthus annuus,* collected from modern stands within the area, range from 3.9-5.2 mm while prehistoric varieties from Late Woodland through Village period contexts measure 5.1-14.6 mm (Adair 1988) (Figure 46). Thus, the single Avoca specimen, while significantly larger than wild seeds, falls in the smaller range of recorded cultigen *Helianthus* from prehistoric Central Plains sites. Asch and Green (1992:25-47) provide an informed summary of the size ranges of the eastern "weed sunflower" *(H.annuus* ssp. *annuus),* the common western "wild sunflower" *(H. annuus* ssp. lenticularis), and the giant monocephalic domesticate *(H. annuus* var. *macrocarpus)* according to Heiser's (1950, 1951, 1954, 1955, 1976, 1985) extensive research and discuss the evidence for early domesticated sunflower in the Middle West.

The archeobotanical remains recovered from the Avoca site support the claim that without systematic flotation, reconstruction of the subsistence pattern of Late Plains Woodland peoples will continue to overlook the relative importance of plants and domesticates as well as the evidence for the emerging agricultural economy. Before the Avoca excavations, corn was the only recognized cultigen of the Late Plains Woodland period; one kernel having been recovered

Figure 46. Helianthus annuus var. macrocarpa *achenes and seeds from the Two Deer site (14BU55).*

from the Stiles site (14MM13), one cupule fragment identified from 14JN349, one kernel recovered from 14BU57 in Butler County, Kansas, and several kernels reported from the Lawson site, 25PT12, in northeastern Nebraska. For the most part, these single fragments were the only botanical remains recovered, or at least the only remains included in the literature.

From the Two Deer site (14BU55) in south-central Kansas, a transitional Woodland/Village occupation with an average radiocarbon date of A.D. 1000, a much greater quantity of corn was recovered, along with domesticated squash, marshelder, and sunflower (Adair and Brown 1978). In addition, a recent analysis of a small number of goosefoot *(Chenopodium* cf. *berlandieri)* seeds from this site revealed the presence of a thin testa and truncated margins (Adair 1993b), both known characteristics of the domesticated variety (Smith 1992). If this weedy annual is counted as a domesticate (a determination that really needs more research, since these characteristics can occur in small percentages in wild populations), the cultigens from the Two Deer site account for 68% of the total seed assemblage (the figure drops to 49% if the *Chenopodium* seeds are excluded). A comparison of the percentages from Avoca and Two Deer suggests that domesticates increased in importance during the Late Plains Woodland period, but that wild seeds, as well as nuts (over 4,600 fragments, approximately 108 grams, of nutshell remains were recovered from the Two Deer site) continued to be important.

Preliminary and ongoing analyses of flotation samples from the Loseke Creek complex Andrews site (25DO12) in east-central Nebraska, tend to confirm the pattern of about equal importance of cultigens and wild plants for the latter part of the Late Plains Woodland period. This pattern changes significantly during the Plains Village period. From House 4 at the Patterson site (25SY31), a Central Plains tradition site in east-central Nebraska, cultigens, dominated by corn, accounted for 96% of the identified assemblage (Adair 1992) and nuts decreased significantly, being represented by only 232 fragments (28.8 grams).

Hertha Phase

The Hertha phase was defined by Blakeslee and Rohn (1982) for the Late Plains Woodland components identified in the Bull Creek locality in the Hillsdale Lake area, Miami County, Kansas. The spatial extent of this phase was broadened to include the northeastern portions of the Osage Plains in Kansas and the Western Prairies in Missouri. Radiocarbon dates (Table 24) indicate a temporal span of A.D. 365 to A.D. 760, roughly contemporaneous with the mid to late Middle Woodland period.

Five types of sites were recognized for the Hertha phase: (1) habitation sites with no more than one house per site; (2) upland camp sites situated on bluff edges along major streams; (3) lowland camp sites that are linear arrangements situated on natural levees; (4) limited activity sites; and (5) sites for which no function can be assigned (Blakeslee and Rohn 1982:1272-1275). All of the sites investigated were determined to represent winter habitation or campsites, and most are now inundated by the lake. Architectural features include oval-shaped houses with central rock-filled hearths (hence the determination of winter occupancy), hearths of burned earth and charcoal, and cache/trash pits. At site 14MM26, an oval postmold pattern suggested that house structures measured about 5 to 5.5 m by 6.5 to 7 m (Artz et al. 1975).

Ceramics associated with the Hertha phase are mainly of one type but with various kinds of temper. Vessels are globular with medium to high rims, with cord-roughened exterior surfaces. Rims are vertical to slightly flaring and lips are rounded to flattened. Decoration, when present, consists of incised, notched, or crenated lips. Tempering materials include grog, crushed granite, sand, crushed and burned bone, shell, and nontempered sherds. These ceramics share some of the characteristics defined for the Greenwood phase, as well as limited rim decorations similar to styles found in the late Middle Woodland, Edwardsville phase.

The chipped stone tool assemblage includes small corner-notched (Scallorn type) projectile points, indicative of the use of the bow and arrow, as well as medium to large corner-notched or expanding stemmed points more commonly associated with the atlatl. Bifaces, drills, retouched and utilized flakes, and large scrapers are also present in the assemblage, although ground and pecked stone tools are rare. No bone tools have been recovered.

Subsistence data is also quite limited, a fact that researchers have attributed to the proposed seasonal occupancy of the sites (Blakeslee and Rohn 1982:1263). Identified faunal remains suggest that hunting deer *(Odocoileus* sp.), bison *(Bison bison)*, jackrabbit *(Lepus* sp.), and turtle, and gathering freshwater mussel were common activities. The exploitation of mussels, however, seems an unlikely activity if the sites were occupied mainly in the winter, as suggested by Blakeslee and Rohn (1982) . Flotation of feature fill at the William Sherwood site (14MM509) produced charred black walnut and hickory shells and a few pigweed seeds (Blakeslee and Rohn 1982:961-963). While the nut shell fragments may represent deliberate procurement for food or fuel, the presence of only a few pigweed seeds could be due to natural seed rain rather to any cultural factor.

According to Blakeslee and Rohn (1982:1271), the Hertha phase differs significantly from all of the surrounding Early Ceramic (Woodland) complexes defined so far. The only criterion given, however, is the lack of the conoidal vessel form and this appears to have been based on a sample of less than 200 sherds from the William Sherwood site. No basal fragments were recovered. The adaptation and subsistence practices appear strikingly similar to that described for the adjacent Greenwood phase. Some researchers have assigned the Hertha phase to the Pomona variant (Brown and Simmons 1987).

Wakarusa and Deer Creek Phases

Both of these phases were defined by Johnson (1968) from investigations conducted along the Wakarusa River in Douglas and Shawnee counties, Kansas. Both were recognized by the remains of wattle and daub structures, storage pits, and hearths. The Anderson site (14DO32) is representative of the Deer Creek phase, while the Kampschroeder site was assigned to the Wakarusa phase. Both sites exhibit similar ceramics which can be described as relatively thick walled, elongate jars with slightly excurvate rims and rounded lips. Exteriors are vertically cordmarked, occasionally smoothed over. The temper is either grit or sand. Logan (1990b) remarks on the similarities of this ceramic type with that defined for the Grasshopper Falls phase. Work at the Anderson and Richland sites yielded small corner dart points indicative of the use of the bow and arrow. This tool type is not currently associated with the Wakarusa phase.

The Richland site (14SH101), tested in 1989, disclosed the presence of a crematorium. This feature was identified by the concentration of burned limestone, burned earth, and charcoal, a few chipped stone artifacts and ceramic pieces, and an abundance of human remains. Two individuals were represented in the fill, an adult male and another individual, age and sex undetermined. This site produced the first radiocarbon date for the Deer Creek phase (Table 24). A few ***Chenopodium*** sp. seeds and fragments of black walnut shells were recovered from the cremation feature although it is unsure if these represent food remains (Adair 1990).

Sterns Creek Complex

Sterns Creek is one of the least understood complexes in the Woodland sequence (Haas 1983), being identified from only four sites. Although it was perhaps one of the earliest formally defined taxa for cultures ancestral to the Nebraska phase (Strong 1935), its spatial and temporal dimensions and diagnostic characteristics have waxed and waned over the years. Haas (1983) provides an excellent historical perspective on Plains Woodland taxonomy and the placement of Sterns Creek.

Sterns Creek components are found in the Eastern Glaciated Region of eastern Nebraska to southeastern South Dakota and are located on buried alluvial terraces at junctures of tributaries entering the Missouri River floodplain (Haas 1983:31). Villages are small but include structural evidence and numerous hearths, trash-filled pits, and cache pits. At the Walker Gilmore site, one structural pattern was consistently found in the three main Woodland bearing zones (Zones 2, 3, and 4). The structures have been described as having two converging exterior walls with the possibility of smaller interior support posts and measure about 15-25 feet long by 1-4 feet wide. They are associated with one or more trash-filled storage pits and less frequently, an interior hearth. The sequence of construction of these structures at Walker Gilmore indicates that the site area was reoccupied on several occasions. The recovery of "vegetal fibers" from the early investigations at Walker Gilmore lead Strong (1935) and Wedel (1961a) to suggest that the structures were more typical of the Eastern Woodland type than that common to the Plains. These vegetal fibers have not been identified, however, and they may be remnants of interior mats or cordage rather than wall coverings.

Sterns Creek ceramics reflect a Late Woodland technology with simple-stamped surface treatment, extensive smoothing of body and rim, a more globular orientation, thinner vessel walls, a greater rim inflection, and limited decoration focused on the lip. Haas describes four ceramic types for the Woodland zones at Walker Gilmore: Sterns Creek ware, Sterns Creek Tool-Impressed, Sterns Creek Plain, and Missouri Bluffs Cord-Impressed Ware. The presence of small jars was suggested to reflect the storage of seeds.

Subsistence strategies included the exploitation of both small and large mammals, including deer *(Odocoileus* sp.), beaver *(Castor canadensis)*, canid *(Canis* sp.), rabbit *(Sylvilagus floridanus)*, squirrel, muskrat, migratory waterfowl (great blue heron, Canada goose, ducks, and sandhill crane), bobwhite, turkey, rails, crow, finches, grouse, turtle, and catfish (Falk and Argus 1983). Identified seeds include squash *(Cucurbita pepo)* and gourd *(Lagenaria siceraria)* seeds, groundnut *(Apio tuberos)*, and black walnut *(Juglans nigra)* (Cutler and Blake 1983). Given the excellent preservation at Walker Gilmore, several of the squash seeds were not completely charred but survived through dessication. The presence of a relatively large quantity of these cultigens led Haas (1983) to suggest that squash harvesting was a primary subsistence activity at Walker Gilmore.

Loseke Creek Variant

Sites assigned to this complex are distributed along the Missouri River from central Nebraska to south-central South Dakota. They are also recognized in western Iowa (Benn 1981), in southeastern South Dakota and in northeastern Nebraska (Kivett 1952). The spatial distribution of the Loseke Creek variant is somewhat comparable to that of the Valley complex. Settlement pattern includes villages or hamlets of extensive temporal duration or frequent reoccupation (similar to Grasshopper Falls and Keith), as demonstrated from excavations at the Feye (25PT9), Lawson (25PT12), and Arp (39BR101) sites. Clusters of structural remains, storage pits, and interior and exterior hearths at both sites suggest that each site contained from four to eight houses roughly 4 to 6 feet in diameter (Kivett 1952, Gant 1967). Temporary camps are identified at the Tramp Deep site (25KX204) in Knox County, Nebraska, and at the 39BR102 in southeast South Dakota (Hurt 1961).

Subsistence includes hunting, gathering, and cultivating. Evidence for hunting is represented by the remains of bison *(Bison bison)*, deer *(Odocoileus* sp.), antelope *(Antilocarpa americana)*, wapiti *(Cervus canadensis)*, and smaller mammal forms. Gathering is evidenced by the recovery of plum pits *(Prunus* sp.) from the Arp site and *Chenopodium* sp. from the Andrews (25DO12) site. Cultigens are represented by remains of a few maize kernels from the Lawson site (25PT12), charred corn remains from the Arp site (39BR101), and an as yet unquantified but relatively substantial amount from the Andrews site (Adair, unpublished notes).

Loseke Creek ceramics may have derived from the earlier Valley Cord Roughened ware (Hurt 1952) since the two types exhibit a close similarity in exterior cordmarking, and decorations such as bosses and punctations. As defined by Benn (1990), Loseke ware incorporates previously defined types from Nebraska, South Dakota, and western Iowa, including Feye Cord Impressed (Kivett 1952) and Missouri Bluffs Cord Impressed (Keyes 1949). In western Iowa, the Late Woodland ceramic style leads directly into Great Oasis and Plains Village ceramics (Benn 1990), while in South Dakota it is believed that Loseke Creek influenced the development of the Initial Middle Missouri pottery types (Johnston 1967).

South Platte Phase

The South Platte phase was proposed by Butler (1988) to include all of the High Plains Woodland complexes previously defined as separate taxa. Basically, Butler argues that terms such as Parker, Graneros, Hog Back, and Franktown do not exist as separate and valid taxonomic units since they cannot be defined or distinguished on the basis of ceramics, lithics, house styles, location, or duration of occupation. The South Platte phase therefore encompasses these previous designations and is defined to include all Woodland complexes located in the northern half of the Western Plains subarea, from the Palmer Divide north to about the Wyoming border and from the Front Range to the High Plains border at about the Kansas state line. This area approximates the South Platte drainage basin, or roughly the High Plains and Front Range of the Rocky Mountains. Woodland sites in this area date from ca.1850 to 800 B.P. (A.D. 100-1150) (Table 24). Sites are distributed along the upper reaches of the North Platte, South Platte, and White River drainages in Colorado, Nebraska, South Dakota, and Wyoming. Outlying components are found in the western Sand Hills and the Republican River drainage of Nebraska. Sites are found along streams or within rock shelters. The paucity of rich sites suggests a somewhat mobile lifestyle.

South Platte ceramics are very similar to Harlan Cord-Roughened, lacking only the calcite tempering. Kivett (1952) assigns South Platte ceramics to Ash Hollow Cord-Roughened. Bone tools are not as frequent as from Keith sites but include awls, beads, and flakers. Modified shell is also infrequently recovered. South Platte burials are mainly single flexed individuals interred in specially prepared pits. Grave goods are present and are usually more abundant when associated with infants and juveniles. A single burial excavated in western Sioux County, Nebraska yielded a ceramic vessel typical of Central Plains Woodland styles. However, the biological similarities of this skeleton more closely compared to ones from adjacent but culturally unrelated populations to the west in Wyoming (Gill and Lewis 1977) than to Woodland populations in central and eastern Nebraska and Kansas. The authors state that this tends to support a concept of the spread of Woodland culture across the Plains (Gill and Lewis 1977:72).

Subsistence during the Woodland period in eastern Colorado includes emphasis on wild plants and small and large game animals. The plant remains from the LoDaisKa site indicate the collection of a variety of different plant types, such as small weedy annuals *(Chenopodium* sp. and *Carex* sp.), fruits *(Prunus* sp.), nuts and berries *(Crataegus* sp. and *Quercus* sp.), grass *(gramineae)*, and bulbs *(Allium* sp.). Also of interest is the recovery of several cobs and kernels of maize (Irwin and Irwin 1959; Galinat 1985). Corn has been recovered from other Woodland occupations in southeast Colorado (Campbell 1976; Eddy et al. 1982), although the context of some of the remains within recent rodent caches makes its association directly with the Woodland period somewhat questionable. Given the proximity of the eastern and southern Colorado Woodland complexes to the Southwest, where corn becomes well established during the Basketmaker period, it would not be unreasonable to hypothesize on the spread of corn north and east through the high altitudes of Colorado and eastward to the foothills of the Rockies. This route was actually proposed some time ago (Galinat 1965, 1985). Eighmy (1984), on the other hand, believes that both the evidence for corn and the cordmarked ceramics in the High Plains Woodland sites is evidence of trade or contact from the East.

Ash Hollow focus

The Ash Hollow focus of the Plains Woodland pattern was formally proposed by Irwin and Irwin (1957) after Kivett (1952) suggested that the adaptations at such sites as Ash Hollow Cave and Kelso in western Nebraska differed from the Keith and Valley complexes. Also included with the Ash Hollow complex were the Agate Bluff site in north-central Colorado and Component B at the Hatch site in northeast Colorado (Irwin and Irwin 1957; J. J. Wood 1967). More recently, Bozell and Winfrey (1994) place the Ash Hollow Cave, LoDaisKa, and Kelso sites with the South Platte complex.

The ceramics from these sites are described as thick with cord-roughened exterior surfaces. Sand is the major temper used although clay and shell has also been reported (Kivett 1953). Decoration is rare but can be identified as a thin band of cord impressions applied diagonally to the lip. Vessels are described as exhibiting an elongate body with a conoidal base. Kivett (1953:37) thinks that the lack of fabric or cord impressions on the interior of Ash Hollow vessels distinguishes this type from Harlan Cord Roughened while the total absence of elaborate rim decorations distinguishes it from the Valley Cord Roughened type.

Aside from the ceramics, there appears to be quite a bit of similarity between the Ash Hollow, Keith, and Parker complexes. Projectile points from Ash Hollow Cave and the Kelso site include stemmed, corner-notched, and small, side-notched triangular forms. Other lithic artifacts include endscrapers, side scrapers, ovoid knives, retouched and utilized flakes, and ground stone milling stones and abraders. Bone artifacts include tubular beads, disk beads, and splinter awls. Burials assigned to the Ash Hollow focus compare to those described for the Keith complex. A sizeable ossuary, containing over 35 individuals (both adults and children), was located near Scottsbluff in western Nebraska. Like the "beaded boy" from the Woodruff ossuary (Kivett 1953), an infant exposed in the Scottsbluff ossuary was wrapped with over 700 tubular beads (Gunnerson 1987). The ossuary contained primary, secondary, and cremated burials.

The subsistence practice of the Ash Hollow complex is represented only in the recovered faunal remains. No plant remains have been recovered, although Irwin and Irwin (1957) report on the presence of a yucca fiber rope from the Agate Bluff site. From the Kelso site comes information to complement the diffuse hunting strategies already described for the Doyle and Lawson sites. Identified animal remains included bison *(Bison bison)*, deer *(Odocoieleus* sp.), antelope *(Antilocarpa americana)*, beaver *(Castor canadensis)*, coyote *(Canis* sp.), badger *(Taxidea taxus)*, prairie dog *(Cynomys* sp.), jackrabbit (Lepus sp.), cottontail *(Sylvilagus floridanus)*, and turtle *(Testudines)*. Without flotation to recover small elements, the importance of foods such as fish and rodents cannot be addressed.

Central Great Plains Woodland Period Research Needs

Despite the recognition of 17 phases or complexes assigned to the Woodland period in the Central Plains, there remain significant questions concerning the distribution of basic traits, the chronological developments within and between the phases, and the responses brought on by economic and technological changes. For the area as a whole, well defined and unique cultural assemblages with adequate radiocarbon dates are a major stumbling block. When many of the complexes or phases were originally defined 40 to 50 years ago, they were identified on the basis of a relatively small assemblage of ceramics and chipped stone tools. While several of these have been grouped together by recent research (Butler 1988; Bozell and Winfrey 1994) and can now be recognized by a common name, we still have a limited understanding of how the prehistoric inhabitants adapted to a specific area and how their adaptation may have differed from a cultural phase located in another area. In particular, our meager substantive information pertaining to subsistence practices, and in particular to the use of plants in the diet, critically inhibits our ability to address Woodland subsistence over time and space.

Most of the archeobotanical data presented in this chapter is described in a presence/absence format; the data are too insufficient to quantify in a meaningful way. Archeobotanical remains comprise only one of the various types of artifacts or cultural debris produced, altered, or arranged by prehistoric inhabitants. Yet these remains are only one of the few that can directly aid subsistence, dietary, or nutritional research. Charred seeds, nutshells, and tubers can provide convincing evidence for the selection of certain plants for food, while changing frequencies or percentages of select species over time and space can help document economic change. Quantification of these data are critical if we continue to label the adaptive pattern of the Woodland period as "Incipient Horticulturalists." Such a term implies that cultivated or domesticated crops were initially incorporated into the subsistence realm and that this beginning laid the foundation for an increased reliance on these foods. Was this increase over time a gradual and progressive pattern, or was it marked by rapid and dramatic changes in the importance of certain species?

To date, very few Central Plains Woodland archeobotanical assemblages can demonstrate the increased use of domesticates (either native or introduced) over time, or show any corresponding decline in the use of wild plants. Several factors are probably equally responsible for this, including inadequate recovery methods and techniques (waterscreening and flotation are not identical techniques), insufficient funding for the identification and analysis of archeobotanical remains, and poor preservation of plant remains in open air, clay soils. Each of these obstacles can be challenged by requiring that the collection, identification, and presentation of archeobotanical remains be included with the rest of the assemblage. Archeobotancial remains are not restricted to charred seeds and nutshells but also include preserved pollen and phytoliths.

It will always be important to describe distinctive cultural characteristics of the Woodland period and to note how these characteristics vary through time and space. The origins of decorative ceramics, the function of different ceramic vessel shapes, the widespread use of the bow and arrow, and the arrangement of people into social structures of varying sizes are all important and critical areas for future research for the Central Plains Woodland period. If subsistence patterns are also viewed as important and critical areas of research, greater attention must be given to archeobotanical remains. With sufficient and representative botanical assemblages, it is also possible to go beyond subsistence research and address such things as discard patterns, functional use of different features, differential use of foods by select, perhaps sociopolitical, members, reduction or depletion of deciduous trees in the floodplain forests to increase farming acreage, and trade with adjacent areas for select items.

6 The Plains Village Period on the Central Plains, by Brad Logan

The archeological concept Plains Village was defined by Lehmer (1954:139) as a pattern. It has since been applied as a form of adaptation to some Plains environments during the Ceramic age or as a chronological period, which in the Central Plains dates ca. A.D. 900-1500. Plains Villagers are distinguished from Woodland cultures or adaptations by distinctive traits in their lithic, ceramic, and modified bone assemblages, changes in settlement/subsistence patterns, house forms, and evidence of an increasing reliance on domestic plant foods, including corn, beans, squash, sunflowers, and marsh elder (Lehmer 1954; Wedel 1959). Although the degree of reliance on cultigens has not been satisfactorily quantified, it is apparent from the relative abundance of preserved plant remains that it was significantly greater than that of preceding ceramic cultures (Adair 1988). The practice of horticulture or small-scale agriculture in combination with continued dependence on hunting and gathering led to a more sedentary lifestyle than that of Plains Woodland groups in the Central Plains.

Six cultures characterized by the Plains Village pattern have been recognized in the region. These are the Pomona variant, Steed-Kisker phase, three comparable complexes assigned to the Central Plains Tradition (CPT)—Nebraska, Smoky Hill, and Upper Republican—and the St. Helena phase. The Upper Republican complex has been divided by some archeologists into three subphases, Solomon River, Classic Upper Republican, and Loup River, in chronological order. Only the last two of these are now in vogue, and the most recent, Loup River, is also referred to as the Itskari phase. Two complexes, Oneota and White Rock, are generally assigned to the Protohistoric period and are so treated here. However, both have their origins, at least temporally, in the Plains Village period. Oneota, as it is represented in the states of Iowa, Nebraska, and Missouri, extends into the historic period.

In general, these cultures are distinguished by temporal, geographical, and/or formal differences, which are described below.

Pomona

The Pomona variant was first defined as a focus (Witty 1967, 1978, 1981), but has recently been redefined as a variant with four phases (K. Brown 1985). Site descriptive reports relevant to this complex include those by Moore, Birkby and Smith (1964), A. E. Johnson (1968), Wilmeth (1970), Carrillo (1973), Artz et al. (1975), Stein (1976), Schmits, Reid et al. (1980), Brogan (1982), Reynolds (1987a), Brown and Ziegler (1985), Blakeslee and Rohn (1986), Williams (1986), and Logan and Hedden (1993). Radiocarbon dates from Pomona sites are listed in Tables 27 and 28. Core areas of all phases of the Pomona variant, as far as they are currently known, were limited spatially to eastern Kansas, although it has been suggested that western Missouri served as a resource area at certain times for some phases.

The most salient characteristic of Pomona that distinguishes it from complexes of the Central Plains tradition is house form, or rather, the lack at most Pomona sites of any distinctive habitation structure. Lodges of oval outline have been discovered at some sites, but most Pomona occupations have structures represented by ambiguous scatters of postmolds. The houses lack central hearths but intramural storage pits may occur (Witty 1967, 1978, 1981). Pomona sites in the Hillsdale Lake area of northeastern Kansas exhibit some variety with respect to settlement type, where Blakeslee and Rohn (1986:1285-1287) recognized seven kinds of sites. These include extended communities, isolated habitations, small campsites, large camps, large linear limited function sites, small limited function sites, and butchering stations. This variety may be applicable to Pomona throughout its range.

Kenneth Brown (1985) has suggested that the Pomona settlement pattern was a continuation of the preceding Plains Woodland and Late Archaic patterns in the same region. This was characterized by a shift between upland, warm weather settlements and lowland, cold weather sites. Our knowledge of the former sites has been hampered by the bias toward investigation of sites on terraces in valley settings. Seasonal abandonment of sites to pursue game in the mixed grass prairie to the west of the project area and in the Ozark Highland to the east (i.e., resource areas) has also been proposed as part of the Pomona settlement-subsistence pattern.

While maize has been found at Pomona sites, remains are not abundant and are poorly documented (Adair 1988:38). Too often, Pomona sites fail to yield any remains of this domesticated plant (e.g., Blakeslee and Rohn 1986:1302). Excavations at the Shadow Glen site (14JO21) in northeastern Kansas, which included systematic recovery of flotation samples (not yet completely sorted and identified), yielded a few kernels and a cupule of maize. At present, the evidence for agriculture is scant. While scapula hoes have been found, they are not nearly as prevalent as these farming/gardening implements are at other Plains Village sites. This scarcity of agricultural evidence provides support for the interpretation of Pomona as an adaptation derivative from an indigenous Plains Woodland culture (Witty 1967, 1978, 1981; K. Brown 1985).

Pomona pottery is distinctive from the ceramics of other Central Plains Villagers. Small to medium-sized vessels of globular shape may be either cordmarked or plain with relatively high, straight, and generally undecorated, unthickened rims. Temper is variable but most frequently consists of crushed sherd. Grit or sand may also occur and shell temper appears in low frequency in the northern part of the variant's range, perhaps reflecting not only proximity to but interaction with Steed-Kisker (Witty 1967:2, 1978:60, 1981:78; Wilmeth 1970; K. Brown 1985).

Table 27. Gakushuin University Radiocarbon Dates from Pomona Sites (considered unreliable).

Lab Number	B.P. Date	Calendar Date	Calibrated Age Range*	Site	Reference
GAK-599	1050±100	A.D. 900	A.D. 890-1150 (1005)	14MY316	Marshall 1972
GAK-405	930±150	A.D. 1020	A.D. 984-1276 (1052,1085,1121,1139,1156)	14CF301 Dead Hickory	Schmits et al. 1980
GAK-600	760±90	A.D. 1190	A.D. 1217-1300 (1280)	14MY335	Marshall 1972
GAK-876	640±90	A.D. 1310	A.D. 1286-1408 (1307,1360,1379)	14MY305 Infinity	Marshall 1972
GAK-1736	350±80	A.D. 1600	A.D. 1449-1651 (1516,1591,1621)	14JF303 Keen	Witty 1983
GAK-1737	550±110	A.D. 1400	A.D. 1302-1446 (1441) (1408)	14JF303 Keen	Witty 1983
GAK-597	460±110	A.D. 1490	A.D. 1403-1621 (1441)	14MO308 Slough Creek	Witty 1982a
GAK-598	390±120	A.D. 1560	A.D. 1425-1651 (1478)	14MO308 Slough Creek	Witty 1982a
GAK-1176	1400±100	A.D. 550	A.D. 595-690 (654)	23BE149 Saba Shelter	Vehik 1978
GAK-1177	2070±100	120 B.C.	193 B.C.-A.D. 60 (50)	23BE149 Saba Shelter	Vehik 1978
1-1165	1770±80	A.D. 180	A.D. 146-390 (253,304,314)	14CF1320	Thies 1981

* One sigma calibrated age ranges (and intercepts) based on Stuiver and Pearson (1993).

Table 28. Radiocarbon Dates from Pomona Sites, Excluding Gakushuin University Dates.

Lab Number	B.P. Date	Calendar Date	Calibrated Age Range*	Site	Reference
I-12327	1230±180	A.D. 720	A.D. 651-1005 (786)	14BO319 Roth	Brogan 1982
I-12338	1100±90	A.D. 850	A.D. 881-1020 (973)	14BO319 Roth	Brogan 1982
UGA-2666	1175±130	A.D. 775	A.D. 687-1009 (884)	14MM506 Garrison	Blakeslee & Rohn 1986
UGA-2670	1045±130	A.D. 905	A.D. 884-1161 (1008)	14MM506 Garrison	Blakeslee & Rohn 1986
BETA-18611	1090±50	A.D. 860	A.D. 893-1011 (978)	14DO32 Anderson	Logan 1987
UGA-4704	950±150	A.D. 1000	A.D. 973-1254 (1041,1150)	14DO32 Anderson	K. Brown 1985
UGA-4705	1075±65	A.D. 875	A.D. 893-1020 (987)	14DO19 Hatcher	K. Brown 1985
BETA-19873	970±60	A.D. 980	A.D. 1013-1162 (1032)	14DO19 Hatcher	Logan 1987
GX-6488	1040±150	A.D. 910	A.D. 881-1168 (1011)	14DO154	Nathan 1980
GX-6487	840±150	A.D. 1110	A.D. 1025-1295 (1222)	14DO154	Nathan 1980
I-11164	890±80	A.D. 1060	A.D. 1032-1247 (1168)	14CF1320	Thies 1981
I-11166	990±80	A.D. 960	A.D. 989-1162 (1025)	14CF1320	Thies 1981
M-1246	860±100	A.D. 1090	A.D. 1036-1280 (1214)	14OS305 Hart	Wilmeth 1970
I-9654	890±80	A.D. 1060	A.D. 1032-1247 (1168)	14CF508 Anderson	Stein 1978
I-9655	705±135	A.D. 1245	A.D. 1221-1403 (1291)	14CF508 Anderson	Stein 1978
DIC-1522	780±90	A.D. 1170	A.D. 1192-1295 (1275)	23JA43 May Brook	Schmits 1982
DIC-1526	730±130	A.D. 1220	A.D. 1214-1395 (1286)	23JA43 May Brook	Schmits 1982
M-1930	720±110	A.D. 1230	A.D. 1225-1393 (1288)	23HI172 Blackwell Cave	Vehik 1978
DIC-1603	680±65	A.D. 1270	A.D. 1282-1392 (1298)	23JA238 Black Belly	Schmits et al. 1981
UGA-2352	615±65	A.D. 1335	A.D. 1297-1408 (1318,1343,1392)	23JA115 Seven Acres	Brown & Ziegler 1985
UGA-2353	705±55	A.D. 1245	A.D. 1279-1373 (1291)	23JA115 Seven Acres	Brown & Ziegler 1985
I-9656	580±150	A.D. 1370	A.D. 1286-1449 (1400)	14CF506 Winn	Stein 1978
I-9657	455±145	A.D. 1495	A.D. 1327-1638 (1442)	14CF506 Winn	Stein 1978
I-9653	490±80	A.D. 1460	A.D. 1402-1463 (1433)	14CF511	Rohn et al. 1977
BETA-38584	450±60	A.D. 1500	A.D. 1425-1478 (1444)	14JO21-A Shadow Glen	Logan 1990
BETA-38585	470±60	A.D. 1480	A.D. 1415-1464 (1438)	14JO21-A Shadow Glen	Logan 1990
BETA-10122	1030±60	A.D 920	A.D. 978-1032 (1014)	14AT2	Williams 1986
TX-7774	990±60	A.D. 960	A.D. 1004-1156 (1025)	14AT327 KSHS	unpublished
BETA-35858	1150±110	A.D. 800	A.D. 775-1011 (891)	14JO46	Logan 1990

* One sigma calibrated age ranges (and intercepts) based on Stuiver and Pearson (1993).

The four phases recognized by Kenneth Brown (1985) are summarized below. These are based on limited cultural attributes as well as geographical ranges and temporal spans that, in some cases, overlap. Future research will probably require some revision of these taxa (cf. Logan and Hedden 1993:25-26).

Clinton phase. Brown (1985:446) redefined this phase, originally proposed by A. E. Johnson (1968) from excavations in the Wakarusa River drainage, as characterized by arrow points made from nonlocal cherts and ceramic vessels with undecorated lips. Use of shell temper in the pottery was variable. Chronological placement is A.D. 960-1330. Sites of this phase are located in Kansas drainages south of the Kansas River.

Wolf Creek phase. Brown (1985:446) introduced this phase as a new taxon. It is characterized by the exclusive use of local cherts for the production of arrow points, the lack of decoration of the lips of ceramic vessels and the rare use of shell temper in their manufacture. The Wolf Creek phase dates from ca. A.D. 980 to A.D. 1325. Geographically, it is restricted to the Neosho and Verdigris River drainages, though hunting camps affiliated with it may occur in the Truman Reservoir locality in Missouri.

May Brook phase. Brown and Ziegler (1985) originally defined this phase from excavations in the Little Blue River drainage in Jackson County, Missouri. It has subsequently been refined on the basis of an investigation at one of the type sites by Schmits (1981) and by more comprehensive comparative research by Brown (1985:447). The latter summarizes the phase as follows: arrow points are made of nonlocal cherts, and ceramic vessels exhibit decorated lips (exclusive of knobbing) and frequent use of shell temper. Chronological placement is A.D. 1150-1285. Sites of this phase are distributed throughout the Wakarusa, Neosho, Marais des Cygnes, and Verdigris river drainages in Kansas and the Little Blue and Truman Reservoir localities in Missouri.

Apple Valley phase. Brown (1985:447) introduced this taxon and distinguished it from others of the Pomona variant by the presence of knobs on the lips and rims of ceramic vessels. Other forms of lip decoration are known for this phase, and shell temper occurs consistently in the ceramic assemblages of Apple Valley sites. Arrow points made of nonlocal cherts rarely occur in the lithic assemblages. The chronological placement is A.D. 1300-1350. Geographic distribution of this phase includes the Delaware, Bull Creek, Verdigris and Neosho River localities. The Delaware River drainage is suggested to have been its core area.

Recently, A. E. Johnson (1991) has suggested the Pomona variant was ancestral to the historic Kansa. His interpretation is based on similarities in settlement patterns and house structures. However, others have disputed this interpretation by interpreting the Pomona people as Caddoan rather than Siouan (Vehik 1993), attributing the occupation of the Fanning and Doniphan sites to the Kansa rather than, as A. E. Johnson (1991) does, to the Oto (Henning 1993), or by noting the distinction between Pomona and Kansa ceramics and house forms (Logan and Hedden 1993).

Steed-Kisker

Steed-Kisker is a Mississippian-influenced or derived complex centered along the lower Missouri River trench north of Kansas City. It was first recognized by Wedel (1943) following excavations at the type site (23PL13) and at a few burial sites in Platte County, Missouri. Though several other settlements and burial sites in the Kansas City locality have been described (Calabrese 1969a; Shippee 1960, 1972; O'Brien 1978a, 1978b, 1981, 1993; Chapman 1980:156-160), little fieldwork has been done at Steed-Kisker sites in Missouri since completion of the Smithville Lake project in the late 1970s (O'Brien 1977b; McHugh et al. 1982; O'Brien and McHugh 1987). Radiocarbon dates taken from Steed-Kisker sites are listed in Tables 29 and 30. The most recent investigations of Steed-Kisker occupations have focused on sites in Leavenworth County, Kansas. These include the 1988-1989 excavations of the Kansas Archaeological Field School at the Zacharias site (14LV380) which is on Salt Creek, a west bank tributary of the Missouri River (Logan 1988, 1990a:23-39; Logan and Ritterbush 1994:5-6), and the 1995-1996 excavations of the DB site, a multicomponent occupation on an upland ridge near the confluence of those streams (Logan 1995c, [ed.] 1996, 1997).

Certain ceramic traits of the Steed-Kisker phase display obvious similarity to Middle Mississippian cultures of eastern Missouri and western Illinois and on this basis the culture has been attributed to a migration of peoples from those areas (Wedel 1943; O'Brien 1978b, 1981; Chapman 1980:156). O'Brien (1978b, 1981, 1988, 1993) has been the strongest advocate of this view, inferring a trade relationship between Steed-Kisker and Cahokia. Others consider the Mississippian traits to be little more than a veneer over a typical Central Plains tradition manifestation that developed locally (Henning 1967). O'Brien (1978a; 1978b; 1981, 1993) places the temporal span of the Steed-Kisker phase from ca. A.D. 1000-1250, though recent review and calibration of the available radiocarbon dates indicate a broader span, ca. A.D. 950-1400 (Logan 1988; Logan and Ritterbush 1994).

Settlements of this complex consist of remains of one or two shallow pit houses of subrectangular outline. These occur on terraces along tributary streams of the Missouri, Platte, and Little Platte rivers. Sedentism is indicated by trash-filled storage pits and the presence of extensive burial grounds near some settlements. Hunting, gathering, and horticulture are reflected in the lithic tools, faunal, and floral remains. Long distance hunting has been suggested as one facet of Steed-Kisker subsistence, an inference based on data from a single site (Vista Shelter) in the Ozarks of southwestern Missouri some 100 miles from the core area (W. R. Wood 1968).

Ceramic artifacts include shell-tempered bowls and jars with plain surfaces, a variety of incised lines or scroll designs, and appendages such as lugs or loop handles (Wedel 1943:95-97; Shippee 1972). Calabrese (1969a:70-73) refers to Steed-Kisker pottery as Platte Valley ware. Chapman (1980:159, 292-293, 297) recognizes two wares, Platte Valley Plain and Steed-Kisker Incised. Other artifacts include clay and stone pipes, animal and human effigies, triangular side-notched and side-and-basal-notched arrow points, small endscrapers, alternately beveled knives, ground stone celts and axes, sandstone shaft abraders, and worked hematite (Wedel 1943; Shippee 1972; Chapman 1980:156-161). Burials are generally extended, though flexed and bundle skeletal remains are also found, and include associated grave goods, such as bowls and arrow points (Wedel 1943; Barnes 1977; O'Brien 1977b).

The relations between Steed-Kisker and other Plains Village complexes in the lower Missouri and Kansas River valleys are as yet poorly understood. Calabrese (1969a) has suggested that the Steed-Kisker phase was ancestral to the Nebraska phase. However, a number of radiocarbon dates from sites of both complexes clearly demonstrate contemporaneity and, consequently, do not support the hypothesis of an ancestral relationship. The geographic ranges of the Nebraska and Steed-Kisker cultures overlapped in the region of St. Joseph, Missouri, where several sites have yielded mixed ceramic assemblages of Platte Valley (i.e., Steed-Kisker; Calabrese 1969a) and Nebraska wares (Feagins 1988; cf. Logan 1997). Whether this association indicates contemporaneity and interaction of two distinct populations is as yet unknown.

Testimony to interaction among or between contemporary groups of the Plains Village period, including Steed-Kisker, Nebraska and Pomona, is the frequent association of ceramics indicative of each complex at sites in northeastern Kansas. Pottery characteristic of the Steed-Kisker phase was recovered at the Keen site, an occupation attributed to the Pomona culture, in the Delaware River valley (Witty 1983). Witty (1983) interpreted this as evidence of contact and some form of exchange. The frequent association of ceramics of the Steed-Kisker phase and the Pomona variant at sites in Stranger Creek basin, a north-bank tributary of the Kansas River located between the Delaware and Missouri River valleys, led Logan (1985, 1988) to suggest that it had been a shared frontier. Recent excavations at the Zacharias site have yielded additional evidence of contact between these cultures or populations (Logan 1988, 1990a).

Central Plains Tradition

The Central Plains tradition (CPT) was first outlined by Lehmer (1954), primarily in contrast to the Middle Missouri and Coalescent traditions of the Northern Plains, on the following basis:

1) Villages are small, unfortified, and composed of houses, usually square, with four primary post supports centered on a hearth, that were arranged in no particular order.

2) Burial places consist of hilltop ossuaries located near the villages.

3) Ceramics consist of grit-tempered vessels, either plain or cordmarked, with flared or thickened (collared) rims and tool impressed decorations.

4) Arrow points with base or multiple side notches, diamond-beveled knives, chipped celts, equal-arm elbow pipes, bone awls made from deer cannon bones, single-hole arrow shaft wrenches of bone and antler, figurines.

Lehmer based his definition of the CPT on data from sites of Upper Republican and Nebraska aspects, as they were then referred to in the Midwestern Taxonomic System. A third "aspect," Smoky Hill, was added by Wedel (1959). With minor variation (e.g., the predominance of sherd temper in the paste of Riley Cord-roughened ware), it fit this general outline. Each of these complexes has since been taxonomically redefined as phases (L. Brown 1967; Blakeslee and Caldwell 1979) and variants (Krause 1969). Indeed, the problems inherent in archeological systematics have been exemplified, for better or worse, by the taxonomic placement of these Central Plains complexes (cf. Krause 1989). Other problems in CPT interpretations, including the relations among the complexes which comprise that tradition and between it and others north and south, are found in a volume of research papers, distilled theses, and condensed dissertations edited by Blakeslee (1978), subsequent critical review by Krause (1982), and comments on the latter (Blakeslee et al. 1982). Roper (1993) presents the most recent review of the tradition, particularly with respect to its putative ancestral relationship to the historic Pawnee.

The three complexes of the CPT, Nebraska, Upper Republican and Smoky Hill, traditionally have been distinguished on the basis of their geographic locations and ceramics. Nebraska is located along the lower Missouri River valley on the Iowa-Nebraska border southward to northeastern Kansas and northwestern Missouri. The Upper Republican and Smoky Hill variants both occur within the upper Kansas River basin. As originally defined, Upper Republican, as its name implies, was centered in the Republican River drainage of northwestern Kansas and southwestern Nebraska "mainly west of the Smoky Hills and north of the Arkansas River" (Wedel 1959:562). The Smoky Hill culture was centered along the Smoky Hill River eastward to near the confluence of the Big Blue and Kansas rivers (Wedel 1959:562-563). The spatial gap between the core areas of these latter two variants has, however, become less distinct with surveys and excavations of Plains Village sites in the intervening area (Krause 1970; Lippincott 1976).

Differences in the material culture inventories between CPT variants are most noticeable in ceramic attributes, such as rim form. However, when analyzed along geographic gradients from the core area of one complex to another, these differences do not appear to be as distinct and may reflect spatial variations in the relative frequency of shared ceramic types (Hedden 1992). These variations, along with the blurring of geographic boundaries between variants, challenge the taxonomic integrity of the Upper Republican and Smoky Hill archeological complexes as originally defined (Steinacher 1976; Krause 1982; Blakeslee et al. 1982; Wedel 1986:132). A typological analysis by Hedden (1992) of Riley Cord-roughened rim sherds from ten Smoky Hill sites discerned a general directional trend in the relative frequencies of the various ceramic types. His geographical seriation suggests that rather than the discrete variants currently recognized as Upper Republican and Smoky Hill, there is a continuum which extends between the "boundaries" of those entities. The interpretation provided by Hedden demonstrates in a preliminary way the fragile nature of our current taxonomic conception of Plains Village cultures in the Central Plains.

In a statistical analysis of radiocarbon dates from CPT and other sites (i.e., Steed-Kisker, St. Helena and Initial Coalescent), Roper (1976) detected a northward trend from older to younger assays that she suggested mirrors a geographic extension of Plains Village cultures through time. Kvamme (1982) refined the trend-surface analysis about which, ironically, Roper (1985, 1994a, 1994b) had developed some reservations (largely attributed to inadequacies in the data she perceived after her original work). Kvamme (1985) then defended Roper's analysis, referring to the data weaknesses as "noise" inherent in most statistical analyses and took the opportunity to remind us that statistics are tools frequently used to illustrate perceptions often apparent. He noted (Kvamme 1985:263), for example, that the general outline of a northward trend through time of the Plains Village cultures compared by Roper (1976) can be seen by simply plotting the base data on a map. Most recently, Roper (1994a) has substantially revised her earlier scenario of CPT dynamics with respect to time and space, recognizing the greater complexity of cultural developments and relationships in the light of newer data.

Nebraska

The first CPT complex recognized by archeologists, the Nebraska phase (L. Brown 1967; Blakeslee and Caldwell 1979; Blakeslee 1978, 1990; Billeck 1993) or variant (Krause 1969, 1982, 1989) was referred to as the Rectangular Earth Lodge culture by Sterns (1914, 1915b), the first professional to define it. His investigations of this complex had been preceded by

Table 29. Gakushuin University Radiocarbon Dates from Steed-Kisker Sites (considered unreliable).

Lab Number	B.P. Date	Calendar Date	Calibrated Age Range*	Site	Reference
GAK-590	870±80	A.D. 1080	A.D. 1041-1266 (1196)	23PL13 (Steed-Kisker Pit)	Shippee 1972
GAK-1993	980±90	A.D. 970	A.D. 989-1168 (1028)	23CL113 (Friend & Foe Hse3)	Calabrese 1969a
GAK-1994	900±90	A.D. 1050	A.D. 1025-1247 (1165)	23CL113 (Friend & Foe Hse 3)	Calabrese 1969a
GAK-1995	1190±80	A.D. 760	A.D. 727-967 (881)	23CL113 (Friend & Foe Hse 3)	Calabrese 1969
GAK-330	690±90	A.D. 1260	A.D. 1274-1396 (1295)	23PL54 (McClarnon Hse 1)	Shippee 1972
GAK-266	660±80	A.D. 1290	A.D. 1283-1400 (1302)	23PL6 (Vandiver Md. C BurC13)	Shippee 1972
UGA-2715	385±115	A.D. 1565	A.D. 1430-1651 (1480)	23CL226	McHugh et al. 1982

* One sigma calibrated age ranges (and intercepts) based on Stuiver and Pearson (1993).

Table 30. Radiocarbon Dates from Steed-Kisker Sites, Excluding Gakushuin University Dates.

Lab Number	B.P. Date	Calendar Date	Calibrated Age Range*	Site	Reference
M-2179	1170±150	A.D. 780	A.D. 680-1017 (886)	23CL118	Calabrese 1974
UGA-379	1180±110	A.D. 770	A.D. 711-990 (883)	23PL16 (F 1B)	O'Brien 1984
UGA-467	1045±60	A.D. 905	A.D. 969-1027 (1008)	23PL16 (F. 1)	O'Brien 1984
UGA-466	645±60	A.D. 1305	A.D. 1291-1399 (1306,1364,1376)	23PL16	O'Brien 1984
UGA-392	635±60	A.D. 1315	A.D. 1294-1402 (1309,1357,1382)	23PL16	O'Brien 1984
BETA-36365	1190±70	A.D. 760	A.D. 775-962 (881)	14LV380 (Zacharias)	Logan 1990a
BETA-36366	910±50	A.D. 1040	A.D. 1036-1215 (1162)	14LV380 (Zacharias F 9)	Logan 1990a
BETA-34371	900±50	A.D. 1050	A.D. 1041-1218 (1165)	14LV380(Zacharias F 9)	Logan 1990a
M-1182	1075±150	A.D. 875	A.D. 787-1158 (987)	23PL48 (Gresham Hse 1)	Shippee 1972
M-1397	1090±110	A.D. 860	A.D. 871-1028 (978)	23PL13 (Steed-Kisker Pit)	Shippee 1972
M-1395	950±110	A.D. 1000	A.D. 997-1222 (1041,1150)	23PL13 (Steed-Kisker Midden	Shippee 1972
M-1395A	840±110	A.D. 1110	A.D. 1041-1286 (1222)	23PL13	Shippee 1972
23PL13				Steed-Kisker Midden	
M-1398	740±100	A.D. 1210	A.D. 1221-1379 (1284)	Steed-Kisker Pit	Shippee 1972
M-1399	720±100	A.D. 1230	A.D. 1229-1391 (1288)	23PL13 Steed-Kisker Hse. 3	Shippee 1972
M-2347	880±110	A.D. 1070	A.D. 1025-1278 (1176)	23PL4 Young Hse. 1	Shippee 1972
M-2346	660±100	A.D. 1290	A.D. 1279-1405 (1302)	23PL4 Young Hse. 1	Shippee 1972
UGA-1149	995±70	A.D. 955	A.D. 993-1158 (1024)	23CL108 Reeves Md.	O'Brien 1977b
UGA-1201	980±65	A.D. 970	A.D. 1008-1161 (1028)	23CL108 Reeves Md.	O'Brien 1977b
UGA-1200	920±70	A.D. 1030	A.D. 1025-1218 (1064,1075,1127,1133,1159)	23CL108 Reeves Md.	O'Brien 1977b
UGA-1446	1260±90	A.D. 690	A.D. 668-886 (776)	23CL109 Richardson Hulse F. 5	O'Brien 1977b
UGA-1445	865±70	A.D. 1085	A.D. 1048-1259 (1212)	23CL109 Richardson Hulse F. 4	O'Brien 1977b
UGA-1447	835±75	A.D. 1115	A.D. 1162-1280 (1223)	23CL109 Richardson Hulse F. 5	O'Brien 1977b
UGA-1448	695±100	A.D. 1255	A.D. 1257-1397 (1294)	23CL109 Richardson Hulse F. 6	O'Brien 1977b
M-9026/7	850±110	A.D. 1100	A.D. 1036-1284 (1218)	23CL113 Friend & Foe Hse. 1	Calabrese 1969a
UGA-1454	845±80	A.D. 1105	A.D. 1058-1279 (1220)	14WY7 Calovich Md.	Barnes 1977

* One sigma calibrated age ranges (and intercepts) based on Stuiver and Pearson (1993).

the pioneering efforts of Gilder (1907b, 1909, 1911, 1912). Subsequent investigations of several habitation sites along the Missouri River trench in eastern Nebraska in the 1930s by W. Duncan Strong (1933, 1935) of the University of Nebraska and Columbia University, Earl Bell and M. R. Gilmore (1936) of the University of Nebraska, and Asa T. Hill and Paul Cooper of the Nebraska State Historical Society (e.g., Hill and Cooper 1936a, 1936b, 1938; Cooper 1936, 1939) provided the broad outline which still serves as the definition of the Nebraska culture. Subsequent research has included additional data acquisition and numerous attempts to enhance our understanding of the taxonomy, variation and development of this culture (e.g., Gunnerson 1952; Ives 1955; Anderson and Anderson 1960; Davis and Rowe 1960; Anderson 1961; L. Brown 1967; Gradwohl 1969; W. R. Wood [ed.] 1969; Krause 1969; Heavin 1970; Zimmerman 1971, 1976, 1977a, 1977b; P. C. Johnson 1972; Shaw 1974; Anderson and Zimmerman 1976; Hotopp 1978a, 1978b, 1982; Blakeslee 1978, 1989, 1990; Blakeslee and Caldwell 1979; McNerney 1987; Feagins 1988; Green 1990, 1992; Ludwickson and Bozell 1993; Billeck 1993).

The geographic range of the Nebraska phase extends along the Missouri River trench primarily in Nebraska, southward from Thurston County, but with an important locality along Keg and Pony Creeks near Glenwood, Mills County, Iowa (Anderson 1961; L. Brown 1967; Zimmerman 1971, 1976, 1977a, 1977b; Hotopp 1978a, 1978b; Blakeslee and Caldwell 1979; Billeck 1993). The southernmost extent of the phase is in Doniphan County, Kansas and Buchanan County, Missouri (W. R. Wood [ed.] 1969; Feagins 1988). However, at least one site (14JO46) as far south as Johnson County, Kansas has been attributed to a Nebraska phase occupation (Logan and Hedden 1990). Radiocarbon dates for the Nebraska phase range from about A.D. 1000 to 1450 (Blakeslee 1990:29) in Nebraska and A.D. 1000 to 1250 in the Glenwood locality (Billeck 1993).

As Sterns (1915b) first described what is now called the Nebraska phase, one of its hallmarks is the rectangular or subrectangular lodge constructed of post supports and pole framework centered on a pit hearth and covered with earth or daub. Pits extending below the floor of these structures were used to store foodstuffs and other goods. Though some sites appear to have several such lodges, it is as yet debated whether these were contemporaneously occupied habitations of extensive villages (Gradwohl 1969) or serially occupied farmsteads (Blakeslee 1990).

The subsistence pattern is comparable to that of the Steed-Kisker phase, characterized by hunting of wild animals of the prairie-woodland-riverine habitats, gathering of wild plant resources, and a significant reliance on the cultivation of domesticated plants (Adair 1988). Blakeslee (1990) has suggested that Nebraska phase agriculture entailed slash-and-burn gardening, which depleted soil and required relatively frequent moves along tributaries resulting in a serial lodge occupations.

Ceramics include both shell-tempered and grit-tempered bowls and jars with lug and strap handles and rim-incised designs. Distinctive wares that have been defined include McVey, Beckman, and Swaboda pottery (Gunnerson 1952; Ives 1955; Anderson and Anderson 1960). Seriations of Nebraska phase ceramics have been established by Blakeslee and Caldwell (1979) and Billeck (1993). Both of these sources are major revisions of Nebraska phase spatial, temporal, and developmental parameters. Lithic artifacts are similar to those of the Steed-Kisker phase and other CPT complexes.

The extent of Mississippian influence on the development of the Nebraska phase has been the subject of considerable research. Several researchers have noted the diffusion or introduction of certain traits from Mississippian cultures in Nebraska phase ceramics (Strong 1935; Ives 1955; Wedel 1959:129-130; Anderson 1961; L. Brown 1967). Henning (1967) suggests such influence was indirect and channeled through the Steed-Kisker phase, which had established a pattern of cultural interchange. McNerney (1987) reviewed the effigy complex and some exotic ceramic vessels from Nebraska sites. He sees a connection between the Nebraska phase and populations of the southern section of the central Mississippi Valley subarea, Caddoan area, and Spiro-Southeastern Ceremonial complex.

Upper Republican

The Upper Republican manifestation of the CPT was initially described by Strong (1933, 1935) based on archeological excavations in 1930 of the Lost Creek site (25FR3), in Franklin County, Nebraska. Subsequent excavations in the Medicine Creek drainage, a tributary system of the Republican River in Frontier County, southwestern Nebraska, added considerably to the data base of this complex (Wedel 1933, 1934a). Following the Second World War, the River Basin Survey program of the Smithsonian Institution augmented knowledge of this complex with extensive research in the Medicine Creek locality (Kivett 1949; Kivett and Metcalf 1991), in the Red Willow Creek area 35 km west of Medicine Creek (Grange 1980), and in the Solomon River valley of north-central Kansas (Carlson 1971; Lippincott 1976; Krause 1970). Additional investigations in the Medicine Creek locality included excavation of the Mowry Bluff site (24FT35) undertaken in 1967 as part of a seminar offered by W. R. Wood (1967). This project took as its research design a comparison of two sites of the Nebraska and Upper Republican cultures (cf. Wedel 1970). More recent work in that important area has been carried out by Roper (1988, 1991a, 1993) with support from the Bureau of Reclamation. This entailed excavations of a lithic workshop area at the Marvin Colson site (25FT158) and of House 4 at 25FT22. At present, extensive surveys of the Medicine Creek area are being conducted under a cooperative agreement between the Bureau of Reclamation and Wichita State University. To date, these surveys have considerably augmented the number of previously recorded Upper Republican sites in that significant locality (Bob Blasing, personal communication, 1994).

The geographic range of Upper Republican, as it is presently understood, is the most extensive of the three CPT complexes. Sites assigned to this complex are in the High Plains of southeastern Wyoming and northeastern Colorado (Irwin and Irwin 1957; Reher 1973; W. R. Wood 1967, 1971), as well as southwestern Nebraska (see references above), northwestern Kansas (Wedel 1959:381-407), and north-central Kansas (e.g., the Solomon River locality referenced above).

Temporally, the Upper Republican manifestation of the CPT has been divided into three units, only two of which are currently in vogue. Referring to the complex as a variant (a term he applied to Nebraska and Smoky Hill as well), Krause (1969) recognized, from oldest to youngest, the Solomon River, Classic Republican, and Loup River phases. Chronological placement of the first of these phases, Solomon River (cf. Carlson 1971), was based on radiocarbon assays done by the laboratory at Gakushuin University in Japan, determinations now generally regarded as suspect. Lippincott (1976; 1978), in a review based on ecological and formal archeological data, was critical of the sequence developed by Krause and Carlson. On the basis of more recently obtained radiocarbon dates from Upper Republican sites in the Solomon River locality, Blakeslee (1991) demonstrated the contemporaneity of sites therein with those previously regarded as Classic Upper Republican.

The Loup River (also called Itskari) subphase (here adopting the taxonomic placement of Upper Republican as a phase) has proven more durable. This is despite the fact that its chronological placement has been revised and that its relationship to the subsequent Lower Loup phase, a protohistoric Pawnee manifestation in the central Nebraska drainage of that name, is not entirely clear. This regionally distinct expression of the Upper Republican culture was first recognized by archeologists on the basis of data from the Sweetwater site (25BF1), on a tributary of the South Loup River (Strong 1932; Champe 1936), and the Lehn Farm site (25HW2), which is located near the North Loup River valley (Hill 1932). These sites were assigned by Strong (1935:2) and Wedel (1934c:252) to the Sweetwater focus of the Upper Republican aspect. Champe (1936) subsequently redefined Sweetwater as the Loup River focus. Despite the paucity of supporting chronological information, Krause (1969) interpreted Loup River as the most recent Upper Republican phase (or subphase, depending on the taxonomic scheme). With more radiocarbon dates available, Ludwickson (1975; 1978) suggested a temporal placement of ca. A.D. 1250-1450 for Loup River. On the basis of

Table 31. Gakushuin University Radiocarbon Dates from Smoky Hill Sites (considered unreliable).

Lab Number	B.P. Date	Calendar Date	Calibrated Age Range*	Site	Reference
GAK-2794	1320±80	A.D. 630	A.D. 654-783 (680)	14SA403 Winslow	O'Brien 1984
GAK-2795	1440±90	A.D. 510	A.D. 547-668 (635)	14SA403 Winslow	O'Brien 1984
GAK-593	1040±100	A.D. 910	A.D. 893-1153 (1011)	14JW301 Hse. 1	O'Brien 1984
GAK-295	750±120	A.D. 1200	A.D. 1193-1385 (1282)	14CY30 Woods Hse. 2	Witty 1963e
GAK-803	1530±90	A.D. 420	A.D. 1425-1631 (1454)	14CY102 Moll Creek F. 119 post	Steinacher 1975
GAK-591	470±80	A.D. 1480	A.D. 1407-1478 (1438)	14BT420 Winslow	O'Brien 1984
GAK-1446	320±100	A.D. 1630	A.D. 1453-1666 (1530,1537,1635)	14RY401 (14RY21) F. 3	M. Brown 1982
GAK-1447	260±70	A.D. 1690	A.D. 1525-1954 (1654)	14RY401 (14RY21) F. 8	M. Brown 1982
GAK-1448	370±70	A.D. 1580	A.D. 1446-1641 (1488,1609,1611)	14RY401 (14RY21) F. 32	M. Brown 1982
GAK-1449	320±80	A.D. 1630	A.D. 1472-1660 (1530,1537,1635)	14RY401 (14RY21) F. 30	M. Brown 1982

* One sigma calibrated age ranges (and intercepts) based on Stuiver and Pearson (1993).

Table 32. Radiocarbon Dates from Smoky Hill Sites, Excluding Gakushuin University Dates.

Lab Number	B.P. Date	Calendar Date	Calibrated Age Range*	Site	Reference
TX-5913	1010±210	A.D. 940	A.D. 789-1254 (1020)	14RY8 Fancy Creek F. 1	Schmits et al. 1987
TX-5814	1090±80	A.D. 860	A.D. 886-1020 (978)	14RY8 Fancy Creek F. 3	Schmits et al. 1987
I-509	963±100	A.D. 987	A.D. 994-1213 (1035)	14LC301 Root	Witty 1962a
SI-143	940±90	A.D. 1010	A.D. 1014-1218 (1046,1097,1115,1144,1153)	14MD502	O'Brien 1984
M-113	780±150	A.D. 1170	A.D. 1052-1385 (1275)	14CY30 Woods Hse. 1 fl.	Crane 1956
M-869	760±150	A.D. 1190	A.D. 1162-1393 (1280)	14PO4 Budenbender Hse. 1 post	Johnson 1973
SI-230	920±90	A.D. 1030	A.D. 1019-1226 (1064,1075,1127, 1133,1159)		O'Brien 1984
SI-231	770±80	A.D. 1180	A.D. 1217-1295 (1278)	14GE21 Miller pit	O'Brien 1984
SI-232	410±100	A.D. 1540	A.D. 1425-1638 (1462)	14GE21 Miller Hse. fl.	O'Brien 1984
GA-827	670±60	A.D. 1280	A.D. 1286-1393 (1300)	14RY401 (14RY21) F. 19	M. Brown 1982
UGA-828	810±60	A.D. 1140	A.D. 1191-1282 (1245)	14RY401 (14RY21) F. 20	M. Brown 1982
UGA-465	860±60	A.D. 1090	A.D. 1064-1255 (1214)	14RY401 (14RY21) F. 20	M. Brown 1982
BETA-16479	730±70	A.D. 1220	A.D. 1251-1303 (1286)	14OT5 Minneapolis pit	KSHS unpublished
BETA-16480	680±70	A.D. 1270	A.D. 1281-1393 (1298)	14OT5 KSHS Minneap. Hse. 8 pit	unpublished
UGA-824	700±75	A.D. 1250	A.D. 1276-1389 (1293)	14GE600 Witt post	M. Brown 1982
UGA-825	595±60	A.D. 1355	A.D. 1303-1413 (1397)	14GE600 Witt post	M. Brown 1982
UGA-826	835±65	A.D. 1115	A.D. 1165-1278 (1223)	14GE600 Witt post	M. Brown 1982
UGA-3866	250±440	A.D. 1700	A.D. 1295-1955 (1657)	14RY442 F. 2	O'Brien 1984
UGA-3867	660±165	A.D. 1290	A.D. 1227-1432 (1302)	14RY442 F. 2	O'Brien 1984
BETA-45873	630±50	A.D. 1320	A.D. 1297-1401 (1310,1353,1385)	14WH319 Wollenberg	Reynolds & Wulfkuhle 1991
BETA- 46652	580±50	A.D. 1370	A.D. 1310-1416 (1400)	14CY17 Moore	Ritterbush & Logan 1992

* One sigma calibrated age ranges (and intercepts) based on Stuiver and Pearson (1993).

more recently obtained dates, Roper (1994a) suggests a placement of ca. A.D. 1150-1350, which makes it roughly contemporaneous with other CPT cultures.

The trait that most distinguishes Loup River from Upper Republican proper is the more variable house form, including both the rectangular or square shape of CPT lodges and a more circular lodge outline. Ludwickson (1978:96-97) has also noted the more varied topographic settings of Loup River sites. Beyond these distinctions, there is little in the formal characteristics of Upper Republican and Loup River to separate them. The following outline of ceramic, lithic, bone tool assemblages and subsistence patterns is applicable to both manifestations.

Upper Republican ceramics have been described by Wedel (1936:188) as belonging to two wares, thickened (collared) and unthickened, also referred to as classes I and II (cf. Wedel 1986:106-108; Strong 1935:248; Champe 1936:270-272; Cooper 1936:35-38). Vessels are small to medium-sized globular forms generally tempered with sand. Exterior surfaces are cordmarked and the body lacks decorative treatment. Decorated rims exhibit a variety of incised lines, including opposed diagonals, parallel horizontal lines, and chevrons, as well as tool impressions and finger-pinched nodes. Sigstad (1969:17-23) provides a detailed analysis of typical Upper Republican pottery from the Mowry Bluff site, Medicine Creek locality occupation. He defines a typical Medicine Creek paste, which is distinguished from grog-tempered ceramics. The former includes two wares, a collared form defined as Frontier ware, and an unthickened form called Cambridge ware. Miniature vessels were also represented in the assemblage.

Lithic tools are characteristic of Central Plains tradition chipped and ground stone tool assemblages. The former includes triangular notched and unnotched arrow points, a variety of bifacial cutting tools (such as typical alternately beveled knives) and axes. Ground stone artifacts include grooved sandstone abraders, especially of the paired type, manos, metates, hammerstones, pipes, and pendants (Strong 1935; Wedel 1936, 1986:111; Champe 1936; Klippel 1969; Calabrese 1969b). Exotic material indicative of trade is rare but includes copper (Wedel 1986:112-113), malachite and turquoise (Roper 1988). Raw materials for chipped stone tools are predominantly the brown to yellow silicified chalk of the Niobrara Formation known by a plethora of names (e.g., Niobrara jasper, Graham jasper, Niobrarite, Republican River chert or jasper, Smoky Hill jasper; Wedel 1986; Wright 1985; Stanford 1974; Holen 1983b; Banks 1990; Hofman 1990a), as well as Flattop flint, Ogallala quartzite, Alibates agatized dolomite, and Permian cherts from the Flint Hills (Wedel 1986:111)

Bone, antler, and shell were shaped into a variety of usable forms (Falk 1969a:39-43; Wedel 1986:108-112). Bone tools include agricultural implements such as bison scapula hoes and knives, hideworking tools such as awls and needles, fishhooks, antler shaft straighteners, and picks. Ornamental items include beads of bone and shell and antler bow guards. An example of the latter is an artifact recovered by Strong (1935:111; Wedel 1986:112-113) from Graham ossuary in Harlan County, Nebraska, that bears an incised design reminiscent of the hand and eye motif of the Southeastern Ceremonial Complex. Exotic shell indicative of trade occurs in the form of Gulf Coast conch, freshwater snails from the Ohio and Wabash rivers region, marine *olivellas* from the Gulf or Atlantic coasts, and *marginella* from the Florida or Gulf Coasts (Strong 1935:111-114; Wedel 1986:111).

Upper Republican mortuary sites consist of blufftop pit ossuaries, such as Graham (25HN5), into which the disarticulated bones of the dead were disposed (Strong 1935:108-114; Adair et al. 1987:78-89). Artifacts included with the remains include pottery, shell pendants and beads, arrow points, scrapers, modified bone tools, and copper ornaments.

Upper Republican subsistence patterns were dependent on agriculture, hunting, and gathering. Wedel (1986:114-121) has discussed the various implications of dry farming of maize in a marginal climatic region such as the Upper Republican River basin. Problems of crop yield, seasonal variations in rainfall and frost appearance, food preparation, and storage are explored. Adair (1988) also examines the development and practice of agriculture among CPT, as well as other cultures, in the Central Plains. The generalized and varied nature of Upper Republican hunting and gathering practices is also examined by Falk (1969a, 1969b), Mick (1983), Bozell (1991), and Scott (1993). Wedel (1970; 1986:123-126) has critically reviewed W. R. Wood's (1969) interpretation of the need for long-distance bison hunting from the Medicine Creek locality. W. R. Wood (1971) offered as support of such forays the presence of Upper Republican sites lacking evidence for agriculture in eastern Colorado (cf. Reher 1973:119). More recent evaluation of these High Plains sites by both W. R. Wood (1990) and Roper (1990), however, indicates they appear to be evidence of local Upper Republican populations in that area who lacked the houses and farming practices of that culture and may therefore deserve special recognition as a distinctive phase or subphase of the Central Plains Tradition.

Smoky Hill

The Smoky Hill phase (L. Brown 1967) or variant (Krause 1969; A. E. Johnson 1973) was the last complex of the CPT to be defined. Of the three CPT complexes, it is the most poorly known, a reflection of the fact that fewer sites of this affiliation have been investigated and reported. Wedel (1959:563) distinguished it on the basis of geographic core area and its associated pottery, which he defined as Riley Cord-roughened ware. His type sites included Griffing (14RY21) and Minneapolis (14OT5; Wedel 1936:210-237), both extensive sites that included a series of lodge remains, and Whiteford (14SA1), a cemetery containing the interred remains of more than 140 individuals. Settlements occur throughout the core area, which centers on the Smoky Hill, Lower Republican, and Blue rivers in Ottawa, Clay, Riley, and Geary counties, Kansas. The extent of this complex into Nebraska, for example along the upper Blue River drainage, is as yet unknown or poorly documented. Nonetheless, it is likely that it did extend into Nebraska given the presence of sites in Jewell and Washington counties, Kansas, just a few miles south of Nebraska (Witty 1978). Radiocarbon dates from Smoky Hill sites are listed in Tables 31 and 32.

Excavations of Smoky Hill lodge sites were conducted in the 1920s-1930s by Floyd Schultz, a largely self-taught amateur archeologist from Clay Center, Kansas (Hawley 1991, 1993; Ritterbush and Logan 1991, 1992). His extensive collection of artifacts and field notes was donated to the University of Kansas in 1949 and has since been the source of several research papers and theses at that institution (see Hawley 1993: Appendix E). Other reports and theses that focus on the Smoky Hill culture include Wille (1958), Witty (1963e), Sperry (1965), Kelly (1966), A. E. Johnson (1973), Steinacher (1976), M. Brown (1982), Donahue et al. (1988), Reynolds (1990), and Ritterbush and Logan (1991, 1992). Several of the research papers and reports attribute assemblages to the Upper Republican culture but, given their geographic location and artifact descriptions, these are more likely Smoky Hill (e.g., 14JW312, Theis 1982b; 14WH319, Reynolds and Wulfkuhle 1991).

One of the best reported Smoky Hill settlements is Budenbender (14PO4), located in the Tuttle Creek Lake area on a terrace along Spring Creek, a tributary of the Big Blue River in Pottawatomie County, Kansas. The remains of two to three houses were recorded, with one fully excavated in 1957 (A. E. Johnson 1973). The house form was circular, indicating more variety in CPT architecture than the more stereotypic subrectangular lodge. Four main posts, surrounding a central hearth, supported the central portion of the house. Two interior storage pits were found near the northern edge of the structure. Two more irregular pits occurred near its eastern edge. Traces of an entryway were found at the southern edge. The lodge, which was 25 ft in diameter and included about 490 sq ft (53 sq m) of floor space, is postulated to have housed from five to 10 persons. Associated with the structure and its features was a variety of lithic, ceramic, and bone artifacts. Chipped stone artifacts included triangular notched and unnotched arrow points, perforators, thin and thick bifaces, spokeshaves, endscrapers, side scrapers, retouched and utilized flakes, cores, and debitage. Ground stone artifacts included celts, pipes, manos, metates, grinding stones, hammerstones, grooved and ungrooved abraders, and worked hematite. Bone tools consisted of an awl fragment, fishhooks, a bead, antler shaft straightener, and antler handle. In addition to the dominant Smoky Hill ceramic ware, a smaller but significant number of smooth, shell-tempered and incised sherds interpreted as evidence of Eastern contact were recovered. A single radiocarbon date of 760 ± 150 years B.P. (A.D. 1190 uncorrected), was derived from a post associated with the house.

Subsistence practices of Smoky Hill populations in the project area have been analyzed by Marie Brown (1982). Her analysis, based on the faunal assemblages from the Budenbender and Witt (14GE600) sites and 14RY401, is a detailed discussion of their utilization of a variety of animals from prairie, woodland, and riverine habitats as food resources and for bone tools. Sequences for the butchering of game and production of bone tools are presented. The latter artifacts at Smoky Hill sites include bison scapula hoes and knives, needles, awls, and beads, and deer mandible sickles or corn shellers (Figure 47).

Riley Cord-roughened ware, the artifact hallmark of the Smoky Hill culture according to Wedel (1959), consists of medium to small jars and bowls with cordmarked exterior surfaces and high, decorated rims often thickened with a fillet or collar (Figure 48). They are generally tempered with stone (either crushed grit or sand), which is characteristic of all CPT ceramics, or crushed sherd/clay, which is particularly diagnostic of Smoky Hill pottery. Decoration includes evenly spaced pinches or stick impressions at the base of the collar or fillet, tool impressions on the top of the lip, or diagonal incisions across the lip. Appendages such as strap handles and, more rarely, effigies (Figure 49) also occur. A ceramic typology for Riley Cord-roughened ware, based on decorative attributes, has recently been defined by Hedden (1992). Other ceramic artifacts include elbow pipes and perforated disks reshaped from body sherds (Figure 50).

Steinacher (1976) has reviewed data from six Smoky Hill sites, two in Geary County and the balance in Clay County. For his information on these sites Steinacher relied entirely on descriptive analyses of those assemblages conducted by undergraduate students at the University of Kansas during the 1950s. In particular, Steinacher focused on the ceramics from these sites in his effort to produce a temporal seriation and, more importantly, to determine the nature of the relationship between Smoky Hill populations and Mississippian (i.e., Steed-Kisker) groups of the eastern margin of the Central Plains. This relationship is thought to be best revealed in the presence of shell-tempered, incised ceramic ware. Steinacher concluded that Smoky Hill populations encountered westwardly moving groups of the Steed-Kisker phase in an "interface" zone, the western perimeter of which extended to the present Tuttle Creek Project Area and the confluence of the Republican and Smoky Hill rivers (i.e., near present Junction City). The interaction of these populations resulted in a readaptation of both cultures that resulted in the archeologically recognized Nebraska phase (Steinacher 1976:109-114).

Steinacher's interpretation must, at this point in time, be considered hypothetical. Indeed, what is required is a reevaluation of some of its basic assumptions, particularly the nature of the so-called Mississippian ware that is frequently part of Smoky Hill ceramic assemblages. It has not yet been demonstrated whether this pottery is imported ware or made by the Smoky Hill people themselves. If it is of local manufacture, it may not be necessary to posit the taxonomic change suggested by Steinacher. It may be sufficient to simply

Figure 47. Bone tools from the lodge floor of the Mugler site (14CY1) (from Ritterbush and Logan 1992:77).

Figure 48. Reconstructed Riley Collared Pinched vessel from the Mugler site (14CY1) (from Ritterbush and Logan 1992:46).

Figure 49. Reconstructed effigy vessel from Lodge 2 of the Moore site (14CY17) (from Ritterbush and Logan 1992:130).

Figure 50. Ceramic disks and clay pipe from the Moore site (14CY17) (from Ritterbush and Logan 1992:130).

recognize a certain degree of change in the ceramic inventory of Smoky Hill populations through time. At any rate, this aspect of the dynamics of the Central Plains populations of the Plains Village period still requires investigation (Beck 1995). Indeed, the incised and shell tempered pottery found at Smoky Hill sites should not be called Steed-Kisker or Platte Valley ware since its consistent decorative motif, a series of parallel, opposed-diagonal lines, is not matched by any such decoration in the pottery from Steed-Kisker sites. This distinction was first noted by Wille (1958) and later by Sperry (1965), who nonetheless referred to it as Mississippian pottery and went so far as to identify the Miller site (one of two he described which yielded such ceramics) as a Steed-Kisker occupation.

St. Helena

Less well known than any of the complexes discussed above, the St. Helena complex nonetheless occupies an important place in any discussion of the Plains Village adaptation of the Central Plains. It is particularly relevant to the CPT, as its characteristics have been seen as transitional between Nebraska and Upper Republican since it was first defined as a focus by Cooper (1936). Moreover, it is temporally transitional between the CPT and later Coalescent tradition and geographically transitional between the Central Plains and Middle Missouri regions (Blakeslee 1988:1). Roper (1993) discusses St. Helena in the context of Northern Caddoan developments in the fifteenth and sixteenth centuries with particular reference to the relationship between Caddoan culture and the Initial and Extended Coalescent variants (after Lehmer 1971) of the Big Bend area of South Dakota. She notes that sites assigned to all three archeological taxa "at once reflect a good deal of continuity with the Central Plains tradition, a good deal of adoption of traits from the Middle Missouri tradition, and some ideas entirely new to the region" (Roper 1993:87).

St. Helena is confined to a small area of northeastern Nebraska along the Missouri River valley that includes the counties of Dixon, Cedar, and Knox. The original definition of the St. Helena "focus" by Cooper (1936) was based on Works Progress Administration (WPA) projects in Cedar County. Subsequent WPA projects to the south in Dixon County added to the number of known St. Helena sites (Frantz 1963). Other limited excavations at two sites of this complex were the only investigations of St. Helena between the WPA projects of the 1930s and projects supported by the Omaha District, U.S. Army Corps of Engineers in the 1980s (Blakeslee 1988:2). These focused on one site in Santee, Nebraska (Carlson 1976) and the Gavins Point site, a multicomponent occupation, in southeastern South Dakota (Hall 1961; L. Brown 1968; Zimmerman and Bradley 1978).

Data about St. Helena acquired from 1980 to 1985 resulted from a cultural overview of the Missouri National Recreation River, a 58-mile reach of the Missouri River from Ponca State Park to Gavins Point Dam (Ludwickson et al. 1987), a survey of the shoreline of Lewis and Clark Lake above Gavins Point dam (Blakeslee and O'Shea 1983), survey and testing of sites in the Coon Creek valley of Dixon County by the Wichita State University (WSU), Nebraska State Historical Society and Earthwatch, excavation of a house at Annie's site (25DX30) by the WSU and Earthwatch, and surveys in Dixon County by WSU with support from the Nebraska State Historical Society (Blakeslee 1988).

St. Helena was assigned, along with the Loup River phase, to the Basal Coalescent variant by Ludwickson and others (1987:165-166). They suggested the complex dated from ca. A.D. 1250 to 1400, though few reliable radiocarbon dates were then available. Three radiocarbon dates, corrected and calibrated, from Annie's site fall within the fifteenth century A.D. and indicate the complex extends to that time (Blakeslee 1988:10).

Although the St. Helena house form is comparable to that characteristic of CPT complexes, they occur in greater numbers at some sites. Ludwickson and others (1987:165) note that as many as 31 houses have been documented at some St. Helena sites, though not all could be considered contemporaneous as some may have been rebuilt or constructed after others had been abandoned.

Subsistence was like that of other Plains Village complexes, based on agriculture, hunting, and gathering. Evidence for long distance hunting by the occupants of House 2 at Annie's site was inferred from the wide catchment area represented by the high frequency of nonlocal lithics (Padgett 1988) and the absence of certain faunal elements (Manz and Blakeslee 1988).

Ceramics are comparable to CPT pottery, though a high proportion of the rims, particularly the collared forms, are decorated. A wide range of incised or trailed motifs is exhibited, including multiple bands on the collar face. Copies of vessels characteristic of Oneota, Mill Creek, and other Middle Missouri tradition complexes occur (Ludwickson et al. 1987:166).

Lithics and bone tools are like those described above for CPT complexes. Descriptive and processual (i.e., manufacturing sequence) studies of a wide assortment of bone tools, including scapula hoes, cleavers and knives, deer mandible sickles, awls, pottery making tools, fleshers, punches, picks, beamers, wrenches, scoops, etc. are presented by Hill (1988) and Giessen (1988).

7 The Protohistoric Period on the Central Plains, by Brad Logan

The period between the arrival in North America of Europeans and their first intensive exploration or settlement of the Central Plains (ca. A.D. 1500-1700) is called the Protohistoric or Late Ceramic period. This period was characterized by intermittent or indirect contact between some indigenous peoples and immigrant Euro-Americans or by no evidence of any interaction. It is that post-Columbian period for which there is little historical documentation of indigenous populations. This period in the Central Plains is represented by complexes identified, often through the direct historical approach, as ancestral Pawnee (Lower Loup), Plains Apache (Dismal River), and Ponca (Redbird). As noted in the introduction to the Plains Village section, two complexes, Oneota and White Rock, have been regarded traditionally as protohistoric, though radiocarbon dating indicate both had their origins in the late Plains Village period. The complexes are discussed in approximate chronological order.

Oneota

In Missouri and Iowa, the Oneota culture has been linked to later historic Siouan groups (Henning 1970; Harvey 1979; Chapman 1980:236). In the Central Plains, Oneota is represented by only a few sites, Leary, Fanning, Doniphan, Stanton, and Ashland (Hill and Wedel 1936; Wedel 1959:131-172; Henning 1970:145-146; Harvey 1979:199-204). The Leary site (25RH1) is located in extreme southeastern Nebraska at the confluence of the Big Nemaha and Missouri rivers. Fanning and Doniphan are located a relatively short distance from Leary in Doniphan County, Kansas. Stanton and Ashland, both multicomponent sites, are located in northeastern and east-central Nebraska respectively. A report on the Oneota component (Occupation B) at Ashland is provided by Hill and Cooper (1939: 267-271, 275-278). Waldo Wedel (1959:170, 609) briefly evaluates the Oneota material from the Stanton site.

Ceramics from Leary, the most extensive of these Oneota sites, have been interpreted by Henning (1970) as indicative of occupation by both the Correctionville-Blue Earth and Orr phases of the Oneota complex. Both of these complexes are centered in Iowa. Leary also contains a Nebraska phase component (Hill and Wedel 1936; referred to therein as Upper Republican). Two houses have been excavated at the site, one excavated by the Nebraska State Historical Society in 1935 under the direction of A.T. Hill (Hill and Wedel 1936) and the other excavated in 1965 by Marvin Kivett and Wendell Frantz of the University of Nebraska, Lincoln (unpublished; see Corbyn 1975). Both are square and comparable to CPT houses. That dug by UNL may be Nebraska phase, given the ceramics associated with it. Radiocarbon assays from a post of that house yielded two widely divergent and unreliable dates. The house described by Hill and Wedel (1936:15-19), though comparable to CPT lodges in many respects, nonetheless was clearly occupied by Oneota people. Cache pits that contained Oneota ceramics had been truncated by the floor of the structure and clearly ante-dated it. Materials found on the floor were also Oneota.

In addition to the house, Hill directed excavation of 153 cache pits (others were found but not excavated), nearly all found during fruitless searches for more houses (Hill and Wedel 1936:19-22). Fifteen burials were also dug, three of which were house-intrusive and pre-dated that structure. Eight of the interments were extended, two were bundle and the remainder too fragmentary to determine the nature of burial (Hill and Wedel 1936:23-30).

The only radiocarbon assays believed to date the Oneota component at Leary, recovered by J. Mett Shippee from a pit that yielded Oneota pottery, are 740±55 B.P: A.D. 1210 (Wis-151) and 600±55 B.P.: A.D. 1300 (Wis-155) (Henning 1970:153, 170).

Wedel (1959:171) has suggested that the Fanning site can be tentatively identified as an early Kansa manifestation, given several eastern traits in the recovered assemblage, yet he also believes it was occupied just prior to A.D. 1700 and may be evidence that corroborates the identification of the Kansa in that area on the Delisle maps of 1703 and 1718. A. E. Johnson (1991) has disputed this interpretation, however, and suggests sites such as Fanning and Doniphan were occupied by the Oto, another Siouan group. Johnson's view has, in turn, been criticized by Henning (1993) and Vehik (1993), who both support the argument for a late (seventeenth century) arrival of Dhegihan-speaking populations, such as the Kansa, on the Plains.

White Rock

Most of our knowledge about the White Rock culture is still based on data from six sites and brief descriptive reports about them. These sites are located in three localities: Harlan County Lake in south-central Nebraska and the Glen Elder/Waconda and Lovewell Reservoirs in north-central Kansas. Investigations in the Glen Elder area focused on the Glen Elder site (14ML1); in Harlan County Lake they centered on the Green Plum (25HN39) and Blue Stone (25HN45) sites; those in the Lovewell area occurred at the White Rock (14JW1), Warne (14JW2) and Intermill (14JW202) sites (Cummings 1953; Kivett 1947a; Rusco 1960; Neuman 1963; Marshall 1969b). However, ongoing investigations at Lovewell Reservoir have added significant temporal insights and promise to increase our understanding of this complex (Logan and Hedden 1992; Logan 1993; Logan and Banks 1994; Logan 1995a).

Though some traces of two habitation structures were found at the White Rock site, no satisfactory data concerning their architectural form could be obtained. No such information was forthcoming from any of the other five sites of this culture. Consequently, we have no knowledge of this formal characteristic of White Rock. Features such as hearths and storage pits (basin, cylindrical and bell-shaped) are associated with these sites, as is a variety of stone, bone and ceramic artifacts. Chipped stone and bone tools from White Rock sites are indistinguishable from those of Plains Village sites in the same area. Most distinctive of the culture, however, are the ceramics (Rusco 1960; Marshall 1969b). Defined as Walnut Decorated Lip, the ware consists of vessels of the same general shape and form as Plains Village pottery. The pottery is generally tempered with moderate amounts of medium to coarse grained sand, though shell temper is evident in low frequency in some vessels, and is easily distinguished by its paste color (buff, gray or light orange), relative thinness (body thickness ranges from two to eight mm with most sherds falling within the 3-6 mm range), smoothed or simple stamped exterior surfaces, and decorative motifs that consist of trailed or incised lines on the lip, interior of the rim, or shoulder. Appendages such as strap handles occur and are frequently decorated with tool impressions or incised lines.

As defined by Rusco (1960), the White Rock "aspect" included two "foci" (following the McKern Taxonomic System), called Blue Stone and Glen Elder (cf. Kiehl 1953; Cummings 1953; Stephenson 1954). They were distinguished geographically and with respect to their associated site settlement types. Sites of the Blue Stone focus were limited to small hunting camps along the Republican River in south-central Nebraska. Sites of the Glen Elder focus occurred along the Solomon River in Mitchell County, Kansas and White Rock Creek in Jewell County, Kansas. These included larger settlements, suggested to have been base villages with more substantial house structures. Rusco (1960) suggested the two foci might represent seasonally determined settlement types of one population which adopted the Kansas localities as its core area and the Harlan County area as a hunting territory.

Marshall (1969b) reevaluated the data from the six excavated White Rock sites, with particular reference to the Glen Elder site, and found no significant difference between the two foci. He suggested they be reclassified into a single focus, called Glen Elder. Because of the presence of Oneota-like pottery at several of the White Rock sites, Marshall also compared their traits with those of the Utz site, an extensive Oneota occupation in Missouri. Differences between them were sufficient to distinguish the White Rock culture from the more easterly Oneota culture but similar enough to suggest some affiliation. On that basis, he tentatively suggested the White Rock culture represented the western penetration of a Siouan speaking population during the Protohistoric period. He also suggested that the presence of Walnut Decorated Lip ceramics in minor amounts at sites of the Dismal River culture in south-central and southwestern Nebraska and western Kansas also indicated a relationship between White Rock and that ancestral Apache culture, an interpretation critically reviewed below.

Small samples of ceramics noted in private collections from other sites located on tributaries of the lower Republican and upper Blue rivers support an extension of the White Rock culture to this region (Ritterbush and Logan 1991:87-94). For example, lithic (in the form of a high frequency of jaspar) and ceramic evidence from two sites (14CY5 and 14CY462) in the Five Creek drainage, indicates that the White Rock culture area extended eastward in the lower Republican River basin as far as Clay County, Kansas. The presence of several pipestone artifacts from 14CY5 in the Schultz Collection at the University of Kansas Museum of Anthropology, as well others in private collections in that county, supports such an interpretation and also points to Oneota derivation of White Rock. Pipestone pipes have also been recovered from the Glen Elder, White Rock, and Warne sites (Wedel 1959:612; Neuman 1963; Marshall 1969b).

Brown and Simmons (1987:XVIII-22) note that excavations at the Spillway site in the Blue River valley, Pottawatomie County, Kansas "yielded materials similar to the White Rock aspect". However, in his description of this material, Cumming (1958:57) states that the limited assemblage from the Spillway site precludes its cultural identification and that the dozen small sherds in it "are suggestive of but certainly not identical to" White Rock ceramics. He also notes (Cumming 1958:60-61) that the limited artifact sample from the adjacent, and perhaps contemporary, Rainy site "is too small to permit the making of a positive cultural identification" but that the presence of a copper jingle and fragments of copper and iron, as well as shell-tempered pottery may be indicative of an historic Kansa occupation. Consequently, these sites do not provide convincing evidence of White Rock in the lower Blue River valley.

Precise temporal placement of White Rock is problematic. Rusco (1960:43, 71, 75) and Wedel (1986:134-135) suggest a date of ca. A.D. 1500-1600 for the complex based on the Oneota-like nature of its ceramics, the presence in low frequency of shell-tempered "Oneota" pottery, and the relative absence of Euro-American artifacts. Prior to radiocarbon dating of charcoal from pit features at 14JW1 and 14JW24, the only other absolute date for White Rock was a dendrochronologic determination of A.D. 1614 on charred wood samples from the Green Plum site (25HN39) (Weakly 1962). This date was in keeping with the general temporal assignment of the White Rock aspect to the protohistoric period based on relative means, particularly the presence of Oneota ceramic ware at some White Rock sites (Marshall 1969b). However, as radiocarbon dates from western Oneota sites (e.g., Dixon, Leary, Guthrie) indicate, this complex has a broad temporal range, ca. A.D. 900-1700, that spans the late prehistoric and protohistoric periods (Henning 1970:168-170).

Assignment of the complex to the protohistoric period based on the presence of artifacts of Euro-American manufacture is tenuous. Marshall (1969b:91) suggests that such evidence, in part, supports a temporal placement of Lovewell Reservoir sites (White Rock, Warne and Intermill) ca. A.D. 1650-1700. However, only the Intermill site yielded objects of Euro-American manufacture. These were limited to a single tubular copper bead and a few pieces of worked glass, all from shallow, disturbed contexts (Neuman 1963). Recent surface survey of Intermill also resulted in recovery of a fragment of an historic clay pipe (Logan and Hedden 1992:57). The small sample of historic material, its ambiguous context and the proximity of the site to the historic nineteenth century settlement of Ruben (14JW202), which might have been the source of some historic artifacts at Intermill, undermine Marshall's suggested temporal placement.

Five recently obtained radiocarbon dates (Table 33), one from a small pit feature at 14JW24 and four from two pits at 14JW1, now indicate a Late Prehistoric, Plains Village, period origin of the White Rock culture. Such placement requires revision of the relations between White Rock and cultures of the Central Plains tradition, particularly Smoky Hill. A fourteenth to fifteenth century occupation of the lower Republican River basin by the White Rock culture may have been contemporaneous with Smoky Hill in the same region (Logan and Ritterbush 1994). However, to date, there is no evidence from any site of either archaeological culture of direct contact.

At present, it is possible to speculate that the lack of any evidence of contact between White Rock and Central Plains tradition populations suggests the latter had abandoned the area occupied by the former and that radiocarbon dating is too rough a measure to detect the time when one left and the other arrived. It is interesting to note that the area occupied by White Rock is believed to have been one of those not affected by the increased aridity of the Pacific I climatic episode, which has been touted by some (Bryson and Baerris 1968), criticized by others (Blakeslee 1993) as the cause of the migration of CPT populations from their core areas. Indeed, the core area of White Rock corresponds precisely with an area suggested to have experienced increased July rainfall during the Pacific I episode (Blakeslee 1993: Figure 1). The onset of the Pacific coincides roughly with the earlier dates of the White Rock culture. The circumstantial evidence provides the basis for hypothesizing the entrada of an Oneota population from the lower Missouri River region to the geographic niche that may have been forsaken by Smoky Hill and Upper Republican groups during the fourteenth and fifteenth centuries. Another hypothesis posits the displacement of CPT populations from the Lower Republican River valley by expansive Oneota migrants (Logan 1996a).

The terminal date of the complex has yet to be determined. That it may have extended into the protohistoric period is suggested by the presence of Walnut Decorated Lip ceramics at the Burkett site (25NC1), a major Lower Loup occupation near Genoa, Nebraska. Of 41 Lower Loup sites whose ceramic assemblages he examined, Grange (1968:123; Plate 33) notes that only this site yielded such material, which suggests contact between the White Rock and Lower Loup cultures. It is noteworthy that according to Grange's chronological ceramic seriation of Lower Loup pottery, Burkett was occupied during the earliest period of the sequence. A single radiocarbon date of 320±100 B.P.: A.D. 1630 from Burkett was suggested by Grange (1968:129) to be slightly later than the earliest occupation of the site, which he believes dates ca. A.D. 1500-1650.

Contemporaneity of White Rock and Dismal River, a protohistoric Plains Apache culture of the Central Plains, has been inferred by Marshall (1969b:76) based on the association of ceramics of both complexes at some sites in Hooker, Cherry, Lancaster, and Sioux counties, Nebraska (Gunnerson 1960:207-208, 211, 227). However, Gunnerson (1960:239), who dates Dismal River to a 50-year period centered ca. A.D. 1700, suggests the "Glen Elder-White Rock" material predates Dismal River. Both Grange (1968:122) and Wedel (1959:594) have noted that no Lower Loup or Dismal River site has yielded evidence of contact between these two complexes, despite their temporal overlap during the late Lower Loup period. It is difficult to explain any association between White Rock and Dismal River when the former appears to have had only marginal contact with Lower Loup during the early period of that complex.

Thus, the present evidence appears to indicate a temporal span for White Rock from the thirteenth to the sixteenth centuries A.D. (ca. A.D. 1300-1500). Undoubtedly, more radiocarbon dates and ceramic cross-dating will further refine this tentative assignment.

Lower Loup

There is no dispute by archaeologists that the central-Nebraska culture referred to as Lower Loup is the protohistoric expression of the Pawnee, who are grouped with the Kitsai, Wichita, and Arikara as the Northern Caddoan branch of the Caddoan linguistic family (Lesser and Weltfish 1932; Parks 1979; Lesser 1979:60-61). Strong (1935) so interpreted the culture, based on the 1901-1907 explorations by Blackman (1903, 1905, 1907, 1924) and subsequent excavation by the University of Nebraska Archeological Survey in 1931 at the Burkett and Schuyler-Gray sites. Confirmation was provided soon thereafter by Wedel (1936, 1938, 1940) using the same data. More recent perspectives of Lower Loup archaeology have included comparative and seriational analyses of ceramics (Grange 1968, 1974, 1984), interband relationships as reflected in ceramic variability (Grange 1979), lithic analyses focused on procurement strategies (Hudson 1982; Holen 1983a, 1983b, 1991), and comparison of Lower Loup hunting camps with models based on ethnohistoric data of Pawnee hunting practices (Roper 1989, 1992, 1994b). Biometric analyses of Lower Loup skeletal remains have demonstrated their close affinity to the historic Pawnee, evidence of an ancestral relationship also echoed culturally by common mortuary practices (Jantz 1977; Ubelaker and Jantz 1979; O'Shea 1984). Still subject to controversy is the validity of an ancestral connection between this complex and the Central Plains tradition, an idea first tentatively offered by Strong (1935:245-246).

Steinacher et al. (1991) evaluate data which they believe precludes interpretation of any ancestral relationship between CPT cultures and protohistoric Pawnee. Their major points of contention are: (a) a 200-year gap between the CPT and Lower Loup cultures; (b) major archaeological differences between them; (c) no demonstrable biological connection despite intensive analysis of skeletal remains between them; and (d)

Table 33. Radiocarbon Dates from White Rock Sites.

Site/Fea #	Lab #	^{14}C Age	A.D.	Cal. Ageσ1	Reference
14JW1/ 4	Tx-7984	510±40	1440	1407 (1426) 1439	Logan and Banks 1994
14JW1/ 4	Beta-65893	720±70	1230	1261 (1288) 1373	Logan and Banks 1994
14JW24/1	Beta-53612	660±80	1290	1283 (1302) 1400	Logan 1993
14JW1/8	Beta 73924	390±60	1560	1443 (1478) 1631	Logan 1995
14JW1/8	Tx-8193	720±50	1230	1276 (1288) 1300	Logan 1995

1. Stuiver and Pearson 1993; one sigma age range and (intercept)

"irreconcilable discrepancies between archaeological hypotheses and tribal origin accounts," In her review of these data and others for the Smithsonian Institution's Repatriation Office, Roper (1993) points out that it is unnecessary to posit any direct ancestral relationship between cultures within the geographic area of Lower Loup. Therefore, Roper argues that the northward movement of CPT populations to the Middle Missouri River region during the temporal hiatus (the Initial Coalescent period; Lehmer 1971:111-115; cf. Lehmer 1954:147-154), interaction with Siouan populations there and consequent transculturation, subsequent split of protohistoric Pawnee from their Caddoan kin, the Arikara, and return of the former to the Loup River basin as the Loup River culture is sufficient reason to accept an ancestral relation between some CPT groups and the historic Pawnee. The implications of this interpretation for the repatriation of mortuary and sacred artifacts from CPT sites under NAGPRA (Native American Graves Protection and Repatriation Act) are, of course, profound.

Formal characteristics of the Lower Loup culture have been described by Strong (1935), Wedel (1936, 1938b) and Dunlevy (1936). The results of more recent research are reviewed by Roper (1989:25-29, 1993) and O'Shea (1989). Dunlevy's (1936) detailed description of the Burkett and Schuyler-Gray sites, the type sites of the culture, established the Lower Loup focus as an archaeological taxon within the Midwestern Taxonomic System. Within that system, Dunlevy found Lower Loup to be comparable to Oneota and therefore part of the Upper Mississippi phase.

Wedel (1938b) compared Lower Loup, Oneota and Pawnee material culture according to a list of 120 selected traits in what has since been recognized as one of the classic examples of the direct historical approach to archaeological recognition of historic cultures. His conclusion that Lower Loup was closer to Pawnee than Oneota refuted Dunlevy's broader taxonomic assignment of that "focus". Wedel augmented his interpretation with a review of the ethnohistoric record that strengthened the Lower Loup-Pawnee connection.

Though less well known than the subsistence practices of the historic Pawnee, those of the Lower Loup appear to have been comparable to them. Hunting was primarily oriented toward bison with procurement of this game dependent to some extent on communal hunts beyond the village that were probably organized much like those of the later Pawnee (Roper 1989, 1992). Farming of tropical and indigenous cultigens was an important part of an economy that also included the gathering of wild plant foods.

Settlements consist of unfortified villages on terraces and uplands in the Loup and Platte River valleys and along the lower reaches of their tributaries. Houses are comparable to Pawnee in outline and differ from those of Central Plains Tradition cultures. As represented at the type sites, they were circular earth lodges from 11 to 15 m in diameter with eastward oriented entryways and interior support posts arranged around a central hearth. At least one of the houses at Burkett had a bison skull altar on the side of the lodge opposite the entryway (Dunlevy 1936:160). Storage pits may be intra- or extramural and, like those of the Pawnee, are deep, bell-shaped features ranging in depth from six to eight feet.

Lower Loup ceramics are generally represented by globular jars of varying sizes with relatively thin walls, rounded to subconical bases, constricted necks and grit temper. Manufactured by the paddle-and-anvil technique, the vessels exhibit plain or simple-stamped exterior surfaces and incised or trailed decorations in the form of parallel diagonal or opposed parallel diagonal lines, chevrons and herringbone designs. Lips may be decorated with incisions or punctates. Shoulders are flattened, angled but predominantly rounded in form. Appendages include strap handles of varying outlines with flattened rectangular or oval cross sections and, in low frequency, loop handles with round cross sections. On direct or collared vessels, these occur in pairs on opposite sides or as four handles at quadrant points. Braced vessels may have a series of multiple handles in the form of a cloister.

Grange (1968), in a detailed analysis of both Lower Loup and Pawnee wares, established several types distinguished by attributes in rim form (straight and flared, direct; solid and S-shaped collared; braced). Named Lower Loup wares are Nance, Burkett, Wright, Colfax and Webster with Nance Flared Plain being the predominant type. He further established a seriation of both Lower Loup and Pawnee ceramics that remains an essential tool for the relative chronological placement of sites, a function that will be discussed later with regard to the temporal placement of Lower Loup. O'Shea (1989:76), while lauding the seriation, is critical of Grange's classification, calling it "over-precise". He believes the plethora of types recognized by Grange masks broad patterns of ceramic change that may reflect significant social developments in Pawnee history. O'Shea notes three parallel trends in ceramic change through time: (1) increase in the proportion of collared vessels vis-a-vis noncollared forms; (2) increase in the proportion of noncollared vessels with rim decoration; and (3) increase in collar height. All of these trends are in the direction of greater ceramic ornamentation and, as this change corresponds with the process of village aggregation among the Pawnee, they may indicate that the pottery served, in addition to its utilitarian function, as a means of expressing group or subgroup identity during that critical time.

Because of the paucity of useful radiocarbon dates (only three are available for Lower Loup; Roper 1993:11), Grange's (1968) seriation still lacks a temporal datum in real time. More recently, Grange (1984) attempted to fix the seriation calendrically by applying the historical archaeology method of ceramic formula dating. This effort is a revision of an earlier attempt (Grange 1974) that "resulted in considerable variety of initial and terminal dates for Pawnee pottery types" (Grange 1984:278). The revised Pawnee dating system is based on ceramics from the seven most securely dated historic sites. Its utility still requires verification through other absolute dating methods, such as radiocarbon and archeomagnetism. The lack of any reliable absolute dates from Lower Loup sites has thus far prevented determination of the time of origin of the culture. Grange (1984:276) assumes an appearance ca. A.D. 1500. In his most recent statement about the culture, Wedel (1986:153) brackets Lower Loup ca. A.D. 1550-1750. O'Shea (1989) skirts the issue by discussing the question of Pawnee history primarily in terms of ethnohistoric documents. However, he notes a significant change in Plains settlement patterns from the small, scattered hamlets of the Plains Village adaptation ca. A.D. 1000 to 1500 to the large villages, such as those of Lower Loup, after that time. Roper (1993:11-12) conservatively accepts a midseventeenth century date for the appearance of Lower Loup while noting that archaeological evidence neither establishes nor precludes its existence "a century or so earlier."

Lithics from Lower Loup sites are comparable in most respects to those from other Central Plains protohistoric complexes. Unnotched, triangular arrow points, alternately beveled knives and small endscrapers are common finds. Other chipped stone tools include heavy duty bifacial tools, drills, notched flakes, and spokeshaves. Ground stone artifacts include grinding implements, sandstone abraders, pipes, and incised tablets. The relative frequency and variety of stone tools differs between village sites and hunting camps (Roper 1994b). More telling about lithic procurement activities is the relative frequency of stone tools and debris at protohistoric and historic Pawnee sites. Holen (1983b, 1991) has demonstrated that the long distance bison hunting trips of the protohistoric Pawnee from the Burkett and Gray (Schuyler-Gray) sites took them to areas that included key sources of lithic raw materials, Niobrarite (a Cretaceous silicified chalk) and Permian cherts. The high frequencies of these "exotic" materials in the village assemblages reflect purposeful collection and preparation of blanks during the hunt, an example of an "embedded" (after Binford 1979) resource procurement strategy. Hudson (1982) has also shown how the importation of Euro-American metal tools to early Pawnee groups affected their stone-age technology. Chipped stone tools, including points, scrapers and cutting tools, were most rapidly replaced by metal equivalents; ground stone tools were more gradually supplanted, and sometimes actually enhanced as honing instruments for metal tools.

Items of bone and shell in Lower Loup assemblages do not differ from those at other Central Plains protohistoric sites. Scapula hoes and other farming implements of bone and antler are ubiquitous. Bone awls, metapodial fleshers, antler shaft wrenches and cancellous bone paint daubers or hide grainers are also common. Mussel valves were used as paint holders and corn shellers.

Euro-American trade goods occur with differing frequency and variety at both Lower Loup and historic Pawnee sites. Indeed, it was the presence of such items at the Burkett and Schuyler-Gray sites in the absence of any historic documentation of these settlements that led to their recognition as protohistoric (Strong 1935; Dunlevy 1936; Wedel 1936, 1938b). Recent analysis of trade goods at 25HW16, an early Skidi village on the Loup River, has focused on their chronological value, as well as their reflection of cultural changes due to contact (Peterson and Watson 1993; Watson and Holen 1994).

Mortuary practices of both the Lower Loup and historic Pawnee consisted of primary, flexed, single inhumations (Ubelaker and Jantz 1979:256).

Though considerable information is available for this protohistoric culture relative to others discussed herein, much more information can yet be culled from extensive, and as yet unreported, collections from Lower Loup and Pawnee sites. In summing the results of a symposium concerning the problem of Caddoan origins, Wedel (1979a) stressed that the question of cultural ancestry of the Pawnee remained unresolved, a status that has not since changed. Extensive investigation of the relationship between the late prehistoric and protohistoric Caddoan populations of the Lower Loup and Middle Missouri (Big Bend) rivers is still required for such resolution. O'Shea (1989:81-83) notes the general culture historical orientation of Pawnee archaeological investigations, as well as more recent studies of a more technological or processual nature (e.g., Grange 1979; Holen 1983b; Hudson 1982). He also points out the urgency of documenting collections long ago obtained that have languished without analysis and that, with proper study, might yet provide valuable insight to processes of culture change among the Pawnee.

Redbird

Little information about the Redbird "focus" has been gained since it was first defined by Wood (1956a; 1956b, 1965) on the basis of data from four excavated sites near the mouth of the Niobrara River in northeastern Nebraska. These sites, all small villages, and unexcavated campsites on the lower Niobrara and middle Elkhorn rivers, the latter a short distance south and east of the excavated sites, were attributed by Wood to the protohistoric Ponca, a Dhegiha-speaking (Siouan) group related to the Omaha. The summary here is based primarily on Wood (1965), which was the final revised version of a series of works on this culture, the first of which was his Master's thesis (Wood 1956a; cf. Wood 1956b, 1957, 1959). Others who discuss this complex are Garrett (1964), who describes excavations at 25KX9, one of the sites analyzed by Wood (1965), and Ludwickson et al. (1987:174-178), who rely heavily on Wood (1956a, 1965) and replace the Midwestern Taxonomic System "focus" taxon with the Willey and Phillips term "phase".

The Redbird culture was initially perceived as intermediate developmentally between Lower Loup and the La Roche focus of the Choteau aspect of central and southeastern South Dakota, an inference that made the Redbird people members of the Northern Caddoan-speaking linguistic stock (Wood 1956a). However, later evaluation of the data led Wood (1965) to identify the archaeological complex with the Ponca of A.D. 1600-1700.

Ceramics dominant at sites of the Redbird focus are Evans and Mackay wares, which are diagnostic of the complex and distinctly different from Stanley Braced Rim. Small percentages of Oneota pottery are also characteristic of Redbird ceramic assemblages and these are compatible with the identification of the complex as Siouan. It is noteworthy that an historic site, Nanza Fort, documented by written records as having been a Ponca settlement and occupied from A.D. 1790-1800, was characterized by an archaeological record that included ceramics dominated by Stanley Braced Rim ware, generally associated with the Arikara, a Caddoan group closely affiliated with the Pawnee (Wood 1965:123-124; 1993:112-114). Though the pottery from Ná^nza Fort could have been made by Arikara women who married into the Ponca occupying Ná^na Fort, the absence of Evans and Mackay wares indicates the Ponca had lost or abandoned the production of their own particular 'brand' of ceramics. The example of Ná ˆ "za Fort provides a cautionary tale about too closely identifying the linguistic affiliation of an archaeological complex based on ceramics.

Redbird houses, based on the sample of 10 described by Wood (1965), were circular to slightly oval earth lodges with central hearths, extended entryways generally oriented eastward, and unprepared earthen floors from 8.5 to 19 m in diameter that offered between 57 and 280 m^2 of living space. They were situated on stream terraces or low bluffs and lack any evidence of fortification. That the Redbird economy had a horticultural component is indicated by the numerous scapula hoes recovered from nearly all sites. Bison were the most frequently hunted animals, though a variety of prairie-woodland edge game were also taken.

Chipped stone tools were made from a variety of raw materials, including Niobrarite, Bijou Hills and other quartzites, chalcedony and "variously colored" cherts (Wood 1965:103). The usual variety of lithics characteristic of Plains Village and protohistoric cultures of the Great Plains are represented, including triangular, generally unnotched, arrowpoints, endscrapers, expanding base drills, knives of various types including alternately beveled forms, and choppers. Ground stone tools include grooved mauls, pebble and discoidal hammerstones, mullers, manos, pitted stone anvils, grooved axes, celts, and abraders.

Modified bone tools include the aforementioned scapula hoes, and other items made from bison elements including horn core scoops, ulna picks, squash knives, rib arrowshaft wrenches, cancellous tissue abraders, and scored ribs. Serrated fleshers made from split elk metapodials and various split bone awls were also produced. Deer antlers were modified into cylinders, tine flaking tools, and scraper hafts. Mussel shells were shaped into pendants and hemispherical pieces (Wood 1965:103-109).

Euro-American trade goods, some of which were useful for dating the Redbird focus, are represented by small numbers of identifiable goods including a mattock, arrowpoint, tube, bangles (n=22) and glass beads (n=16) (Wood 1965:109-110).

Mortuary practices are poorly known. Only two burials, both of adult women, were found at 25KX9. One was a primary interment in a straight-sided, oval pit just beyond the wall of a lodge. The other was a primary extended burial in a pit within a lodge. Both burials included a few grave goods, such as an elk antler scraper handle, glass beads, brass bangles, and shaped mollusc shells. Craniometric analyses have supported a close relationship between these Redbird individuals and the historic Omaha and Ponca (Jantz 1974).

It is unfortunate that no further work has been done on Redbird sites or with data from those previously excavated. Wood (1965) was quite clear about the problems of tribal identification of Redbird and the fact that they remain unresolved. The archaeological comparability of the Redbird focus with La Roche can be explained by the migration of the Ponca from the mouth of the Missouri River via the Big Sioux River area north of present-day Sioux City, Iowa to the mouth of the White River in south-central South Dakota, where they could easily have adopted traits from Caddoan populations there resident. Unfortunately, the historically documented dates of this migration, ca. 1670-1715, are inconsistent with those which place the Ponca at the Redbird sites near the mouth of the Niobrara at the same time. As Wood (1965:127-130) points out, either the dates of the archaeological complex or those derived from ethnohistorical data must be clarified to validate a Ponca identification of Redbird.

Dismal River

Dismal River is recognized as a protohistoric manifestation ancestral to the Plains Apache. Sites of this complex can be readily distinguished by certain traits, including a simple but distinctive pottery called Lovitt Plain and Lovitt Simple Stamped (which may actually be a single ware arbitrarily distinguished on sherds from the same vessel that exhibit different surface treatments). Other hallmarks are roasting or baking pits with bell-shaped cross sections, fired walls and often with burned-rock covered floors; tubular ceramic pipes sometimes referred to as "cloud blowers" that are reminiscent of Southwestern pipes; double bitted drills; house structures with five-post base patterns; absence of storage pits; and presence of trash-filled borrow pits (Gunnerson 1960, 1968, 1987; Wedel 1986:135-151).

Dismal River sites appear in a variety of topographic settings from the Black Hills in South Dakota through the western half of Nebraska and Kansas, eastern Colorado and the Oklahoma Panhandle. All village sites occur in the eastern portion of this range where rainfall conditions permitted more sedentism among these corn growing peoples. The western sites appear as small, more temporarily occupied camps. At least one site, the famous "El Cuartelejo" or Kansas Pueblo in Scott County, has ruins of a seven-room stone habitation (sometimes attributed to refugee Puebloans from Taos or Picuris) and remains of irrigation ditches (Gunnerson 1960, 1968, 1987:102-106). Trade with Southwestern groups is evidenced at some sites by such exotic items as Puebloan potsherds of a type called Ocate Micaceous or painted types such as Tewa Red-on-Buff; obsidian and turquoise from New Mexico, Olivella shell beads and a few Pueblo style shaft straighteners (Gunnerson 1987:105). Contact with Euro-Americans is limited to an iron ax found in a hearth at White Cat Village in south-central Nebraska, which Gunnerson (1987:105) suggests may have been left by a Pawnee raiding party, and two gunflints from that site. Other sites have yielded a few scraps of metal and such artifacts as jinglers and awls.

The Dismal River culture has been dated by dendrochronology and cross-dating of Puebloan pottery to a relatively brief period ca. A.D. 1675-1725. D. Gunnerson (1974) has demonstrated that many of the Dismal River people merged with the Jicarilla Apache to become the Llanero Band about A.D. 1730. Others may have joined the Lipan. Gunnerson and Gunnerson (1971) have suggested that the Northern Dismal River people may have become the Kiowa Apache. The disappearance of Dismal River in the late 1720s has been attributed to pressure from other Plains groups, such as the Pawnee and Comanche (D. Gunnerson 1974; Gunnerson 1987).

8 Historical Archeology in the Central Plains, by William B. Lees

The intellectual foundation for historical archeology in the Great Plains was established with the emergence of the direct historical approach during the 1930s (Lees 1985; cf. Strong 1940, Wedel 1938a). A deductive, problem-oriented method that developed out of anthropology, the direct historical approach offered historical archeology a trajectory somewhat different than found elsewhere at the same time where the field was more closely allied with history than with anthropology.

The onset of a major archeological emergency following World War II (the reservoir salvage) upset this trajectory by overwhelming an emergent professional community on the Plains. The efforts of a handful of archeologists was spread increasingly thin as a result. Historians began to call the shots in terms of historical archeology, and deductive anthropology was replaced by inductive research that served in some cases only to illustrate history; in many cases historical archeology became the proverbial "handmaiden to history." The end of the interagency salvage work in 1969 found Plains historical archeology floundering at a time when the "new archeology" was gaining momentum. Lacking a convincing theoretical orientation, the Plains continued to languish as historical archeology grew and matured elsewhere.

Historical archeology has matured as a discipline within North American anthropology and, on the Plains, it is enjoying a renaissance of sorts. These developments are positive and the many individuals, both on the Plains and elsewhere, who have helped them come about are to be commended. There are nonetheless problems that cast a pall over the future of historical archeology in our area and that ultimately relate to the development and consumption of theory. These problems relate to academic and professional structure that grew out of the historical setting briefly reviewed above, but also relate to a fierce competition for cultural resources from development and recreational interests. The approach to our future must be both efficient and dynamic and must be based on a healthy theoretical arsenal that will allow the best use of a resource base that is at risk and with professional resources that are at best limited.

Resources at Risk

Well over twenty years ago, in 1972, Charles McGimsey challenged the profession when he wrote that:

> The next fifty years — some would say twenty-five — are going to be the most critical in the history of American archeology. What is recovered, what is preserved, and how these goals are accomplished during this period will largely determine *for all time* the knowledge available to subsequent generations of Americans concerning their heritage from the past. (McGimsey 1972:3)

Although it may not be happening as rapidly as McGimsey predicted, that we are suffering rapid site denigration and loss is not at issue. At the same time, a focus on specialized studies in the last several decades has increased our ability to learn from a shrinking resource base. Further, the presence of deeply buried and supposedly well preserved resources have been documented throughout the Plains in potentially impressive numbers. These developments temper but do not erase McGimsey's prediction for the future of our resource base, at least for those resources from the prehistoric past. It is with less confidence that they apply to the bulk of the historic resource base.

McGimsey's concern developed out of observations on sites visible on the surface; those that are easily impacted by agriculture and development projects. Most historic sites are of this type and as a whole are being rapidly lost through these processes; but this is nothing new. What is disturbing, however, is a growing threat to historic sites from hundreds of serious hobby collectors armed with sophisticated research skills, high-tech metal detection equipment, and perseverance. These individuals are identifying site locations through archival and informant research, are finding the sites through exhaustive survey work, and are systematically mining sites of their artifacts. Sites that are targeted by these individuals are diverse in range, but include military sites, contact period and later Native American village and farmstead sites, missions and agencies, Santa Fe and Oregon trail campsites, etc. We are competing fiercely for these sites, and we are loosing.

This is not a revelation and is not meant to condemn the metal detector hobbyist. Rather, we need to rethink our conservation ethic that sees archeological research as an adverse impact to be avoided in favor of putting sites in the "bank" for future research. We need to work with hobbyists and convince them of the importance of segregated, cataloged collections, of the importance of spatial information, and of the importance of sites in general. Further, if we can provide regular opportunities to be involved in controlled research we may develop a group of hobbyists satisfied to channel their efforts towards science. We have done this with amateur archeologists with great success, but have yet to reach the different audience represented by those using metal detectors. We need to build coalitions between archeologists and hobbyists so that we may benefit from their research and use their technical skills to our advantage. Finally, we can no longer fool ourselves into thinking that by avoiding sites we are saving them for our future. There is no historic site that is not threatened and, except for a few instances, there is no "bank" of historic sites. Excavated sites should be selected for their research value and all research should be conceived as salvage.

The Right Questions

Viewing research as salvage does not mean that it should involve atheoretical warehousing of collections. To the contrary, salvage requires efficiency and efficiency in archeology requires a theoretical perspective that is sophisticated and to the point. In conceiving of research we must be able to ask the questions that will allow us to respond to others who may ask: what did this research tell us that we did not already know and that we wanted to know. We must focus on sites and questions that will *profoundly* expand our knowledge of the past.

In discussing research, it is important to recognize that most is being conducted within a compliance or CRM framework and that a relatively small percentage occurs outside this realm. In compliance settings, research is related to the National Register of Historic Places. A body of theory, which I will call "significance theory," has developed that seeks to relate research to the concept of eligibility for listing a site on the register; a site that is eligible is significant. Current views hold that the concept of significance is a relational or relative concept and that significance is not inherent in sites. Site significance is thus determined by its relation to something else, and in most cases this is supposed to be context statements presented in state plan documents. This succeeds, however, only when these contexts codify problem domains or research questions that are of legitimate interest and firmly founded on current theoretical formulations. It is clear from many significance justifications and data recovery plans that we are often on very shaky ground in this area.

There can be no doubt that compliance research is vital to Plains archeology in that it offers our major funding opportunity. Sites so excavated may not be the first to come to mind in terms of research need, but are nonetheless of long-term importance in developing a broad, comparative data base that is currently lacking in most areas and for most periods of history. Here, we must recognize that many of the most vital questions posed by archeologists have resulted from inductive observations made from a comparative data set.

Research conducted outside of a compliance setting, on the other hand, has the potential to provide leadership in developing programs to identify and address important research questions. By being able to broadly consider the resource base, research in this area can target sites based on their potential to profoundly expand knowledge in a way that compliance archeology may never be able to. It is here that we have the potential and the responsibility to firmly engage anthropological research and to seek results of the widest merit and application.

I stress again that we must focus on sites that will *significantly expand knowledge*. I have already mentioned the crisis of site preservation and will next review the limited resources that we have to work with. Detailed investigations of sites outside the CRM setting is a luxury that must be approached with the utmost wisdom and forward thinking.

Focus on Infrastructure

It is a fact that the Great Plains lags behind most other regions of the U.S. in terms of the number of practicing professionals and in the strength of academic programs in archeology. Given the challenges facing Plains archeology in general, then, none of us are in the best of worlds. But when we look at historical archeology the problem is magnified to such a degree that it is a wonder that anything happens at all. There is a very clear crisis in infrastructure that perpetuates the post World War II crisis in historical archeology on the Plains and that fails to recognize historical archeology as an anthropological pursuit.

Nonetheless, historical archeology in our region is increasingly required in compliance and interpretive settings. This development is the result of a growing and appropriate inclusion of historic sites of all periods under the compliance umbrella and an increased recognition of the interpretive potential of archeological research. This, however, is generally a development emanating from outside the Plains and has caught many Plains states off-guard because of their lack of trained historical archeology professionals; this has created a setting not unlike that of the reservoir salvage period. The result is an increasing number of cross-over professionals, many of whom are doing admirable jobs but most of whom have no background in historical archeology including the theoretical base that identifies it as patently anthropological in orientation.

It is important, however, to look at our academic infrastructure in light of this development. There is a growing interest and need for historical archeology on the Plains and elsewhere and, further, some expertise in historical archeology is recognized as a need for any professional working in agency or private sector compliance settings as well as those involved in research, museum interpretation, and teaching. Most academic programs, however, pretend this is not so and continue to graduate professionals as if the world belonged to the specialist and where the specialist is never a historical archeologist. The general lack of faculty and academic programming in historical archeology poses several serious problems for the Plains.

The first problem concerns the somewhat insular development of professionals and research. The lack of professionals serving as mentors presents an obvious problem for those seeking to specialize in historic sites and gives a signal of the non-importance of that area for those who could benefit from some exposure. A related problem is the lack of sufficiently trained professionals to handle the work currently available. Attractive projects are very often done, because of the lack of other options, by individuals with no background and who go into the project with an incredible handicap and with a very limited theoretical orientation.

Another problem is the lack of faculty to pursue directed research programs in historical archeology through their own work and through thesis and dissertation work of their students. There can be no doubt of the importance of such research on the development of theoretical approaches to specific regions or problems. While there is no necessary reason that this has to be accomplished in an academic setting, leadership for such a program is perhaps best vested there.

I am not suggesting that every academic program on the Plains go out and hire an historical archeologist, but that on the Plains we do need to provide increased opportunity for such training, where that training is anthropological, and where directed research programs can flourish. I would add that universities are missing the boat in terms of capitalizing on student interest, grant funding, and ability to build an anthropological bridge between other departments in terms of research and teaching opportunities.

Theory and the Future

The potential of the Great Plains to contribute to anthropological theory and to the anthropological knowledge of the historic period should be apparent. Over and over again, however, this very tenet is being questioned by those who do not understand that we are not seeking a redundant history of things trivial or things already known. Given some of the problems I have outlined, however, this questioning is not surprising because we have very little to point to that is different from this stereotype. Plains historical archeology very clearly needs to break out of this stereotype and reconnect with the pursuit of anthropological knowledge. There are some very compelling reasons to do so:

First, the Great Plains contains many, many historically disenfranchised groups—those groups for which archeology is the primary or only source of historical and anthropological information. A concerted research focus on African-American slave life in the Southeast and Caribbean has resulted in a geometrically expanding body of knowledge that has not only written a culture history previously lacking but has provided the data for addressing questions of general anthropological interest. We have the same potential on the Plains and I believe we must increasingly identify and target similarly disenfranchised groups and build an anthropological history that will not exist otherwise.

From my own interest, the Native American groups that were resettled to Kansas in the 1830s from the Great Lakes region present a perfect example. Known primarily from scattered missionary and traveler accounts, the farmsteads and villages occupied by these people prior to the Civil War hold data that can write an anthropological history of their lives that can be reconstructed in no other way. To me this has profound value. This value is increased dramatically when a comparative approach is taken between the Shawnee and Ottawa, for example, and between Ottawa life prior to and after removal to Kansas.

Second, the Great Plains offers some of the most profound situations of cultural diversity and change to be found anywhere in North America and particularly during the nineteenth century. The comparative, anthropological laboratory offered in the Great Plains is an incredible resource and offers unique potential to evaluate and expand theories of consumerism, acculturation, and ethnicity—to name a few examples—against the patently multicultural and rapidly changing fabric of the nineteenth century Great Plains.

If historical archeology is to improve its contribution to the anthropological history of the Great Plains, it must fully engage an anthropological approach and current theoretical discussions. We appear caught in a circular trap, however, because this may not happen without change in infrastructural commitment to historical archeology which may, in turn, not come about because of the current lack of a truly anthropological approach in Plains historical archeology. But while this circle remains in place, the resource base continues to degrade, good research opportunities are lost, and the true contribution of the Great Plains to the anthropology of the historical period continues to languish. To be sure, significant contributions will continue to emerge from the Plains, just as they are now. But if we choose to consciously reintegrate historical archeology into the framework of Plains anthropology, the breadth and vitality of these contributions to the substantive and theoretical knowledge of the historic past will certainly blossom.

Adaptation Types

The discussion of adaptation types becomes difficult after the transition into the historic period because of the cultural and economic diversity and the rapidity of change that characterizes this period. Further, not only is change rapid, but it is uneven across the study area. Where broad adaptation types, possibly tied to differing environments, may have characterized this period in prehistory, and while these may have changed in lock-step as time progressed, this is no longer the case after the Spanish entrada of the sixteenth century. In the following centuries, there is significant change in the makeup and nature of the Native American settlement of the study area, and a growing influx of those descended from Europe, Africa, and Asia. And when we arrive in the nineteenth century and the period of territory and statehood formation, the study area is divided into three political units, Colorado, Nebraska, and Kansas, that have differing trajectories of development.

Adaptation types as intended in this study are a construct that, if properly developed, should allow us to understand the archeological record. Because of the variables outlined very briefly above, the concept of adaptation types that is used in the following is one that is derived out of the archeological record or, where the record has yet to be exposed, the expected archeological record. By reviewing the archeological resources that have been documented in the study area, significant groupings of sites are developed using a combination of cultural, topical, and functional criteria. A culture-chronological framework simply does not work unless it is done with subregions. While this is feasible, more desirable is the ability to discuss research and research needs from the perspective of the entire study area and, in some cases, from beyond.

The adaptation types for this study unit, and brief descriptions of their intent, are:

Indigenous Native Americans. At the time of European contact, a variety of Native American peoples are known to have inhabited the study area. These groups, regardless of their longevity in this area prior to this contact, are referred to as the indigenous Native Americans. They remained an important population for the study area for much of the historic period, although most were removed to other lands during the nineteenth century.

Resettled Native Americans. During the nineteenth century, reduced lands were negotiated for many of the indigenous groups in the study area, and many were eventually removed entirely to other areas, generally to what is now Oklahoma. Into this setting, although primarily in eastern Kansas, were interjected numerous Native American groups who had agreed to exchange their lands in the northeast for reserves in the study area.

Transportation. Transportation is a major theme in the nineteenth and twentieth centuries in the study area, but was important earlier as well. The river trade on the Missouri River and tributaries was critical in the history of the area, and affected all peoples. Likewise, major trails such as the Oregon and Smoky Hill trails had profound impacts on the development of the region, as did the development of a network of railroads starting in the mid-nineteenth century. Finally, the development of systems of rural roads and highways has left a probably indelible imprint on the countryside.

Military. Although military sites cannot be understood without reference to many other factors, they represent a peculiar adaptation type that can stand alone. Military sites include forts, campsites, and battlefields.

Rural Settlement. Most Native American and military settlement is rural, and most transportation systems are rural. Here, however, we look at the settlement that came to characterize the study area during the nineteenth century and which brought scores of European-American, African-American, and Asian-American emigrants from the east to the study area in pursuit of agricultural livelihoods.

Urban Settlement. Urban settlement developed hand in hand with the rural settlement introduced above and cannot be understood otherwise. Nonetheless, urban settlement represents a different adaptation type than does rural settlement and deserves separate consideration.

Industrial. Sometimes rural and sometimes urban, industrial settlement was important in the nineteenth and twentieth centuries in the study area. It, like the urban settlement, is distinct in terms of adaptation and is thus treated separately.

None of these adaptation types can or should be considered as mutually exclusive categories. The cultural setting of the area was dynamic, ever changing, and interactive over the course of the last several centuries. Each of these adaptation types could be found during most of this period, and together they form a cultural network that defined the workings of the region. Once again, the goal here is not a culture-historical scheme, but one that can be used to order and discuss archeological resources, and to order and discuss archeological problems.

In the following narrative, each of these adaptation types is reviewed in more detail. First, a review of some of the key examples of investigated sites is presented. This is intended to provide the reader with an example of excavations at sites assigned to a particular adaptation type. No attempt has been made to review all of the pertinent excavated sites. This review is followed by a discussion of the nature of any gaps in the data on this adaptation type, and with a discussion of appropriate research goals and problem domains. In all cases, it should be assumed that data gaps do exist, and that these are substantial. In no case has sufficient archeological research been conducted so as to exhaust the need for additional investigations. Also, the research goals and problem domains that are presented are examples rather than prescriptions, and are not intended to be comprehensive. The range of possible research goals and problem domains that can be discussed is broad and will vary based on individual scholar, the particular site, and the project that causes research to be undertaken. Knowing the literature, the research deficiencies, and devising realistic and useful research problems is a professional responsibility of the individual archeologist.

Indigenous Native Americans

Substantial work on sites occupied by Native Americans indigenous to the study area has been conducted. These sites range from protohistoric to those dating relatively late in the historic period, and consist of village sites. Because these sites have been of interest to prehistorians, sites of this adaptation type have received more attention than other types, and thus this type is best known of any adaptation type reviewed in this section.

Sites related to indigenous Native Americans were among the first to receive serious attention by Plains archeologists. Notable here is the pioneering work of Waldo Wedel of the Smithsonian Institution on the Pawnee sites in Nebraska in the 1930s. These sites were excavated to solve a problem involving the relationship of prehistoric cultures of the region to the historically known groups such as the Pawnee. His excavations and subsequent analysis stands today as a key example of the application of the direct historical approach (Wedel 1936).

Most sites of this type in this region have been excavated, however, to allow cultural-historical reconstructions. The Scott County Pueblo in western Kansas, where excavations began with the work of S. W. Williston and H. T. Martin of the University of Kansas in 1897 and 1898, is a good example of this approach. Subsequent work by Wedel in 1939, by James Gunnerson of Northern Illinois University in 1965, and by the Kansas State Historical Society in 1970, 1975, and 1976 all focused on understanding the lifeways of this site's inhabitants, of determining its historical placement, and determining the identity of the builders/occupants.

Besides the excavations of Pawnee sites in Nebraska in the 1930s, certainly the most massive excavations within the study area—of any adaptation type—have been the excavations conducted on proto-Wichita sites in Kansas. The first scientific excavations on these sites was conducted by Wedel in 1940 at the Tobias site in Rice County, Kansas. On the surface, the site is characterized by about 19 low mounds and, beneath the surface, by innumerable cache pits and other features. Wedel's 1940 investigations at this site focused on the excavation of 12 cache pits and the testing of three mounds. One of these mounds was actually a complex made up of a large, low mound and surrounding depressions known locally as the "council circle." Wedel's work resulted in the conclusion that most of the low mounds were refuse rather than house mounds, but that the mounds and depressions making up the council circle represented the remains of semisubterranean pit-structures. Wedel spent several other seasons at Tobias as did the Kansas State Historical Society which now owns this site (Wedel 1959).

In addition to Tobias, Wedel and the Kansas State Historical Society have investigated a number of other Wichita sites in Rice County, as well as sites in Marion and Cowley counties in Kansas. Sites in all three areas show similarities, yet there are noted differences. All show some evidence of contact with Europeans although this evidence is strongest in the Rice County sites (Wedel 1959).

In 1939, 1940, and 1941, the site of the Big Village of the Omahas was excavated by John Champe and Paul Cooper using WPA crews. This was one of many WPA projects that received little attention in the archeology of the region because of the lack of a report, until recently, of the findings. This Big Village of the Omaha was occupied between 1775 and 1845 and represents a key site for this adaptation type within the study area. Five earth lodges, six exterior bell-shaped storage pits, and deposits of village refuse were excavated at this site. In addition, excavations at two cemetery sites adjacent to the village were conducted. The material culture from this site shows a rich complement of trade goods which reflect the prominent role of the village in the Missouri River trade of this period (O'Shea and Ludwickson 1992a).

Future Research Needs

A substantial amount of research has been conducted into the indigenous Native American sites of the study area of which the above review provides but a sample. Some notable gaps in data exist, however, such as the lack of substantial excavation of contact or early historic Kansa sites. A more pressing gap exists in the lack of reports on many of the excavations described above. Until these are available it will be difficult to conduct meaningful synthetic work on the problems to which these sites may contribute.

Research in this area needs to continue to grapple with the question of the prehistoric origins of these groups. This cannot be done, however, without working hand in hand with the prehistoric record of this and perhaps other regions (cf. Lightfoot 1995). As to the contact and early historic sites represented, work needs also to continue on the identification of the specific historic identities of the occupants of the sites, and of their relationships to other groups and to the natural resources they relied upon. What is the meaning of the three large clusters of proto-Wichita sites, for example, in chronological and cultural terms? The massive amount of material out of the ground makes it almost unconscionable that we do not have answers to basic questions such as these about the proto-Wichita.

Another need centers around the protohistoric occupation of the western part of the study area, on the high plains. In particular, some controversy exists on the nature of the use of this area during this period, and the to identity of those responsible for certain complexes, and in particular the Dismal River complex. Relationships between the Dismal River and other contemporary complexes to protohistoric complexes to the east, such as Pawnee and Wichita, needs to be fully explored.

Resettled Native Americans

The Native American groups that were resettled to the study area during the early nineteenth century, and in particular to eastern Kansas, have received relatively little archeological attention. This lack of attention runs contrary to the significance of this settlement for the history of the study area and the fact that there is a great lack of information about certain aspects of this settlement. The data gaps that are present here are similar in structure to those that are found among other historically disenfranchised groups such as AfricanAmerican slaves (cf. Ferguson 1992). The potential of archeology to contribute to the understanding of this adaptation type is therefore substantial.

Illustrative of this is the lack of information on the settlement pattern of these groups. The location of missions and other prominent sites (prominent from a Euro-American perspective) are all that are recorded for most of the reserves. In the former Pottawatomie reserve near Topeka, Kansas, a collector has located a series of apparent farmstead sites along a small drainage. This settlement pattern, and information for individual sites, comment on an aspect of the history of the study area that is not recorded and the proper study of which will yield significant historical and anthropological information.

Three examples are illustrative of the few excavations that have been conducted on this adaptation type. In 1968 the Great Plains Archeological Field School (University of Kansas, Kansas State University, Wichita State University) excavated three historic period burials dating to the 1840 to 1860 period. A range of artifacts was found on the site, including an iron tankard, flintlock pistol barrel, strike-a-light, pocket knife, brass pendant, brass bells, and a variety of glass beads. Analysis suggested a possible Sac affiliation (Scott 1976).

Site 14SH315, a domestic trash pit dating to the midnineteenth century, was excavated in 1969 by the Kansas State Historical Society because of its location in the now cancelled Grove Reservoir. Artifacts and other remains were found within a filled depression and are interpreted to be discard items that were intentionally placed in the depression. Evidence of nearby domestic structures was lacking but it is suspected that they were located on the uplands to the east of the site (Reynolds 1987a:97).

The artifacts recovered from the site revealed an interesting blend of both Native and Euro-American items. Some of these items, like the iron arrowpoint, were either made by Native Americans or were specifically manufactured for trade with them. The other historic artifacts found at the site are of common utilitarian origin and are items used widely by both Native Americans and Euro-Americans during the nineteenth century. The trash deposition event at 14SH315 is tentatively dated to the period from 1847 to 1875, with the actual date probably falling before the Civil War, and a Pottawatomi cultural affiliation is suspected (Reynolds 1987a:98).

In 1985 the Kansas State Historical Society and the Kansas Anthropological Association undertook excavations at the site of Jotham Meeker's farmstead at the Ottawa Baptist Mission in Franklin County, Kansas. This site was occupied between 1845 and 1856 by Meeker and until about 1860 by others. Meeker served as a missionary to the Ottawa who had been relocated to Kansas from Ohio in 1836. Meeker is well known in Kansas history for establishing the first printing operation in Kansas at the Shawnee Baptist Mission in 1834. In 1837 he established a mission among the Ottawa, but this was destroyed by the devastating flood of 1844. In 1845 he relocated the Ottawa Baptist Mission to higher ground at the site investigated in 1985. Meeker moved his printing operation from the Shawnee Baptist Mission to this second Ottawa Mission in 1849 (Lees 1986).

Excavations focused on two areas: the site of Meeker's dwelling and the site of his printing office. The site of the dwelling was visible on the surface as a large depression flanked by two low mounds of limestone rubble. Excavations at the site of the dwelling resulted in the discovery of a cellar, six foundation piers, and two fireplace foundations. Based on these features and historical documents, this building was interpreted as an L-shaped structure formed by a kitchen attached to the back of a rectangular building. No definite architectural remains were discovered at the site of the printing office. Verification that the area investigated was associated with the printing office came, however, through the discovery of a number of pieces of lead alloy printer's type and through the demonstration that there were other differences in the distribution of artifacts between this area and the location of the dwelling (Lees 1986).

Future Research

There are substantial gaps in the data related to this adaptation type. This conclusion is commanded by the basic paucity of excavated sites associated with this type. Also important is the fact that many of the site types associated with the resettled Native American are poorly recorded historically. The dwelling sites, small industrial sites, and many aspects of life and activity on mission and other non-Native American sites are not recorded or are poorly recorded.

A focus on the identification of the full range of site types associated with this adaptation type is needed. The investigation by excavation of a sample of site types is necessary to produce the data to begin examination of research questions and to construct general interpretations of poorly recorded aspects of life of these Native Americans and other disenfranchised individuals in their midst. Comparative analysis between sites in Kansas and sites in the areas from which these groups were removed also has potential for defining differences or similarities in adaptive approaches taken by the same cultures in different areas.

Transportation

It is somewhat surprising, perhaps, that a wide range of transportation-related sites have been investigated within the study area. Transportation sites include the actual routes of travel, improvements such as bridges, sites providing direct service to transportation, and vehicles of transportation.

Actual roads that have been investigated include work on documenting the Fort Zarah Road (and associated ford and bridge sites) in Kansas. Although not an excavation project, documentation of these transportation features is fundamental to an understanding of the historic use of the study area. Related to the operation of a road was the Mahaffie Farmstead located along the Santa Fe Trail in eastern Kansas. Portions of this site were excavated in 1986 to better reveal the nature of this place at the time of its use as a stop along the Santa Fe Trail. Similarly, the Hollenberg Pony Express Station in Kansas was excavated to provide evidence of the use and appearance of this site during its brief use by the Pony Express. A similar goal guided the excavations of the Rock Creek Station in Nebraska.

Excavations of the Steamboat *Bertrand* in a former channel of the Missouri River in Nebraska and the *Great White Arabia* in Kansas provide striking evidence of river transportation in the study region (Hawley 1995; Petsche 1974). The Missouri River was a major transportation route of the Central and Northern Great Plains during the nineteenth century and before. Both boats sank fully loaded on their way upstream, the *Arabia* in 1856 and the *Bertrand* in 1865. Much of their cargo and the ships themselves were well preserved due to their waterlogged state, and much of the collections are preserved in museums, operated by the federal government in the case of the *Bertrand* ,and privately in the case of the *Arabia*. These boats and their cargoes provide important time-capsule views of trade and commerce on the Missouri River, material culture available on the Plains, transportation technology, and changes in these variables as reflected in the 10 years that separate their sinking.

Future Research

A great amount of very good archeological information exists on transportation-related sites in the study area. The collections from the *Arabia* and *Bertrand* are an incredible yet untapped resource for the study of the midnineteenth century in this area. Considering the fundamental role of transportation for the historic period utilization of the project area, however, more research is needed to identify and document the types of construction used in the transportation systems, and the nature and form of sites directly servicing transportation routes. Notably lacking in the discussion of transportation-related sites are sites related to railroads. An area of great importance here is the process of railroad construction, and in particular the temporary railroad camps associated with the construction of the network of railroads in the region.

Military

Military sites include forts, campsites, and battlefields. Military sites, and in particular forts, have traditionally received a substantial amount of interest from archeologists. This is due partly to the importance of these sites in the history of an area, and also partly to the fact that forts have been the focus of efforts of restoration and interpretation for many years. Battlefields and campsites were for many years believed to be unaccessible using traditional archeological techniques but have recently become the focus of new interest using metal detector surveys.

The first military site to receive extensive excavation within the study area is the site of Fort Atkinson in Washington County, Nebraska. Fort Atkinson was occupied between 1820 and 1827 and was located on the Missouri River. Excavations were conducted at this site by the Nebraska State Historical Society for six seasons between 1956 and 1971. Work at this site was focused on recovering information needed to interpret and reconstruct this site. The multiple seasons of excavations resulted in the investigation of a broad range of buildings and other features at the site and the post cemetery, and the recovery of a substantial collection of tightly dated artifacts (Carlson 1979).

Similarly, excavations at Fort Scott, Kansas, were conducted to assist in the reconstruction of this site by the National Park Service. Fort Scott was a short-lived (1842 to 1853) U.S. military outpost that was established along the Western military frontier in what is now Bourbon County in southeastern Kansas. During the period from 1968 to 1972, the Kansas State Historical Society conducted archeological investigations of 20 fort-related structures within the area of the original Fort Scott (Reynolds 1987b).

These investigations also resulted in the collection of more than 36,000 items of material culture which include such varied artifacts as objects of metal, leather, glass, ceramics, paper, bone, rubber, plastic, wood, cloth, shell, brick, mortar, coal, plaster, and numerous examples of butchered animal bone. Both military and civilian items are represented in the sample and many items can be related to specific functions such as transportation, weaponry, construction, clothing, recreation, etc. Datable items cover a temporal range from the very early history of the fort (1840s) to the mid-twentieth century (Reynolds 1987b:ii).

The Fincher site (14LV358) was one of a number of archeological sites identified within the Fort Leavenworth Military Reservation by Barr (1977) and Rowlison (1977). As originally observed, this site was characterized as a scatter of nineteenth century artifacts in an undeveloped portion of the fort. Test excavations were conducted by American Resources Group, Ltd. of Carbondale, Illinois, at this site in 1988 after earth-moving activities associated with the operation of the Fort Leavenworth Hunt Club disturbed what excavations showed to be midnineteenth century dump deposits. Analysis of the artifacts from these three areas suggests they were deposited there between 1840 and 1880, and that they probably represented refuse from an enlisted soldier context (Wagner et al. 1988).

Archeological research was conducted by the Kansas State Historical Society at the Mine Creek Civil War battlefield between 1989 and 1991. This work was initiated to begin the process of developing an interpretive plan for the battlefield, which was owned and under development by the Kansas State Historical Society. Utilizing a crew of metal detectors to systematically scan the battlefield, artifacts from the battle were found, excavated, recorded, and their locations precisely mapped. Over a square mile was surveyed using this process, and analysis of the location of artifacts revealed patterns related to the battle. The conclusion was easily reached that the battlefield covered substantially more ground than had previously been thought, and that a considerable portion of the battlefield was located beyond the limits of the land owned by the state (Lees 1994).

Future Research

The above examples illustrate some previous archeology on military sites within the study area but do not approach the number of sites for which investigations at one level or another have been undertaken. Other military sites, it should be noted, were discussed or are subsumed under the transportation adaptation type.

Despite significant research on military sites, additional excavation is needed to provide additional information on the diverse range of sites associated with the military occupation of the study area. Notably lacking is excavated information on temporary camp sites used by the military and on sites such as blacksmith shops, stables, and laundries that served to support the military. A more important research need, however, is undoubtedly the need to use the information out of the ground to conduct research on questions related to the supply of posts in the study area with material goods manufactured elsewhere, the subsistence of soldiers stationed at the posts with regard to the importance of domestic vs. wild food sources, the relationship between different social and economic classes present on nineteenth century forts, and the social and economic relationship between soldiers and civilians living in adjacent communities or on post. Once questions such as these are addressed, data missing from the collection of excavated sites will become more apparent and will increasingly direct future research.

Rural Settlement

Certainly the key industry in the study area was agriculture and the range cattle industry. These were and are patently rural endeavors but are tied into urban settings through transportation links such as roads and railroads. Sites associated with this adaptation type are receiving increasing attention, yet given their overall importance in defining the character of the study area relatively little has been done. Some examples of this research follow.

The Black Ranch was one of a number of large ranches established following the Civil War in western Kansas. Historical research failed to provide any clear information on the initial establishment of the Black Ranch, but the 1878 date on the barn at this site clearly indicates it was established by that date. At the time of the 1984 testing, the site was characterized by a substantial number of standing buildings and other features. These included a standing frame dwelling, a sandstone spring house, a sandstone barn (dated 1878), a modern metal shed, a modern concrete block and metal shed, a trench silo, a windmill, a twentieth century tractor barn, a poured concrete barn foundation, a modern concrete-block garage, a twentieth century frame outbuilding, a 1930s frame outbuilding, a frame privy, two privy pits, three poured concrete slab foundations, a cistern, a brick-lined shaft well, and two frame chicken coops. This architectural record obviously reflects the use of this site from at least 1878 up to the construction of Kanopolis Lake in the 1940s (Lees and Shockley 1986).

The archeological testing of this site involved the intensive survey of the site, the mapping and recording of all observed features, and the excavation of four 1 x 1 m test pits. Two of these test pits were excavated near the nineteenth century dwelling, one by the 1878 sandstone barn, and one near the foundation of a probably twentieth century barn. In addition, tests with bucket augers were excavated into three privy pits located near the dwelling. These test excavations demonstrated the general good state of preservation of the subsurface archeological remains at the site. They did not, however, result in any information about the site that was not readily apparent from a study of the site's architecture, which provided good information on the age of the site, its length of occupation and use, and the function of structures and parts of the site (Lees and Shockley 1986).

The Huse corncrib was excavated in 1975 because it was superimposed over a relatively well preserved Kansas City Hopewell site known as the Ashland Bottoms site (14RY603), Riley County. Excavations were conducted by Dr. Patricia J. O'Brien of Kansas State University for research and educational purposes (O'Brien et al. 1987). The Huse corncrib was one component of a farmstead that was established probably in the late 1860s. The corncrib itself dates to the nineteenth century and was torn down in 1969. Excavations revealed the limestone footings of the corncrib, a feature interpreted as a gravel drain associated with the corncrib, and a square post mold located adjacent to one of the corners of the corncrib.

The analysis of this site approached it from an experimental perspective. From an independent set of historical and oral historical information, something of the function of this site and its specific and general historical setting were known. A comparison of the site content, or the artifacts from the site, to documented site function was then made as a means to examine the ability of archeology to interpret site function. It was found that the only artifacts found during the excavation that were specifically related to the use of the site as a corncrib was the distinctive foundation and some corn. The majority of the other artifacts found at the site were associated with drinking and smoking behavior, the repair of farm equipment, use by animals to devour scavenged food, and use of the corncrib for equipment storage.

Because of impending destruction by highway construction, the Martin Farmstead in Republic County, Kansas, was extensively documented. This site was occupied between 1875 and 1992 by a series of families. Investigated through architectural analysis and recording and through archeological excavation were an 1875 and 1885 stone cabins along with a storm/root cellar, garage, drive-through corncrib, blacksmith shop, bank barn, and other features. This comprehensive approach to the recording and study of a farmstead allowed a discussion of the structure of this site and its evolution through time, and a relationship of this evolution to the various occupants of the place (Schoen 1994).

Future Research

Rural settlement is without a doubt the adaptation type that is both characterized by the largest number of resources within the study area but is also the type that best characterizes the settlement and evolution of the study area during the past one to two centuries. Significant data gaps exist however, in that relatively few sites of this type have been investigated. A diversity of rural sites exists based on modes of production (farming, ranching, etc.), time period, social and ethnic ties of the inhabitants, proximity to urban centers and transportation, etc.

Within the study area, there are many segments of the rural settlement pattern that are very poorly known historically and for which archeology is the best way to build an historical narrative. Even for those sites for which historical documents exist, the organization and structure of the farmstead and the evolution of this organization through time in relation to changing production, technology, and transportation is poorly known. The need is thus for the development of more case studies dealing with the farmstead as a collection of buildings and activity areas, similar to that seen for the Martin Farmstead, that can be used to address questions such as those alluded to here.

Urban Settlement

Archeology within urban areas, and focused on the urban historic landscape, has only recently been attempted within the study area. As a result, despite some major urban archeology projects, the record from investigated urban sites is minimal.

Although archeology within urban areas and archeology of urban settlement have been major endeavors in certain parts of the country, notably the northeast and mid-Atlantic, this has not been the case in the west. To a very large degree this has been the result of a conventional wisdom among planners, preservationists, and archeologists that the archeological record within modern urban areas has been destroyed. This has been shown to be patently untrue in those areas where attempts have been made to discover the record, including a number of cases within the study area. A good example of this is the research conducted on the Lincoln Pottery Works in Lincoln, Nebraska, but which is discussed in the Industrial Adaptation Type. Several other examples are illustrative of urban settlement, and involve excavation within modern urban centers as well as excavations of former urban centers.

An unofficial cemetery was established in Topeka in 1855 shortly after the town's founding. This cemetery served the community until an official cemetery was established in 1859. Between 1859 and 1864, the burials made in the first cemetery were removed to the new cemetery. In 1986, commercial development on the south edge of downtown Topeka resulted in the discovery of human skeletal remains. Research showed that this construction was at the location of the original 1855 - 1859 Topeka cemetery and it was inferred that the discovered bones were interments that had been missed when the cemetery was moved in the 1860s (Good 1986).

Monitoring of construction within an area of two city lots resulted in the identification of five graves, three of which were empty. Bones recovered from two of the graves were interpreted as a male and a female, both of whom were between 22 and 25 at the age of death. Both individuals were reinterred in the Topeka Cemetery with much fanfare (Good 1986).

Quindaro was a speculative, Euro-American townsite established on the banks of the Missouri River in 1857. Although it was a speculative enterprise, it was also associated with Free State interests and received some backing from the New England Emigrant Aid Society. Although it was one of many towns established on the Missouri River during the Territorial Period, Quindaro was the only one that was sympathetic to Free State interests. Quindaro enjoyed a substantial but short-lived boom and, for a variety of converging reasons, it failed in the first years of the 1860s. Following the failure and abandonment of the town, the Quindaro area became a locus for settlement of refugee African Americans, initially from Missouri but later from other areas of the South. The African Americans established an unofficial community by the name of Happy Hollow within the former platted townsite of Quindaro.

Plans to develop the Quindaro townsite as a private landfill resulted in intensive archeological investigation of the area. Initial, Phase I reconnaissance of the proposed landfill was conducted in 1984 by the Kansas State Historical Society (Reynolds 1984b), and was followed later in 1984 by an intensive, Phase II survey conducted by Environmental Systems Analysis (ESA) of Kansas City (Lees 1984). The Phase I identified 20 features or potential features within the project area, while the Phase II survey documented 50 archeological features, most of which represented structure remains.

Phase III testing of features within the proposed landfill began in late 1984 and was completed in mid-1985. Testing investigated a large number of features, including a linear trash-filled pit located in the vicinity of the Quindaro House hotel, the Wyandotte House hotel, a general mercantile store at 4 Kanzas Avenue, a commercial building at 38 Kanzas Avenue , a probable commercial building at 10 Kanzas Avenue, an office building at 21 Kanzas Avenue, a store and office building at 161 Main Street, and a probable commercial building at 9 or 11 Kanzas Avenue. Other tested features include the brewery, a lime kiln, a commercial building on 75 and 76 Levee Street, the *Chindowan* newspaper office at 7 Kanzas Avenue, probable commercial buildings at 39 and 40 or 42 Kanzas Avenue, and probable dwellings at 23 Kanzas Avenue, 42 "P" Street, and 45 Kanzas Avenue. Additional features, including Quindaro city streets and later features associated with Happy Hollow, were also tested to varying degrees (McKay and Schmits 1986).

Phase IV data recovery excavations have been conducted at a number of locations within the proposed landfill. These excavations and continued historical research have resulted in new interpretations of the historical associations of many of the features described in Phase II and III reports. Phase IV investigations and a final interpretation of all the discovered features is not available due to the cancellation of the landfill project and the cancellation of the archeological contract.

The old Marmaton townsite, 14BO4, was inventoried during the 1967 survey work conducted by the University of Kansas in Bourbon County at the site of the then proposed Fort Scott Lake. Test excavations were conducted there during the University of Kansas' 1968 field season and was intended to establish the degree of preservation of this site which had been cultivated for several decades (Bradley and Harder 1974).

Old Marmaton was established in 1858 at a location about one mile south of the present town of Marmaton. Between 1858 and 1863, Marmaton served as the county seat of Bourbon County. In 1864 the town was attacked by a large band of raiders, and much of the town was burned and a number of citizens killed. In 1882, Marmaton was moved to its present location in order to be adjacent to a railroad (Bradley and Harder 1974).

According to Bradley and Harder, at the time of the 1968 work the site was "marked by depressions where former streets have intersected the gravel road to the north, and also by larger depressions which may have been the locations of buildings (Bradley and Harder 1974:32)." At that time, the majority of the site was located in a cultivated field, which was covered with a scatter of historic artifacts. Three different areas of this site were investigated.

The first area to be tested was the suspected location of the hotel, which was determined on the basis of historical documentation. Some historic artifacts such as glass, ceramics, and nails were found in the plowzone in these trenches, but no material or evidence of features was found below this level. Based on this, and information from the landowner that this area had been bulldozed, test excavations in this area were abandoned. A second area investigated was characterized by a roughly circular scatter of limestone rubble that excavations identified as a well whose shaft was lined with dry-laid limestone. The final area investigated was characterized by limestone rubble on the surface. These excavations revealed no pattern to this rubble and no evidence of the presence of a structure at this location (Bradley and Harder 1974).

The Riggs house is a standing Italianate dwelling located at 1501 Pennsylvania in Lawrence, Kansas. Construction on the Riggs house was begun in the spring of 1863, but the unfinished brick structure was burned during Quantrill's raid on Lawrence in August of 1863. Construction and reconstruction of the building resumed after this event, and the dwelling was occupied in November of 1864 (Jones and Nemec 1986).

The Riggs house served as the site of a dig conducted in 1971 by Dr. Carlyle S. Smith of the Museum of Anthropology at the University of Kansas. Two slightly irregular test pits, approximately three feet square, were excavated along the east foundation wall of this structure beneath a window of the original kitchen for the dwelling (Jones and Nemec 1986).

The artifacts recovered from this excavation include a relatively large number of fragments of ceramics, bottle glass, window glass, glass tableware, nails, and other artifacts. These artifacts were apparently largely found in the builder's trench, and all appear to date from the mid-nineteenth century. All of the artifacts are relatively large, indicating that they probably represent secondary refuse that was intentionally discarded at this location. The conclusion of the report, based on Dr. Smith's hypotheses, is that these artifacts were among the items destroyed during Quantrill's raid, and that they were disposed of in the still open builder's trench.

Future Research

Archeology within modern urban areas must be taken as one of our major needs within the study area. Urban development is currently having the most drastic affect on the cultural resource base within the study area. In many cases, however, this impact is on resources that while they are in a modern urban area now were not urban during their use. Also, within modern urban areas are, however, archeological sites that represent early urban settlement.

Although resources within urban areas are certainly among the best documented of any adaptation type, this generalization is deceptive. Urban resources described in a variety of documentary sources may still remain relatively unknown in terms of their precise construction, physical layout, and change through time. Likewise, the relationships between specific resources and other sites with the community is something that is rarely discussed in archival sources. Finally, there are many resources and population groups that remain invisible within urban areas despite an apparently abundant archival record.

The challenge of urban archeology within the study area is thus to build and understanding of the full range of urban resources and populations at various periods in time; to develop historical information on those resources and populations that are otherwise historically disenfranchised, thus providing a more comprehensive urban history; and to use this setting to examine questions of material culture supply and consumer choice, of urban subsistence and health issues; and of comparative social and economic relations within an evolving urban landscape. To date, while substantial information on early urban centers is available from a number of excavations within the study area, in particular the site of Quindaro, none of these questions or others similarly relevant have been adequately addressed.

Industrial

Industrial settlement has been a key element of the nineteenth and twentieth century development of the study area, but is certainly an area that has been neglected archeologically. Industrial production must be understood as something that ranges from small-scale industrial production on a farmstead to temporary industrial production to large-scale commercial industrial operations. Small scale and temporary production has been an element of life within the study area for several hundred years, with large-scale commercial production becoming important starting in the early 19th century along the Missouri River.

The most important study to date has been the excavations of the Lincoln Pottery Works (25LC42) in Lincoln, Nebraska, in 1986 and 1987 (Schoen and Bleed 1989). The Lincoln Pottery Works dates to the 1880 to 1902 period. It produced a wide variety of utilitarian stonewares and was one of hundreds if not thousands of such works that could be found in the United States at that time. Excavations of this site exposed several of the pottery's kilns and thousands of waster sherds, allowing a detailed technological and typological study. The study is important in that it was the first major industrial archeology project in the study area.

Also, excavations were conducted in the vicinity of a small print shop operated by Jotham Meeker at the Ottawa Baptist Mission between 1845 and 1860 (Lees 1986). In this shop he printed religious tracts in English and Ottawa. Although no architectural remains of this building were found, a scatter of printer's type was found near the documented location of this shop.

New Chelsea was a town started in the late 1860s and chartered in 1870. It represented the movement of the earlier county seat of Chelsea to a location with more favored access to transportation, including location along a proposed railroad. When the railroad did not materialize, the community declined and by 1900 was largely abandoned (Roberts 1982).

The 1979 excavations at the blacksmith shop resulted in the discovery of four features. These features were: 1) a brick and limestone concentration that was interpreted as the foundation for a forge, 2) a basin shaped, clay-filled pit located near the first feature and interpreted as a clinker pit, 3) a limestone filled pit near the first feature, interpreted as the foundation for an anvil, and 4) a small, shallow circular stain of uninterpreted function. Artifacts recovered from the excavations included a number of items that appeared related to the specialized function of this site, and which included blacksmithing tools, iron raw materials and waste, and clinkers. A variety of other artifacts were also found, with most of these including iron artifacts which were possibly the by-product of the smithing operation. Very few domestic type artifacts were found (Roberts 1982:561-567).

Based on a consideration of the distribution of materials in the excavated area, two specialized work areas were identified. These were located on either side of the general work area where the forge and anvil were interpreted as having been located. To the north of the forge was the interpreted location of a specialized work area which may have focused on wagons; to the south an area reflecting a farrier specialization was identified. The lack of evidence for a structure at this site resulted in speculation that this was an open-air blacksmith shop; a type of operation known to have existed at New Chelsea (Roberts 1982:598-603).

In 1996 remains of the dam for the Shawnee Mill in Johnson County, Kansas, was discovered and investigated. Shawnee Mill is one of the earliest industrial complexes in the study area and dates to the 1835 to 1844 period. At this site were a grist and saw mill operated for the benefit of the Shawnee who had removed to this area by provisions of an 1825 treaty. The mills were destroyed in the devastating flood of 1844. Although none of the mill buildings has been found, the remains of the mill dam have been found and documented and provide a significant insight into early industrial construction in the study area (King 1996).

Future Research

The paucity of sites that can be referenced in an archeological discussion of industry is clear illustration of the magnitude of gaps in archeological knowledge on this topic. Other industrial sites are to be expected in the region, including mining sites, other pottery works, blacksmith shops, foundries, sawmills, gristmills, shoe manufactories, rock quarries, and brick works. Some of these industries, such as mining and brick manufacturing, were prominent in some areas and sustained towns and a local infrastructure of sometimes substantial proportions. More typical over the region as a whole was small scale industry serving local need.

Documenting the range of industrial technologies, and the evolution of these technologies, represents a major research question begging to be addressed through archeological research. The nature of small industrial establishments is of particular interest because these are most certainly the most poorly documented. The blacksmith shop, for example, was probably ubiquitous on the rural and urban landscape, but is extremely poorly known in terms of the industrial structure of the shops and in terms of its relationship to an individual residence and to a rural or urban community.

9 Bioarcheological Research in Northeastern Colorado, Northern Kansas, Nebraska, and South Dakota, by Douglas W. Owsley and Karin L. Bruwelheide

Until the late 1950s, few professional archeologists in the Plains were concerned with the recovery and curation of human skeletal remains (Bass 1981). M. W. Stirling of the U.S. National Museum (Wedel 1955) and John Champe of the University of Nebraska (O'Shea and Ludwickson 1992a) were exceptions. Williams (1993) provides a brief summary of early twentieth century archeological investigations in the Northern Plains that included the recovery of human remains. Additional historical information and commentary can be found in Bass (1981) and Hughey (1980).

Prior to 1950, there were no physical anthropologists in the Great Plains and few studies of human skeletons. These few presented measurements and general information on small samples or unusual skulls and were especially concerned with specimens that appeared primitive and possibly of great antiquity.

Modern physical anthropology in the Great Plains began with the River Basin Surveys (RBS) program, which led to the salvage recovery of large numbers of skeletons and the training of students qualified to analyze these materials. Federal archeologists working under the auspices of the RBS program (1945-1969) conducted their salvage excavations in conjunction with collaborating institutions (e.g., universities and state historical societies) at several burial sites in South Dakota before they were destroyed or inundated by waters impounded by new dams along the Missouri River.

The history of this federal salvage program and the specially created South Dakota State Archaeological Commission, which conducted salvage work during this era, can be found in Helgevold (1980) and Lehmer (1971). W. R. Hurt, the professional archeologist who replaced W. H. Over as director of the University of South Dakota Museum in 1949, maintained an active archeological program on behalf of the South Dakota Archaeological Commission and the Museum. Hurt excavated two large and well-preserved Extended and Postcontact burial samples, Four Bear (39DW2) and Swan Creek (39WW7) (Hurt 1957; Hurt et al. 1962).

Federal archeologists excavated small numbers of skeletons from several Coalescent tradition sites along the Missouri River, including Black Widow Ridge (39ST203), Cheyenne River (39ST1), and Leavitt (39ST215) (Lehmer and Jones 1968). At the Buffalo Pasture site (39ST216), the commingled and incomplete skeletons of 28 individuals, which had been unearthed and scattered by heavy machinery while obtaining fill dirt for the Oahe dam, were gathered by construction workers and RBS archeologists (Lehmer and Jones 1968). Middle Woodland Sonota complex burials were recovered from several mounds, including Arpan (39DW252), Swift Bird (39DW233), Grover Hand (39DW240), and Boundary (32SI1) (Neuman 1975).

William Bass, a physical anthropologist for the Smithsonian Institution and the University of Kansas, worked to define the role of physical anthropology in the RBS interagency archeological program and developed techniques for the efficient recovery of large skeletal samples. Through 14 field seasons (1957-1970), he directed excavations of four Arikara cemeteries—Larson (39WW2), Leavenworth (39CO9), Mobridge (39WW1), and Sully (39SL4) (Bass et al. 1971; Bass 1981). Often the work took place only slightly in advance of the rising water level. Bass's excavation at Mobridge began in 1968 and continued through 1970. One of Bass's students, Douglas Ubelaker, and T. Dale Stewart of the U.S. National Museum, directed a final season (in 1971) at Mobridge (Owsley et al. 1982).

Unlike other cemetery investigations along the Missouri River, Bass's objective was comprehensive recovery, rather than limited testing or the collection of isolated skeletons from habitation areas. Three or more field seasons were devoted to threatened sites. Field objectives included defining the limits of a cemetery and recovering and preserving all skeletal material from it. Bass (personal communication1994) estimates that 90% of all burials in the Larson cemetery were recovered. The recovery of unusually large and well-preserved skeletal samples (e.g., nearly 700 individuals from Larson) eliminated the effect of differential preservation as a major source of recovery bias. Most burials were primary interments, rather than secondary, which further increased the likelihood of complete skeletal recovery. Further, there was no evidence of sociocultural exclusion based on age, sex, or class. (The Postcontact Coalescent tradition Arikara characteristically placed graves in a cemetery near a village [Lehmer 1971]. For additional ethnohistoric and archeological information about Plains Indian mortuary practices, see Orser [1980], O'Shea [1978], Ubelaker and Willey [1978], and Snortland [1994].) There is little ethnohistoric information to indicate that specific segments of the population were buried elsewhere. Thus, these samples seem to be largely representative of the mortality profiles of the original populations, a basic requirement for paleodemographic and paleopathological research.

After the RBS unit closed in 1969, few burials were excavated except for the occasional limited collection of remains exposed by erosion or looting. Even during the RBS program, limited time and funds restricted sampling to only a few burial sites. As a consequence, many sites and remains in riverine environments frequently have been exposed and lost. As Rose et al. (1982:91) noted, "Shoreline erosion, subsequent exposure and destruction of archeological remains are facts of life for the Federal impoundments in the Dakotas." Displaced skeletons are often incomplete and lack well-defined archeological provenance. For example, of 44 human skeletons acquired from 14 locations along Lakes Oahe, Sharpe, and Francis Case and analyzed by Rose, Marks, Kay, and Riddick (1984) under contract to the U.S. Army Corps of Engineers, Omaha District, only two had been discovered by professional archeologists, and a third one by a Park Ranger. Disturbed burials lacking specific context are difficult to analyze and interpret, for a sample's "heuristic potential depends to a large degree on a proper understanding of burial or skeletal context" (Rose et al. 1982:91).

Only two large samples have been recovered during salvage excavations during the past two decades: the commingled remains of 486 individuals from a fortification trench at the Crow Creek site (39BF11) by the University of South Dakota in 1978 (Willey and Emerson 1993) and 84 burials from the Indian School site (39HU10) by Augustana College in 1989-1990 (P. Winham, personal communication 1994). Both collections have been reburied, the latter without study. Current policy of the Omaha District of the U.S. Army Corps of Engineers in regard to lands along Lakes Oahe, Bowman/Haley, and Sakakawea in South Dakota and the Pipestem Reservoir in North Dakota is strict avoidance of all human burials, marked or unmarked, whenever possible.

Data obtained from the RBS samples were published during the 1960s and 1970s, usually as descriptive appendices to archeological reports. Qualified and well-trained students continued work on the Plains collections. As a result, the Plains "progressed from one of the least known to one of the better known regions as far as skeletal studies are concerned" (Bass 1981:3). Research from the 1970s to the present has become more relevant to archeological objectives, with greater emphasis on such aspects as population relationships and demography. Bass (1981) illustrated the breadth of this research by citing 29 M.A. theses and Ph.D. dissertations based on Plains collections. An updated list (since 1980) follows.

Master's Theses and Doctoral Dissertations Since 1980
Based on Central and Northern Plains Skeletal Collections

Deitrick, Lynn M. 1980 The Occurrence and Interpretation of Trauma at the Larson Site, 39WW2, Walworth County, South Dakota. M.A. Thesis, University of Tennessee.

Dittner-Plasil, Carol B. 1981 Morphological Changes on the Axillary Border of the Scapula with Special Reference to the Neanderthal Problem. Ph.D. Dissertation, University of Tennessee.

Guagliardo, Mark F. 1982 Craniofacial Structure. Aging and Dental Function: Their Relationships in Adult Human Skeletal Series. Ph.D. Dissertation, University of Tennessee.

Key, Patrick J. 1982 Craniometric Relationships Among Plains Indians: Culture-Historical and Evolutionary Implications. Ph.D. Dissertation, University of Tennessee.

Willey, Patrick S. 1982 Osteology of the Crow Creek Massacre. Ph.D. Dissertation, University of Tennessee.

Joerschke, Bonnie C. 1983 The Demography, Long Bone Growth, and Pathology of a Middle Archaic Skeletal Population from Middle Tennessee: The Anderson Site (40WM9). M.A. Thesis, University of Tennessee.

Hunt, David R. 1983 Age Changes in Shape and Morphology in Arikara Subadult Ilia. M.A. Thesis, University of Tennessee.

Symes, Steven A. 1983 Harris Lines as Indicators of Stress: An Analysis of Tibiae from the Crow Creek Massacre Victims. M.A. Thesis, University of Tennessee.

Zobeck, Terry S. 1983 Postcraniometric Variation Among the Arikara. Ph.D. Dissertation, University of Tennessee.

Puskarich, Cheryl L. 1984 Metric Variations in the Arikara Pelvis. Ph.D. Dissertation, University of Tennessee.

Paquette, Steven P. 1985 Patterns of Root Variation in the Permanent Maxillary Anterior Tooth Roots: A Different Approach to the Problem of Dental Reduction During the Transition from Archaic to Modern *Homo Sapiens*. M.A. Thesis, University of Tennessee.

Leigh, Steven R. 1985 The Allometry of the Palate of Modern *Homo Sapiens* and Archaic *Homo Sapiens*. M.A. Thesis, University of Tennessee

Crumbley, William R. 1986 Variation in Tibial Morphology of Three Arikara Populations. M.A. Thesis, University of Tennessee.

Montgomery, Robert L. 1986 A Paleodemographic Comparison of a Protohistoric Pawnee Site (25NC3) with a Historic Pawnee Site (25PK1). M.A. Thesis, Louisiana State University.

Cashion, Maria 1987 A Diachronic Assessment of Stress Indicators in Three Plains American Indian Populations. M.A. Thesis, Louisiana State University.

Hyman, Suzanne A. 1987 The Relationship Between Dental Age and Long Bone Growth in Arikara Indians. M.A. Thesis, University of Tennessee.

Masters, Cathie L. 1987 Dental Pathologies and Attrition of Some Prehistoric Eastern Great Plains Groups: Implications for Subsistence. M.A. Thesis, University of Nebraska.

Wolley, Anne M. 1988 Prehistoric Zinc Nutrition: Archeological, Ethnographic, Skeletal and Chemical Evidence. M.A. Thesis, University of Nebraska.

Moore-Jansen, Peer H. 1989 A Multivariate Craniometric Analysis of Secular Change and Variation Among Recent North American Populations. Ph.D. Dissertation, University of Tennessee.

Prince, Joseph M. 1989 Secular Trends in Stature in a Historic Sioux Population. M.A. Thesis, University of Tennessee.

Goldsmith, Catherine M. 1990 Metacarpal Entheses Changes as Evidence of Labor Difference in Non-Agricultural and Agricultural American Indian Skeletons. Ph.D. Dissertation, University of Tennessee.

Bigbee, Richard P. 1992 Anthropometric Variation of the Cherokee, Choctaw, Kiowa, and Pawnee Amerindians. M.A. Thesis, University of Tennessee.

Zitt, Jennifer Orlesh 1992 Prehistoric and Early Historic Subsistence Patterns and Dental Pathology on the Northern Plains. M.A. Thesis, University of Wyoming.

Bone, Karen E. 1993 A Bias in Skeletal Sexing. M.A. Thesis, University of Tennessee.

Skeletal samples from the Central and Northern Plains, and especially those from along the Missouri River, have offered some of the best opportunities in North America for population studies through cross-cultural, regional, and temporal comparisons. With the recovery of larger samples, and with new analytical methods and theoretical approaches, the study of human skeletal remains from archeological contexts changed and expanded dramatically. With regard to craniofacial morphology and population relationships and origins, this transition required a shift from typological thinking to a process-oriented approach focused on microevolutionary problems. Computer-aided analyses have provided a better understanding of morphological variation over time and in different geographic regions.

Bioarcheology, concerned with the study of human skeletons in an archeological context, is a development of the last three decades. Principal emphases are demography, bone and dental pathology, subsistence, adaptation, growth and development, and sociocultural relationships, such as interpersonal violence and warfare. Volumes edited by Jantz and Ubelaker (1981) and Owsley and Jantz (1994) reflect the incremental advances in the scope and thoroughness of Plains skeletal biology and bioarcheological research. Investigative procedures and research designs have become more sophisticated and have benefitted from advances in technology and techniques of analysis, as well as from a systematic approach and the development of computerized data bases.

Bioarcheological Research in Four States in the Central and Northern Plains

This section of the report deals with bioarcheological research and collections from four states in the Central and Northern Plains: Nebraska, South Dakota, the northern half of Kansas, and the northeastern corner of Colorado. This area represents the Central Plains and part of the Northern Plains of the Central and Northern Great Plains Overview (CNPO), a project designed to assess (a) the extent of the archeological resource base, (b) data that are lacking, and (c) the current state of knowledge as a basis for planning and managing cultural resources. This overview builds on and complements reports compiled during the Southwest Division Overview Project, which provided information about burial sites in the southern half of Kansas and southeastern and south-central Colorado (Hofman et al. 1989; Simmons et al. 1989). The primary research goals of the new initiative were

- To develop a comprehensive inventory of archeological sites with documented mortuary components;
- To present an initial synthesis of the major research themes and specific research findings based on osteological data; and
- To provide a preliminary synthesis of the bioarcheological data using a comparative framework based on adaptation types.

Human remains represent a key component of the archeological record and are essential for an understanding of trends in population demography, health, origins and migrations, microevolutionary change, sociocultural interaction, subsistence patterns, and mortuary practices through time and in different regions. Thus the unique and varied data derived from human skeletons are crucial to the interpretation of the past.

Native American concern about the recovery, analysis, and curation of human remains has resulted in greater sensitivity on the part of researchers and in special efforts being made to ensure that interested parties are consulted and fully informed about procedures, alternatives, and the information to be gained through osteological analysis. Large numbers of skeletons in museum collections have been reburied, and most construction and development projects and archeological investigations avoid the recovery of human skeletons when possible. Therefore, an irreplaceable osteological resource is rapidly becoming unavailable, and future generations will not have an opportunity to examine such materials firsthand and to apply future, advanced technological and analytical procedures to them. There is urgent need for the systematic recovery and analysis of osteological data as a foundation for a better understanding of Plains prehistory. The completion of regional syntheses is an essential step in pulling together and interpreting research findings, identifying trends, showing where additional data or improved procedures of data collection and analysis are needed, and recommending productive directions for further study of the samples that are still available.

The development of the required syntheses began with a systematic survey of a wide variety of sources as a basis for identifying sites with mortuary components. This task was a collaborative team effort in which standardized information was compiled for each archeological site in which human remains had been documented in 11 states included in the Central and Northern Plains Overview project (see Owsley and Richardson, Appendix A). The following information was recorded:

- Site name, number, and FIPS code
- Cultural affiliation
- Number of individuals represented by skeletal remains and number of skeletons (partial and complete) that have been analyzed
- Burial context and relevant environmental factors
- Type of field project and organization(s) investigating each site.

Sources of the information for this site inventory included published and unpublished reports, field notes, site files, and computer records maintained by the Colorado Historical Society, Kansas State Historical Society, Nebraska State Historical Society, South Dakota State Archeological Research Center, University of Kansas Museum of Anthropology, Department of Anthropology of the University of Tennessee, and National Museum of Natural History. National, regional, and local anthropological and archeological journals, bulletins, and newsletters were checked for osteological citations. Travel to Kansas, Nebraska, South Dakota, Tennessee, and Wyoming provided access to less widely circulated publications, monographs, miscellaneous contributions, unpublished reports on cultural resource management, survey reports, Master's theses, and doctoral dissertations, as well as an opportunity to inventory specific collections.

The sections that follow deal with the sites reported and studied in the four states or portions of states comprising the Central Plains and the Northern Plains overview. The organization is based on the traditional cultural/historical framework including archeological period, tradition, variant, and phase, as described in Appendix A. To identify the archeological context of each burial component within a specific cultural category required heavy reliance on publications, unpublished site records, and the assistance of specialists in the archeology of a region. Sites with multiple burial components (i.e., different cultural units in a burial sample) were classified as multicomponent. (This classification pertains only to the burial features, not to the total archeological site, which may provide evidence for multiple occupations that are not reflected in the burial sample.)

Following this introductory section, which presents the background data on the archeological sites in the four states under consideration, are sections that describe findings and research needs in relation to demography, subsistence patterns, various types of osteological diseases, developmental anomalies, and trauma, dental pathology, and related topics. These sections include tables showing the osteological data available in relation to sites, together with a summary of the current state of knowledge, data needs, and suggested directions for future research. A chapter of the overall report will reorganize the bioarcheological data from these sections and relate them to adaptation types for the Central Great Plains region.

Characteristics of Sites

In Northern Kansas, as Table 34 shows, of 158 archeological sites with human remains, four contained burials representing multiple components. The total number of individuals recovered from these sites was 941, of which slightly more than half (56.5%) have been analyzed.

The distribution of sites among archeological periods is uneven, there being few sites (5, or 3.2% of the 158) from the Paleoamerican, Archaic, and Late Archaic periods, which yielded few burials (15, or 1.6% of the 941 individuals recovered), and only a third of those few burials have been analyzed. Substantially more Woodland (including Middle and Late Woodland) sites have been studied, constituting 34.8% (N=55) of the 158 sites, and accounting for 56.6% (N=533) of the individuals that were recovered. Although nearly all (92%) of the human remains from the 29 Late Woodland sites have been analyzed, only 5.1% of the 205 individuals representing 17 Woodland sites (specific period undetermined) have been studied. Eleven Plains Village sites yielded 176 individuals of which 93.7% have been analyzed. About one-fourth of the 158 sites studied were Historic (23.4%). They yielded 90 individuals, about half (54.5%) of which have been analyzed. The archeological period of another one-fourth of the sites with burials in Northern Kansas has not been determined, and only 4.5% of the 67 burials from such sites have been analyzed.

In summary, slightly more than half of the 941 burials identified from the northern half of Kansas have received some analysis, which, at a minimum, involved determination of age and sex together with other general observations. More Woodland and Plains Village burials have been discovered and examined. Phenice's (1969) study of burials from 17 mounds in North Central Kansas represents one of the more comprehensive investigations. Two numerically important Plains Village samples are those from the Calovich Mound (14WY7), which was analyzed by Barnes (1977), and the Indian Burial Pit site, also known as the Whiteford site (14SA1). The Whiteford site, a prehistoric cemetery complex of the Smoky Hill culture dated ca. A.D. 1300, was excavated between 1936 and 1940 by G. L. Whiteford, an amateur archeologist. More than 146 skeletons were uncovered and left in situ along with associated burial artifacts. A building

Table 34. Archeological Periods of the Burial Sites.

Period	Sites N (%)	Multicomponent N	Individuals N	Analyzed N
Northern Kansas				
Paleoindian	1 (0.6)	–	2	2
Archaic	3 (1.9)	–	4	3
Late Archaic	1 (0.6)	–	9	0
Woodland	17 (10.8)	–	205	12
Middle Woodland	5 (3.2)	–	58	17
Middle/Late Woodland	4 (2.5)	–	61	57
Late Woodland	29 (18.4)	–	209	193
Plains Village	11 (7.0)	–	176	165
Historic	37 (23.4)		90	49
Archaic or Woodland	6 (3.8)	–	25	20
Woodland or Plains Village	6 (3.8)	4	35	11
Undetermined	38 (24.1)	–	67	3
Total Northern Kansas	158	4	941	532 (56.5%)
Northeastern Colorado				
Archaic	2 (4.6)	–	3	3
Early Archaic	1 (2.3)	–	1	1
Late Archaic	2 (4.6)	–	2	2
Woodland	9(21.0)	–	22	21
Early Woodland	2 (4.6)	–	10	10
Late Woodland	2 (4.6)	1	5	1
Late Prehistoric	1 (2.3)	–	1	0
Protohistoric	1 (2.3)	–	1	1
Archaic or Woodland	1 (2.3)	1	3	3
Undetermined	22(51.2)	–	76	12
Total Northeastern Colorado	43	2	124	54 (43.5%)
Nebraska				
Archaic	2 (0.6)	–	2	0
Early Archaic	1 (0.3)	–	1	0
Late Archaic	3 (1.0	–	10	9
Woodland	20 (6.4)	–	48	19
Early Woodland	1 (0.3)	1	1	0
Middle Woodland	4 (1.3)	–	10	6
Middle/Late Woodland	7 (2.2)	–	97	19
Late Woodland	9 (2.9)	2	128	118
Plains Village	107(34.5)	7	1679	1299
Protohistoric	2 (0.6)	–	3	0
Historic	19 (6.1)	–	36	10
Archaic or Woodland	8 (2.6)	4	152	68
Archaic or Woodland or Plains Village	3 (1.0	1	77	0
Woodland or Plains Village	14 (4.5)	10	331	84
Woodland or Historic	1 (0.3)	1	35	35
Late Prehistoric or Historic	3 (1.0)	1	4	0
Undetermined	106(34.2)	1	252	26
Total Nebraska	310	28	2866	1693 (59.1%)
South Dakota				
Archaic	1 (0.5)	1	7	3
Woodland	27(13.4)		119	71
Middle Woodland	10 (4.9)		241	216
Late Woodland	13 (6.5)		192	152
Plains Village	74(36.8)	10	3556	3339
Late Prehistoric	1 (0.5)		1	1
Historic	20(10.0)		37	12
Archaic or Woodland	1 (0.5)	1	1	0
Woodland or Plains Village	8 (4.0)	6	42	37
Woodland or Historic	4 (2.0)	3	37	22
Plains Village or Historic	3 (1.5)	3	18	7
Protohistoric or Historic	1 (0.5)		1	0
Undetermined	40(20.0)		81	38
Total South Dakota	203	24	4333	3898 (90%)

erected over the cemetery remained open as a commercial operation for more than 40 years, until 1991, when the facility was closed and the remains reburied. This series offered an unusual research opportunity, as indicated by Wedel (1959:523):

> Rarely does the archeologist in the Central Plains find such a large series of measurable human remains in unquestioned association with cultural materials that

> can be correlated with defined prehistoric complexes; and the occasion there afforded for identifying the physical type or types represented, for relating these to other native populations in the general region, and for studying the diseases and disabilities which may have afflicted the pre-white populations should not be overlooked.

Unfortunately, the remains were never properly examined and the application of numerous coats of shellac as a means of preservation inhibited the examination conducted by Finnegan (1989) prior to reburial. Only basic observations indicating burial position, age, sex, and stature were possible. It is even more unfortunate that this site is remembered not for its scientific but for its commercial value and the controversy it stimulated, which led to state legislation mandating the reburial of the human remains from this archeological context.

Almost no information is available for the only possible Paleoamerican remains recovered in this region (14WY9003), and until these remains are analyzed and dated, even their assessment as Paleoamerican remains tentative. Only four Archaic sites have been identified, of which the two "Lansing Man" skeletons (14LV315) found at a depth of about 22 feet in a loess bank on the west side of the Missouri River near Kansas City, Kansas, are the oldest (Bass 1973). Their discovery in 1902 caused considerable controversy about the antiquity (possibly glacial) of these skeletons, a debate that received extensive popular press coverage as well as stimulating many scientific publications (e.g., Holmes 1902, Hrdlicka 1903). Only in 1966, following the development of radiocarbon dating, was assignment to the Early Middle Archaic period clearly established. Students of the University of Kansas provided partial funding for the assessment, which resulted in a date of 3579 B.C. The second oldest burial in Kansas, the fragmented skeleton of a young adult female dating to about 1800 B.C., was discovered during a construction project at the Snyder site (14BU9) near El Dorado (Klepinger 1972).

In Northeastern Colorado, as Table 34 shows, the number of sites is substantially fewer (43) than in northern Kansas; however, these sites yielded a substantial number of individual remains (124), less than half (43.5%) of which have been analyzed. As in Kansas, there were few multicomponent sites—only two of the 43.

The archeological period of half (51.2%) of the sites has not been established. Of those for whom period is identified, one-third (32.6%) are Woodland (including Early and Late Woodland and Archaic-Woodland, see Table 34), and these sites accounted for one-third (32.3%) of the total number of individuals. Most (87.5%) of these Woodland burials have been analyzed.

Five sites, yielding the remains of five individuals, have been assigned to the Archaic period. Of these, the fragmentary skeleton of an adult female exposed by erosion along a tributary of Gordon Creek in Roosevelt National Forest was classified as Early Archaic. This burial (5LR99), the oldest from the Western Plains, has a radiocarbon date of 7750 B.C. (Anderson 1966; Breternitz, Swedlund, and Anderson 1971).

In Nebraska, 310 sites, of which 28 (9.0%) are multicomponent, yielded a total of 2,866 individuals. Three-fifths (59.1%) of the burials have been analyzed. One-third (34.2%) of the sites are of undetermined archeological period. Another third, 107, (34.5%) are Plains Village, and they yielded the majority, 1,679 (58.6%), of the burials. Of these Plains Village burials, three-fourths (77.4%) have been analyzed. Table 34 presents the distribution by archeological period of these Nebraska sites and the number of individuals from each that were recovered and analyzed.

Although the number of burial sites identified in South Dakota (201) was less than in Nebraska, the number of individuals found (4,333), and the number of these analyzed (90%) were substantially greater (see Tables 36 and 37). Of the South Dakota sites, 24 (12.0%) were multicomponent, compared to 28 (9.1%) of the 310 Nebraska sites. As in Nebraska, the archeological period of the largest number of sites (74) was Plains Village, and these yielded a majority of the burials 3,556 (82.1%). The cranium of an adult male found at the Medicine Crow site (39BF2) represents the earliest documented human remains from the Northern Plains (Bass 1976). The strategraphic context indicates a date of 5000-2000 B.C., which falls within the Archaic period.

In Northern Kansas, Nebraska, and South Dakota, not all the burials at some of the sites are Native Americans. At some sites, most frequently those in Kansas, there are individuals who are white, and there are two black individuals from one site in Nebraska (Table 35). In all, 36 non-Native American burials were identified of which 52.8% were from sites in Kansas. Two-fifths (41.7%) of the non-Native American burials were analyzed. Jantz and Owsley's (1994) identification of a Euro-American cranium in a protohistoric Arikara cemetery (39WW7) illustrates the potential of applying forensic techniques to identify ancestry of individual crania. Their study provides evidence for direct contact with Euro-Americans half a century earlier than historical records had indicated. Bibliographic citations and an inventory of historic burials in Kansas that have been examined appear in a report by Finnegan (1989).

Records for the 712 burial sites identified by this survey document the discovery of 8,264 sets of individual remains. However, those of at least 276 individuals from 101 sites were only reported, not collected (Table 36). The skeletal remains of more than 2,300 individuals, 27.9% of the total sample, have been reburied during the past decade, thus are not available for examination (Table 37). The majority (82.3%) of these remains were examined prior to repatriation.

Organizations Reporting and Investigating Sites

A number of different types of organizations were responsible for the recovery and reporting of human remains at sites in the four Northern and Central Plains states considered in this section. Among these were federal, state, university, medical/legal, contract archeological, other organizations, and amateurs as Table 38 shows. Of 43 sites in northeastern Colorado, amateur organizations excavated two-fifths (41.9%) and universities one-third (32.6%), accounting for the recovery of half (54%) and one-third (34.7%), respectively, of the human remains at these sites. In northern Kansas, amateurs were again the most frequent excavators (half [48.7%] of the sites and one-third [31.1%] of the individuals), followed by state organizations, which excavated

Table 35. Archeological Sites in Northern Kansas, Nebraska, and South Dakota with Human Remains Identified as Black or White.

State	Race	Sites	Individuals	Studied
Kansas	White	15	19	8
Nebraska	Black	1	2	0
	White	6	9	5
South Dakota	White	3	6	2
Total		25	36	15
				(41.7%)

Table 36. Remains Reported in Northeastern Colorado, Northern Kansas, Nebraska, and South Dakota[1].

State	Sites	Burials
Colorado	9	36
Kansas	16	19
Nebraska	55	175
South Dakota	21	46
Total	101	276

[1]Records do not indicate collection or availability for study.

Table 37. Remains Reburied by an Informant or Repatriated to a Native American Group.

State	Sites	Individuals	Studied
Colorado	1	3	1
Kansas	7	174	170
Nebraska	43	697	568
South Dakota	108	1433	1159
Total	159	2307	1898

one-fifth of the sites (20.3%) and one-eighth (12.6%) of the human remains. In Nebraska, state organizations, amateurs, and universities were those most frequently involved in excavation and recovery. Although the number of sites investigated by state organizations was three times that of universities (32 compared to 11), the percentage of human remains recovered was roughly the same for the two types of organizations, 950 (33.1%) of the 2,868 reported, compared to 980 (34.2%). Amateurs excavated 90 (29%) of 320 sites and recovered 570 (19.9%) of 2,868 individuals. In South Dakota, in contrast to the other states, federal organizations accounted for most of the site exploration, 36.5% of 203 sites reported, with equivalent percentages of sites investigated by museums (19.7%) and amateurs (18.7%), and 10.8% by universities. A combination of organizations (category 2 in Table 38) accounted for the greatest number of individual burials that were recovered and reported, 1,815 (41.9%), followed by universities with 1,480 (34.2%).

The pattern of organizational involvement in such research varies from state to state. In regard to total number of sites, amateurs accounted for the largest percentage (31.2%) excavated, followed by state organizations (22.7%) and universities (14.8%); however, in relation to human remains recovered, universities had the highest percentage (30.5%), followed by combinations of organizations (28.2%), state organizations (13.6%), and amateurs (12.6%).

Table 39 presents a slightly different and more specific approach to organizational involvement in such research, showing the approximate number of sites with burials investigated or reported by particular organizations or groups (for example, local residents) in the four states being considered here. Local residents predominated, and by a wide margin, in both Kansas and Colorado. Amateurs have played such a large role in these discoveries in Colorado because most of the counties in the state's eastern plains have had only tiny fractions of the total area formally surveyed for cultural resources (Office of Archeology and Historic Preservation 1993). The Nebraska State Historical Society was responsible for the investigation of the largest number of sites (132) in that state, with local residents and the University of Nebraska next (90 and 56 sites, respectively). In South Dakota, the River Basin Surveys and the University of South Dakota accounted for roughly equivalent numbers of sites (47 and 41, respectively), followed by the U.S. Army Corps of Engineers, with about half that number (21). The degree of activity of local residents in three of the four states is noteworthy and tends to substantiate anecdotal evidence of long-

Table 38. Organizations Reporting and Recovering Human Remains.

Organizaton		Colorado		Kansas		Nebraska		South Dakota		Total	
		Sites	Individuals	Sites	Individuals	Sites	Individuals	Sites	Individuals	Sites	Individuals
Amateur	(No.)	18	67	77	293	90	570	38	113	223	1043
	(%)	41.9	54.0	48.7	31.1	29.0	19.9	18.7	2.6	31.2	12.6
Combination	(No.)	0	0	6	223	14	295	7	1815	27	2333
	(%)	0.0	0.0	3.8	23.7	4.5	10.3	3.4	41.9	3.8	28.2
Contract	(No.)	2	2	1	2	3	6	1	1	7	11
Archeologist	(%)	4.7	1.6	0.6	0.2	1.0	0.2	0.4	0.0	1.0	0.1
Federal	(No.)	0	0	1	1	11	32	74	458	86	491
	(%)	0.0	0.0	0.6	0.1	3.5	1.1	36.5	10.6	12.0	5.9
Field	(No.)	1	1	0	0	3	18	0	0	4	19
School	(%)	2.3	0.8	0.0	0.0	1.0	0.6	0.0	0.0	0.6	0.2
Medical/	(No.)	3	3	4	5	9	14	6	11	22	33
Legal	(%)	7.0	2.4	2.5	0.5	2.9	0.5	3.0	0.3	3.1	0.4
Museum	(No.)	1	4	0	0	1	1	40	393	42	398
	(%)	2.3	3.2	0.0	0.0	1.0	0.0	19.7	9.1	5.9	4.8
State	(No.)	2	2	32	119	118	950	10	54	162	1125
	(%)	4.7	1.6	20.3	12.6	38.1	33.1	4.9	1.2	22.7	13.6
University	(No.)	14	43	11	16	59	980	22	1480	106	2519
	(%)	32.6	34.7	7.0	1.7	19.0	34.2	10.8	34.2	14.8	30.5
Unknown	(No.)	2	2	26	282	2	2	5	8	35	294
	(%)	4.7	1.6	16.5	30.0	0.6	0.1	2.5	0.2	4.9	3.6
TOTAL 32		43	124	158	941	310	2868	203	4333	714	8266

Table 39. Approximate Numbers of Burial Sites Investigated (or Reported) by Selected Organizations.

State	Organization	Sites with Burials
Colorado	Local Residents	15
	University of Colorado	7
	University of Northern Colorado	5
	Colorado Archaeological Society	3
	Law Enforcement Agency	3
Kansas		
	Local Residents	80
	Kansas State Historical Society	33
	Kansas State University	13
	University of Kansas	6
	Law Enforcement Agency	4
Nebraska		
	Nebraska State Historical Society	132
	Local Residents	90
	University of Nebraska	56
	Law Enforcement Agency	9
	River Basin Surveys	7
South Dakota		
	River Basin Surveys	47
	University of South Dakota	41
	Corps of Engineers	21
	S. D. Archaeologcal Research Center	9
	University of Kansas	5

standing public interest and participation in archeological investigations in many regions of the United States.

Although nonprofessionals have made many contributions to Plains archeological research as both informants and participants in supervised archeological excavations, the activities of some who are interested only in collecting relics and artifacts has resulted in the looting and destruction of many important archeological sites in the Plains and provoked the dismay and condemnation of professional archeologists. Many examples involving burials can be cited, though few are needed to make this point.

• The continuous digging by local residents at 25DK10, an Omaha cemetery associated with the Big Village (25DK5), necessitated Champ's excavation in 1940 (Parks 1992).

• According to Gant (1966), all accidental finds reported by engineers engaged in highway salvage projects in Nebraska in the summer of 1966 were either totally destroyed or badly disturbed by souvenir hunters.

• Salvage archeologists often arrived at sites (e.g., Genoa [24NC20]) to find relic hunters gathered around exposed burials "trying to dig out the bones before the other guy could" (Jones 1970:1).

• When Kivett (1969) terminated investigations at the Woodcliff Recreation Area (25SD31) because a local contractor with a crew of young men continued to loot the site, he emphasized the legal and moral reasons that the excavation of burials should be conducted under the direction of trained archeologists from the Nebraska State Historical Society (or other research institutions). None of the amateurs' discoveries were made available for study.

• Mallam (1971) severely criticized the excavation of a Pawnee burial by two high school students, which was reported in *Nebraskaland* under the title "We Dig Herby" (Batie 1970), as an irresponsible act unworthy of publication. Mallam noted that the article "conveys to the general reader the impression that the cultural antiquities of Nebraska may be freely plundered for personal and private pleasure" (1971:3), and that the article was "a sad testimony to the ever-increasing amateur destruction that threatens to eliminate our prehistoric heritage" (1971:12).

As a final example, when farmhands working on the walls of an old pit silo in Weld county, Colorado, discovered bones, they cut rapidly into the bank and uncovered the skeletons of at least 27 individuals. "Word quickly got out to the local residents who brought in electric lights to illuminate the mass destruction that became a frenzy during the night following the discovery. Farmer Garcia's pit silo disappeared, then other structures, until angered by the wanton destruction, he ran everybody off his property" (Greenway 1961:42). Pillage of the Garcia site (5WL1986) prompted the Department of Anthropology of the University of Colorado to announce that it would provide competent investigators to landowners of Colorado sites to direct or advise on excavations: "Their interests will be scrupulously protected, and they can be assured ... their name will be associated with a contribution to knowledge and not a destruction of it" (Greenway 1961:42).

In contrast, four self-trained, nonprofessional archeologists are noteworthy for their contributions to Plains bioarcheology because they excavated burials using methods that were reasonably systematic (for the time), which included keeping field records, cataloging excavated material, and publishing some of their findings. During the 1930s, Floyd Schultz excavated 32 burial mounds in the Lower Republican River valley in Clay and Geary counties of northeastern Kansas (Phenice 1969; Schultz and Spaulding 1948). Schultz's collection was donated to the University of Kansas in 1948. In Nebraska, the early investigations by A. T. Hill, initially as an amateur and after 1933 as a museum curator and Society Archeologist of the Nebraska State Historical Society, contributed to future Pawnee bioarcheological research and collections through his excavation of burials at the Pike-Pawnee Village site (25WT1). As a result of the activities of R. F. Gilder, the Museum of the University of Nebraska acquired a collection of more than 100 skulls from burial sites on the bluffs overlooking the Missouri River near Omaha (Gilder 1908, 1909). These materials figured prominently in early discussions of the antiquity and supposed primitive morphology of selected specimens, which were described as "Nebraska Loess Man" (Poynter 1915). The fourth of these nonprofessional archeologists who made significant contributions to bioarcheological research was William H. Over of the University of South Dakota. As director (1912-1949) of the museum now named in his honor and as a semiretired curator until 1952, he actively surveyed and tested many of the most important sites in South Dakota. His published field notes and reports document more than 200 sites in 43 counties (Over and Meleen 1941; Sigstad and Sigstad 1973). With the assistance of E. E. Meleen, Over excavated human skeletal remains at more than 30 sites (Owsley and Jantz 1994).

Objectives of Archeological Investigations

The types of professional archeological investigations vary, depending on their principal objective(s): for example, survey, testing, salvage, excavation, and instruction (field school). Table 40 presents data on the sites with human remains in relation to

Table 40. Sites with Human Remains Classified According to the Type of Archeological Investigation.

Type of Project		Colorado		Kansas		Nebraska		South Dakota		Total	
		Sites	Individuals	Sites	Individuals	Sites	Individuals	Sites	Individuals	Sites	Individuals
Survey	(No.)	5	5	6	7	41	58	12	54	64	124
	(%)	(11.6)	(4.0)	(3.8)	(0.7)	(13.2)	(2.0)	(5.9)	(1.2)	(9.0)	(1.5)
Testing	(No.)	2	7	0	0	17	31	3	4	22	42
	(%)	(4.7)	(5.6)	(0.0)	(0.0)	(5.5)	(1.1)	(1.5)	(0.1)	(3.1)	(0.5)
Excavation	(No.)	8	20	26	172	103	2058	34	639	171	2889
	(%)	(18.6)	(16.1)	(16.5)	(18.3)	(33.2)	(71.8)	(16.7)	(14.7)	(23.9)	(35.0)
Salvage	(No.)	5	20	16	32	47	134	104	3503	172	3689
	(%)	(11.6)	(16.1)	(10.1)	(3.4)	(15.2)	(4.7)	(51.2)	(80.8)	(24.1)	(44.6)
Field School	(No.)	0	0	1	2	0	0	0	0	1	2
	(%)	(0.0)	(0.0)	(0.6)	(0.2)	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)	(0.0)
Not Assigned	(No.)	23	72	109	728	102	587	50	133	284	1520
	(%)	(53.5)	(58.1)	(69.0)	(77.4)	(32.9)	(20.5)	(24.6)	(3.1)	(39.8)	(18.4)
Total		43	124	158	941	310	2868	203	4333	714	8266

the type of archeological investigation in the four states under consideration. More than half (53.5%) of the sites in northeastern Colorado could not be assigned to one specific objective, but of those that were, excavation was the objective for eight (18.6%), the largest number of the sites investigated, with salvage and survey next (each accounting for five [11.6%] of the sites). (Undefined cases primarily represent those projects that were initiated by amateurs and local residents.) The number of individual burials present at the sites (20, or 16.1%) was the same in both excavation and salvage projects, but only five (4%) in the surveys.

In northern Kansas, excavation and salvage accounted for most of the sites investigated, 26 (16.5%) and 16 (10.1%) respectively, but in regard to the number of individuals, excavation was the predominant objective (18.3% of 172). In this state, more than two-thirds of the sites could not be assigned to one of the "type of project" categories. In contrast to the large percentages of unassigned projects in both Colorado and Kansas, only one-third (32.9%) of the sites in Nebraska and one-fourth (24.6%) of those in South Dakota could not be assigned to one of the archeological categories. As in Colorado and Kansas, excavation was the type of investigation in Nebraska that accounted for 103 (33.2%), the largest number of sites, with by far the greatest number of individuals (2,058, 71.8%); followed by salvage with 47 (15.2%) sites and survey with 41 (13.2%) of the sites. In South Dakota, however, salvage archeology was by far the most frequent type of investigation in relation to both number of sites (104, or 51.2%) and 3,503 (80.8%) of human remains. For all four states taken together, salvage and excavation accounted for most of the sites investigated and the greatest number of human remains reported. In only one state, Kansas, was the investigation of a site a field school activity.

Burial Context

Another way of classifying the sites with human remains in Colorado, Kansas, Nebraska, and South Dakota is in relation to burial context. In Colorado, isolated burials and cemetery burials accounted for, respectively, slightly more than one-third (34.9%) and one-fourth (27.9%) of the sites, with the greatest number of individuals (59, or 47.6%) being recovered from cemeteries. In Kansas, burial mounds constituted the most frequent site context (53, or 33.5%, of the sites; 453, or 48.1%, of the individuals). Isolated burials (29, or 18.4% of the sites) and cemeteries (21, or 13.3% of the sites) were the next most frequent contexts, with cemeteries accounting for the next highest number of individual burials (218, or 23.2%). In Nebraska, the pattern was quite different, with sites and burials more evenly distributed among a variety of contexts. Isolated burials (55, or 17.7% of the sites) were the most frequent. Cemetery and ossuary contexts were next most frequent, and roughly equivalent in numbers of sites (46, or 14.8%, and 45, or 14.5%, respectively), and habitation areas and mounds, also equivalent in numbers of sites (35 [11.3%], and 34 [11%], respectively), had a somewhat lower frequency. Like Colorado and Kansas, cemeteries accounted for most of the individuals (874, or 34.0%), but unlike these states, ossuaries (840, or 29.3%), had the next highest frequency of individuals. As in Kansas, mounds were also a frequent context in Nebraska, accounting for 612 (21.3%) of the individuals. In South Dakota, mounds (53, or 26.1%) and cemeteries (44, or 21.7%) were the most frequent contexts, and cemeteries were the context of by far the most individual burials with 2,959 (68.3%). Mounds and habitation areas in South Dakota accounted for roughly equivalent numbers of individuals with 608 (14.0%) and 600 (13.8%) respectively, although mounds represented twice the number of sites, 53 (26.1%), compared to habitation areas with 26 (12.8%). Table 41 summarizes these data and shows that, for the four states taken together, mounds (19.9%), cemeteries (17.2%), and isolated burials (16.2%) were the most frequent site contexts, with cemeteries (50.9%), mounds (20.3%), ossuaries (11.3%), and habitation areas (9.2%) having the greatest number of individuals.

Archeological Traditions and Variants

The sites, together with the number of individuals represented by each and the number of these individuals that have been studied, can also be grouped in relation to the archeological traditions with which they are associated and, in some instances, with phases, complexes, and variants within particular traditions. In Table 42, Plains Village burials (that is, sites and the number of individuals associated with them) in Kansas, Nebraska, and South Dakota are grouped by archeological tradition. Central Plains tradition sites, 81 in Nebraska and 16 in Kansas, account for a fourth (26.4%) of the 5,871 individuals included in Table 42 . Most of these (1,343)

Table 41. Recovery Provenience of Human Remains.

Context		Colorado Sites	Colorado Individuals	Kansas Sites	Kansas Individuals	Nebraska Sites	Nebraska Individuals	South Dakota Sites	South Dakota Individuals	Total Sites	Total Individuals
Above Ground	(No.)	2	2	0	0	0	0	1	1	3	3
	(%)	4.7	1.6	0.0	0.0	0.0	0.0	0.5	0.0	0.4	0.0
Cairn	(No.)	0	0	2	3	0	0	2	4	4	7
	(%)	0.0	0.0	1.3	0.3	0.0	0.0	1.0	0.1	0.6	0.1
Cave	(No.)	2	5	1	2	0	0	0	0	3	7
	(%)	4.7	4.0	0.6	0.2	0.0	0.0	0.0	0.0	0.4	0.1
Cemetery	(No.)	12	59	21	218	46	974	44	2959	123	4210
	(%)	27.9	47.6	13.3	23.2	14.8	34.0	21.7	68.3	17.2	50.9
Habitation Area	(No.)	0	0	6	11	35	149	26	600	67	760
	(%)	0.0	0.0	3.8	1.2	11.3	5.2	12.8	13.8	9.4	9.2
Isolated	(No.)	15	17	29	31	55	65	17	24	116	137
	(%)	34.9	13.7	18.4	3.3	17.7	2.3	8.4	0.6	16.2	1.7
Mound	(No.)	2	4	53	453	34	612	53	608	142	1677
	(%)	4.7	3.2	33.5	48.1	11.0	21.3	26.1	14.0	19.9	20.3
Ossuary	(No.)	0	0	2	66	45	840	3	32	50	938
	(%)	0.0	0.0	1.3	7.0	14.5	29.3	1.5	0.7	7.0	11.3
Other	(No.)	0	0	1	1	2	2	0	0	3	3
	(%)	0.0	0.0	0.6	0.1	0.6	0.1	0.0	0.0	0.4	0.0
Unknown	(No.)	10	37	43	156	93	226	57	105	203	524
		23.3	29.8	27.2	16.6	30.0	7.9	28.1	2.4	28.4	6.3
Total		43	124	158	941	310	2868	203	4333	714	8266

Table 42. Plains Village Burials Grouped by Archeological Tradition.

Variant	State	Sites	Individuals	Analyzed N	Analyzed %
Central Plains	Kansas	16	210	175	(83.3)
	Nebraska	81	1343	819	(61.0)
Coalescent	Nebraska	38	629	533	(84.7)
	S.Dakota	52	3450	3248	(94.1)
Middle Missouri	S.Dakota	22	116	104	(89.7)
Oneota/Central Plains	Nebraska	2	94	31	(33.0)
Oneota	S.Dakota	1	9	5	(55.6)
Coalescent or Middle Missouri	S.Dakota	5	20	12	(60.0)
Total		217	5871	4927	(83.9)

Table 43. Numbers of Sites and Individuals Assigned to Specific Archeological Complexes or Phases of the Central Plains Tradition.

Phase	Kansas[1] Sites	Kansas[1] Ind.	Kansas[1] Studied	Nebraska[2] Sites	Nebraska[2] Ind.	Nebraska[2] Studied
Glen Elder Focus	1	1	0	—	—	—
Itskari Phase	—	—	—	12	167	108
Nebraska Phase	—	—		20	484	370
Smoky Hill Phase	2	149	146	1	1	0
St. Helena Phase	—	—	—	5	305	248
Steed-KiskerComplex	1	4	3	—	—	—
Upper Republican Phase	6	22	14	21	74	28
Total	10	176	163	59	1031	754
			(92.6%)			(73.1%)

[1]Excludes two multicomponent sites (e.g., Woodland and Central Plains Tradition) and one site with phase unknown.
[2] Excludes seven multicomponent sites and 15 sites with phase unknown.

were from Nebraska sites, and 61% of the Nebraska burials have been studied. More than four-fifths (83.3%) of the 210 individuals reported or recovered from Central Plains tradition sites in Kansas have been studied. The Coalescent tradition sites in South Dakota and Nebraska accounted for the highest percentages of individuals (69.5%), and most of these 3,450 (58.8%) were from 52 South Dakota sites. Nearly all (94.1%) of the South Dakota burials have been analyzed, as have 84.7% of the Nebraska burials.

The Middle Missouri tradition is represented by 22 burial sites in South Dakota, with 116 associated human remains, of which 89.7% have been studied. Two possible Oneota (or Central Plains tradition) sites are in Nebraska, and these yielded 94 individuals of which only a third (33%) have been analyzed. One Oneota site in South Dakota contained nine individuals, five of which have been studied, and also present in South Dakata in five undefined Coalescent or Middle Missouri sites were 20 individuals, more than half (60%) of which have been studied.

Table 43 shows the complex, focus, or phase of the sites in Kansas and Nebraska representing the Central Plains tradition. Of the 10 sites in Kansas, most (60.0%) represented the Upper Republican phase; however, most of the individuals came from two Smoky Hill phase sites. Of these 149 burials, 94% have been studied. In Nebraska, many of the sites (33.9% of 59) represented the Nebraska phase, as did most of the individuals (46.9% of 1,031). Five St. Helena phase sites yielded 29.6% of the individuals, and there were small percentages of individuals associated with 12 Itskari phase sites (16.2%) and 21 Upper Republican phase sites (7.2%). One individual came from one Smoky Hill phase site. Three-fourths (73.1%) of the individuals from the Nebraska sites have been studied.

Table 44 presents the number of Coalescent tradition sites and associated individuals in Nebraska and South Dakota in relation to archeological variants. In Nebraska, most sites (63.2% of 38) and individuals (79.5% of 629) represented the Disorganized variant. Nine sites (23.7%) and 116 individuals (18.4%) represented the Postcontact. In South Dakota, sites including both Extended and Postcontact variant burials, though only four of the 52, produced the greatest number of individuals (1,277, 37.0% of 3,450). Nearly half (46.2%) of the South Dakota sites and 1,192 (34.5%) of the individuals represented the Postcontact variant, and three sites and 499 individuals (14.5%) were classified as Initial variant. One site identified with the Disorganized variant contained 344 (10.0%) of the individuals. High percentages of the individuals from both Nebraska and South Dakota sites (84.7% and 94.1%, respectively) have been studied. As Table 44 shows, the variants represented by the greatest number of individuals at the sites in these two states

Table 44. Numbers of Sites and Individuals Assigned to Variants of the Coalescent Tradition.

Variant	Nebraska Sites	Nebraska Individuals	Nebraska Studied	South Dakota Sites	South Dakota Individuals	South Dakota Studied	Total Sites	Total Individuals	Total Studied
Initial	1	4	4	3	499	495	4	503	499
Initial or Postcontact?	0	0	0	1	5	5	1	5	5
Extended	0	0	0	13	124	95	13	124	95
Extended or Postcontact	1	2	2	4	1277	1261	5	1279	1263
Extended or Disorganized	1	4	4	0	0	0	1	4	4
Postcontact	9	116	112	24	1192	1049	33	1308	1161
Disorganized	24	500	411	1	344	338	25	844	749
Undefined	2	3	0	6	9	5	8	12	5
Total	38	629	533 (84.7%)	52	3450	3248 (94.1%)	90	4079	3781 (92.7%)

were the Postcontact (32.1%), Extended and Postcontact (31.3%), Disorganized (20.1%), and Initial (12.3%). Nearly all (92.7%) of the individuals from these sites have been studied.

In Table 45, South Dakota sites are further examined in relation to variants of the Middle Missouri tradition. Most sites (54.5% of 22) represent the Initial variant, as do most of the individual remains associated with sites (49.1% or 116). The Southern Extended variant was represented by three sites (13.6%) and 27 individuals (23.3%). All 27 have been studied, as have 86% of the 57 Initial variant individuals.

In Table 46, several important South Dakota sites are grouped by variant and are shown in chronological order within each variant. The means by which dates were established and the presence of burials with trade beads are also indicated. The chronological sequencing of these Coalescent tradition Arikara sites has provided the framework for a number of comparative studies (described in later sections) that have evaluated temporal patterning and variations in demography and skeletal traits. Extensive osteological research has focused on the skeletal collections from these seven cemeteries, which date from A.D. 1600 to 1832. The earliest sites (Mobridge, Rygh, Sully, and Swan Creek) represent late prehistoric or early protohistoric populations and contain few or no trade beads. In contrast, burials at later sites (Four Bear, Larson, and Leavenworth) that date well into the Contact period contain large quantities of European trade materials. Research has dealt with population-environmental relations and the developmental forces affecting the human skeleton.

During the Postcontact period, interdependent forces significantly affected Arikara health, demography, nutrition, and sociocultural structure. These forces included the introduction of infectious diseases such as measles and smallpox, acquisition of the horse, increased European presence, tribal migrations, and intertribal warfare. During the same time period, the Arikara experienced increased, as well as differential, morbidity and depopulation from disease, malnutrition, and warfare, changes in settlement and subsistence patterns, and general sociocultural deterioration. Thus, these collections provide samples with genetic continuity that show an increase in environmental stress as the Contact period proceeded.

Comparative analyses of skeletons from four archeological time periods (i.e., Late Prehistoric, Early Protohistoric, Late Protohistoric, and Historic) have produced data on rates of long bone growth, prenatal development, cortical bone thickness, pathology, and other variables. The ethnohistorical and archeological context of the samples provided a basis for

Table 45. Numbers of Sites and Individuals Assigned to Variants of the Middle Missouri Tradition.

Variant (South Dakota)	Sites[1]	Individuals	% Studied[2]
Initial	12	57	49
Extended	2	3	1
Extended or Terminal?	1	1	1
Southern Extended	3	27	27
Mill Creek	1	7	7
Undefined	3	21	19
Total	22	116	104 (89.7)

[1]Number of sites with human remains
[2] Number (percent) of remains that received some analysis.

Table 46. South Dakota Archeological Sites Arranged in Chronological Order and Grouped by Variant (from Jantz and Owsley 1984:15).

Sites	Burials with Trade Beads (%)	Date Range	Type of Dating
Disorganized Coalescent:			
Leavenworth (39CO9)	53.3	1802-1832	Historic
Leavitt (39ST215)	43.8	1784-1792	Ceramic
Postcontact Coalescent:			
Four Bear (39DW2)	28.1	1758-1774	Tree ring, Cer.
Larson (39WW2)	7.6	1679-1733	Ceramic
Sully E (39SL4)	5.1	1675-1700	Archeological
Mobridge F2	3.0	1675-1700	Archeological
Extended Coalescent:			
Sully A (39SL4)	2.6	1663-1694	Tree ring
Sully D (39SL4)	1.7	1650-1675	Archeological
Mobridge F1 (39WW1)	0.0	1600-1650	Archeological
Rygh (39CA4)	0.0	1600-1650	Archeological

hypotheses in relation to which the observed data could be interpreted. In addition, the sensitivity of specific osteological indicators of biological and cultural stress could be assessed as applied to the study of archeological populations.

Skeletal samples from South Dakota have provided one of the best opportunities in North America for osteological studies of the biological responses to stress during the Postcontact period. The Arikara collections represented by the seven sites listed in Table 46, together with others, include most of the early Contact period and were recovered during River Basin Surveys salvage excavations of sites threatened by inundation following construction of dams along the Missouri River. Large-scale excavations of burials representing other Historic tribes of the Plains were not conducted, although smaller collections that represent groups such as the Omaha, Ponca, and Pawnee, provide some comparative data. For example, Reinhard et al. (1994) have conducted intensive osteological research on collections from two Omaha cemeteries in northeastern Nebraska (25DK2 and 25DK10) that were associated with the Big Village site (25DK5). The two cemeteries date to a period around 1811, as indicated by the abundance of introduced manufactured goods and the occurrence of datable silver ornaments (Table 47) (O'Shea 1984; O'Shea and Ludwickson 1992a).

Table 47. Burial Artifacts in Two Omaha Indian Cemeteries (from O'Shea and Ludwickson 1992:247).

	25DK2			25DK10		
Class	Graves	%	Artifacts	Graves	%	Artifacts
Glass[1]	4	27	6	1	3	1
Trade beads	11	73	20,510	28	82	26,357
Iron	7	47	140	9	26	25
Copper or brass	7	47	299	21	62	243
Lead or pewter	3	20	8	12	35	39
Silver	6	33	28	15	44	83
Stone	4	27	17	9	26	14
Bone	6	40	29	6	18	31
Shell	4	27	16	9	26	14
Any trade good (excluding beads)	11	73		24	71	
Any trade good (including beads)	12	80		33	97	
Native-made artifact	7	47		17	50	

[1]Includes all glass and crockery items but excludes glass trade beads.

Subsistence in the Central and Northern Plains

Dependence on horticulture developed slowly in the Central and Northern Plains (Blakeslee 1994c). Woodland populations relied primarily on hunting a number of game species and on the gathering of wild seed plants and nuts. Only trace amounts of non-native cultigens have been identified in Plains Woodland sites (Adair 1984). Native cultigens are also rare; however, for the Middle Woodland period a minimal number of cultigens have been found in Kansas City Hopewell sites (Johnson 1979). No cultigens have been recovered from Valley phase sites (Ludwickson et al. 1981). In general, the transition to horticulture apparently took place primarily during the Late Woodland period.

Animal bones from Plains Woodland sites in the Middle Missouri regions indicate the predominance of bison, which declines in the Central Plains where hunting included a wide range of smaller game. There is also a difference between eastern and western regions, with fishing occurring at island and peninsula sites in the eastern Dakotas and Minnesota (Anfinson 1979) but not in the west.

During the Plains Village period, cultigens contributed importantly to subsistence. Central Plains tradition villagers and the later Arikara, Pawnee, and Omaha subsisted on a combination of hunting, collection of wild foods, and horticulture, the principal crops being corn, beans, squash, and sunflowers (Holder 1970; Nickel 1977; Will and Hyde 1917; Wedel 1986). Most meat came from bison (Falk 1977; Gilbert 1969; Parmalee 1977, 1979).

Subsistence strategies may have differed among Central Plains tradition populations (e.g., Upper Republican versus the Nebraska phase [Wood ed. 1969]). Furthermore, although the Middle Missouri and the Coalescent traditions relied on both bison hunting and corn horticulture, the extent to which the Mandan, descended culturally from the Middle Missouri tradition, were dependent on horticulture is not clear. The historic Arikara, cultural descendants of the Coalescent tradition, were major suppliers of maize to fur traders (Ewers 1954). Comparative reconstruction of subsistence strategies for the late archeological variants (i.e., Extended, Postcontact, and Disorganized Coalescent) suggest major effects resulting from Euro-American contact and climatic variation. Over the long term, events associated with these two external influences probably profoundly affected nutrition and, consequently, health.

Despite a mixed subsistence pattern, the historic Arikara experienced periods of severe undernutrition and, in fact, actual starvation of some individuals. Natural causes (such as drought, floods, late frost, and grasshoppers) resulted in occasional shortages (Hayden 1862; Will and Hyde 1917; Gilmore 1927; Abel 1939). Tabeau, for example, reported that floods had destroyed nearly all crops in 1803, causing famine (Abel 1939), and Weakly (1971) noted several periods of subnormal tree ring growth that probably reflected drought. Severe drought not only altered the carrying capacity of the prairie grassland, thus affecting the availability of bison (Wedel 1978a), but also reduced agricultural yield.

Although climatic conditions obviously had an impact on the populations of each archeological variant (e.g., the Tabeau example pertains to the Disorganized Coalescent), their results are most evident in the archeological record of Extended Coalescent populations. Small irregular clusters of houses characterized the Extended Coalescent settlement pattern. Cache pits were few and small, and refuse deposits were generally thin and lacking in cultural debris. Apparently, the settlements were occupied for short periods by groups experiencing marginal conditions.

> The available evidence suggests that the great majority of the Extended Coalescent people lived a hand-to-mouth existence in typically small communities that had a high degree of geographic mobility. This pattern contrasts sharply with that of the other village complexes of the region, and there seems to be every reason to assume that it represented a response to the unfavorable climatic conditions of the Neo-Boreal episode (Lehmer 1970:128).

The cooler summers of the Neo-Boreal episode moderated somewhat during the first half of the eighteenth century (Baerreis and Bryson 1965). This change may have led to the establishment of larger, more nearly permanent Postcontact Coalescent villages (Lehmer 1970). Other correlations between cultural history and climatic stress could contribute to a better understanding and interpretation of archeological and osteological/dental dietary trends. The relationship is complex, however, and additional background work on climatic reconstruction is needed.

Factors related to initial European contact also affected subsistence, altering and frequently disrupting Postcontact and Disorganized Coalescent lifestyles. Such factors included: the introduction of acute infectious diseases (with particular impact in crowded, unsanitary conditions); the acquisition of horses; the introduction of a variety of trade materials; and the increased intertribal warfare (often a direct or indirect result of European influence and intervention). The semi-sedentary tribes experienced changes in patterns of settlement and subsistence, adverse sociocultural changes, higher levels of morbidity, and a decline in population size as a result of disease, malnutrition, and warfare. However, prior to A.D. 1750, the impact of European influences was not always negative. Archeological materials from this period suggest that Postcontact Coalescent villages in the Northern Plains were prosperous and stable (Lehmer and Jones 1968). With the acquisition of the horse, bison hunting ranges increased, as did the number of animals killed and the amount of meat transported (Holder 1970). The number and size of cache pits also increased, reflecting successful horticultural productivity (Lehmer and Jones 1968).

The village tribes traditionally followed a shifting settlement pattern associated with planting, harvesting, and summer and winter bison hunting (Hurt 1969). The nutritional deficiencies of maize, which is limited in protein, niacin, and the amino acid tryptophan, was offset by the regular use of legumes and heavy emphasis on bison hunting (Wedel 1986).

> The ecological adaptation of the Plains Villagers obviously involved heavy dependence on both horticulture and the hunting of big game animals. This makes their ecosystem unique in Native North America. There were sedentary farmers in many other parts of the continent, but there is nothing to suggest a comparable reliance on hunting. Native North America had other big game hunters, but their economies lacked the agricultural aspect which distinguishes the Plains villagers. In terms of the subsistence base, the Plains villages resemble the mixed horticultural and pastoral economies of the Old World more closely than they do other cultures of native America. (Lehmer and Wood 1977:87)

Wedel (1986) describes techniques for processing and preparing food. Fresh meats were broiled, cooked over a spit, buried under a bed of coals, or, most commonly, boiled in pots in thick soups or stews. Dried meats, maize, beans, pumpkins, and other vegetables were also boiled. Maize was made into hominy, roasted in the husk, parched, or ground into meal with a mortar and boiled as mush or made into cakes and baked in the ashes or on hot stones.

Nomadic tribes like the Cheyenne and Sioux of the eighteenth and nineteenth centuries were hunters and gatherers who relied primarily on bison, although not to the exclusion of elk, antelope, deer, and a variety of small game (Wedel 1986). The prairie turnip, which was eaten raw or dried for later use in stews and soups along with meat, was the most important wild vegetable food. Maize was obtained through barter or by raiding the horticultural tribes. Other foods included ground nuts, roots, wild fruits and berries, Jerusalem artichoke, and sunflower seeds. This subsistence pattern, although often bountiful, included lean times as well.

> To an even greater extent than with the seasonal bison hunters, these nomadic tribes underwent periods of plenty and scarcity, of adequate and inadequate nutrition, of more or less balanced and unbalanced diets. Lacking the food reserves stored underground used among the permanent villages to the east, the hunters had to adjust to even greater extremes in subsistence. The hardships arising from such a routine of living must have exacted a heavy toll in child mortality and among the women during the long hard winters and the rigorous 'starving time' of late spring. With the dried meat and stored vegetable reserves dwindling or used up, the game was still lean and scarce from the winter, the grass was not yet greening to feed the herds, and few spring shoots and roots were available for the people to gather to eke out the most meager survival diet. (Wedel 1986:200)

Seasonal migration and subsistence patterns were disrupted during the historic period, with food shortages becoming increasingly common in Disorganized Coalescent villages in spite of the greater mobility provided by the horse.

> The food resources of the horticulturalists [sic] also reflected the changing conditions. There was the direct demand of the products themselves. In addition, the labor of the women was diverted into channels of hide working and the production of other commodities for the trade. The failure of food crops, any unusual demands on the stored surpluses, such as raids by nomads, would empty the storage cists of their irreplaceable surplus. The horticulturalists [sic] themselves now operated close to the subsistence minimum for their own needs (Holder 1970:117).

Intertribal conflict caused food shortages. Wedel (1978b) described the problems experienced by the Pawnee under conditions of constant harassment.

> Villages were repeatedly burned during the absence of the tribe on bison hunts; women working fields at a distance were killed, molested, or abducted; and the crops were neglected as a result. Recurrent is the theme that fear of the raiders hampered cultivation, resulting in short crops or none at all. When village hunts were started early to make up with meats the food thus lost, improperly processed maize and beans mouldered in the caches. The hunting parties were under frequent heavy attack, returning to the villages with limited meat and supplies and robes or none at all. In 40 years of reporting there is repeated mention of insufficient food in prospect for the winter (Wedel 1978b:11).

The difficulties of the Arikara paralleled the situation of the Pawnee, as statements among the earliest documents (ca. 1795, see Beauregard 1912) indicate. Tabeau (Abel 1939) called the Leavenworth (39CO9) Arikara the serfs of the Sioux, as they had to endure the presence of the Sioux with little or no benefit therefrom. Throughout the trade period, the Sioux set trade prices to their own advantage, looted gardens, stole horses, and beat the women. After leaving, they wandered about keeping the buffalo away from the villages. Fear of the Sioux also inhibited the Arikara gathering of prairie turnips (Wedel 1978c).

Increased mobility, facilitated by the horse, occurred during the Historic period, which in the case of the Arikara was especially during the last quarter of the eighteenth century following the smallpox pandemic of 1781-1782 (Wedel 1955). Villages, which were normally occupied for 15 to 30 years (Holder 1970), changed location more frequently. Lehmer and Jones (1968) and Wedel (1955) outline Arikara migration from one locality to another during the late 1700s and early 1800s. Some semblance of semipermanence was reestablished with the founding of the Leavenworth and Ashley Island villages in 1803: "Thirty-five years of wandering came to a halt" (Lehmer and Jones 1968:94). However, Ashley Island was abandoned before 1811, and both Leavenworth villages were unoccupied for part of 1823-1824. Furthermore, the Arikara, numerically reduced by smallpox and hemmed in by the Sioux, had to give up tribal hunts as a regular practice by 1815 (Will and Hyde 1917). Previously, bison hunting had provided a substantial proportion of their food.

Demography of Central and Northern Plains Populations

Temporal Trends in Paleodemography

Owsley (1992) examined temporal trends in paleodemography using data from Northern Plains samples representing the Archaic Woodland and Extended, Postcontact, and Disorganized variants of the Coalescent tradition. For comparison, data on 26 Archaic and Woodland sites in eastern North and South Dakota and northwestern Minnesota are included in the analysis, as well as the limited data from one Central Plains and one Southern Plains site. The Northern Plains Woodland samples dating from A.D. 1-600 came from Sonota complex burial mounds (32SI1) near the Missouri River in South Dakota. Subsistence for the Woodland populations represented by these samples depended primarily on the hunting of bison and gathering.

Seven Plains Village samples from South Dakota represent the three centuries of substantial demographic change that occurred following 1550 during the Extended (A.D. 1550-1675), Postcontact (1675-1780), and Disorganized (1780-1860) Coalescent tradition. The seven sites used in the analysis are Cheyenne River (39ST1), Four Bear (39DW2), Larson (39WW2), Leavitt (39ST215), Leavenworth (39CO9), Mobridge (39WW1), and Sully (39SL4). Multicomponent sites with multiple cemeteries, such as Mobridge and Sully, were particularly useful in the examination of trends in morbidity and mortality over time. Subsistence at these Plains Village sites was based on a mixture of horticulture, hunting, gathering, and trade.

For the Central Plains, one site, Linwood (25BU1), a Pawnee village in Nebraska occupied from 1779-1809 and 1851-1857, provided limited data. A sample from one site in the Southern Plains, McLemore (34WA5), a pre-Columbian, Washita River phase village dating to 1150-1375, yielded data for comparison with the Central and Northern Plains sites.

Studies by Bass and Phenice (1975), Palkovich (1978a), Williams (1994), and Owsley (1985-1989) are the sources of the demographic data used in the analysis of trends in mortality over time. To minimize interobserver error, broad age categories are used, and comparisons in the following analyses are of preadults (i.e., age <15 years) and adults (>15 years of age) representing the various regions and time intervals.

As Figure 51 shows, mortality among preadults was approximately 15% greater at Coalescent tradition sites in the Northern Plains than among the Archaic and Woodland samples of the Northern and Northeastern Plains. The two Central and Southern Plains sites had equivalent rates of preadult mortality, both being slightly higher than that of the Northern Plains Coalescent tradition samples. The differences between the Woodland and Coalescent tradition population samples were statistically significant ($X2 = 53.3$; $df = 4$; $P = 0.0000$) and reflected mainly the difference in subsistence patterns, although increasing Euro-American contact and trade played a part. The high rate of preadult mortality at the pre-Columbian Southern Plains site suggests that increasing population density and the accompanying deterioration of sanitary conditions in a sedentary village over time also contributed to high preadult mortality. More data on both precontact and later populations are needed to clarify and substantiate the trends suggested in Figure 51.

The highest rates of preadult mortality occurred during the eighteenth century, with infant deaths accounting for much of the childhood mortality. There was an especially high mortality rate for perinatal infants at Larson, with 40.9% of the total sample dying between birth and one year (Owsley and Bass 1979).

Adult mortality also changed over time, as Figure 52 shows. The Northern Plains Woodland and Southern Plains prehistoric samples showed approximately equivalent rates of death for 15-

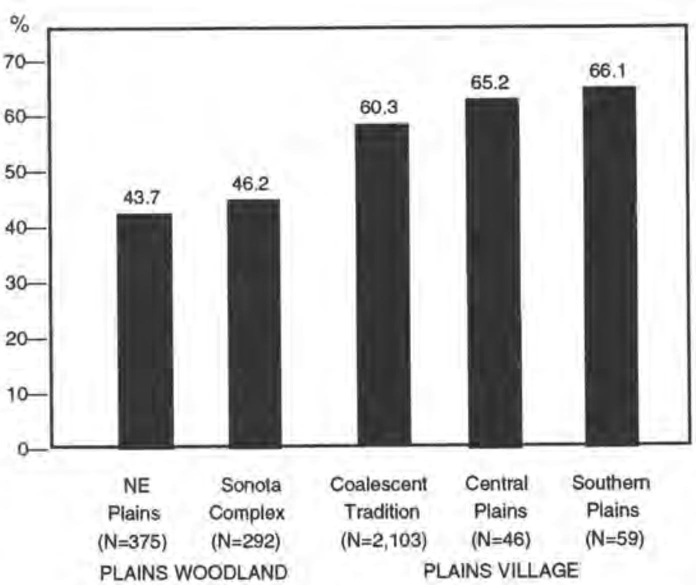


Figure 51. Percent of individuals less than 15 years of age in Woodland and Plains Village mortality distributions.

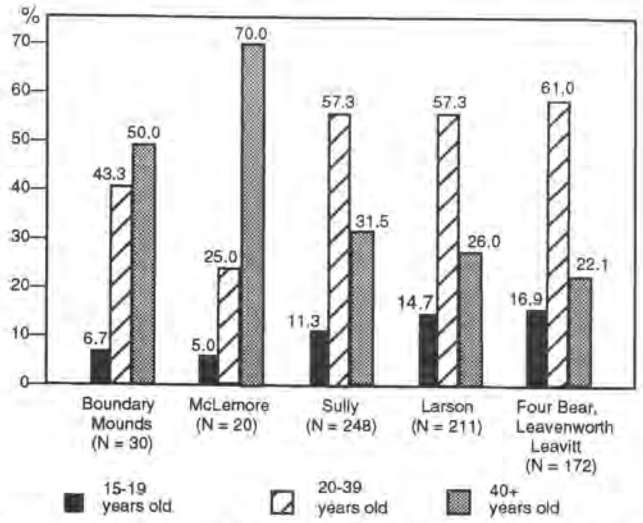


Figure 52. Age-specific mortality distributions of adults in Woodland and Plains Village cemetery samples.

19 year olds, but older adults in the Northern Plains samples did not live as long as those in the Southern Plains sample. Subsequently, during the Coalescent tradition, preadult mortality increased and the number of older adults declined compared to the Woodland period. After 1740, only about one-fifth of the Plains Village population in the Northern Plains attained the age of 40.

Table 48 presents life table values for Sully and for the combined late eighteenth to early nineteenth century series from Four Bear, Leavenworth, and Leavitt. Based on the age distribution at death (Dx), the life table data for the various age categories show the probability of dying (qx), the percentage of deaths (dx), and the percentage of survivors (lx). The percentages of deaths for all age categories less than 20 were higher in the later time period (1758-1832). Slightly more than two-fifths (43.3 %) of the Sully sample survived to age 20, but a century later the percentage had decreased to slightly less than one-third (31.6%). At the later sites, the probability of death was higher for all age categories up to 40 than for these age categories at the earlier site

Sex Differences in Mortality

Mortality profiles of Coalescent tradition villagers from South Dakota are characterized by high percentages of deaths during the first year of life. Such phenomenal losses coincide with large numbers of fatalities of young adult females. At Larson (39WW2), for example, the mortality curve shows a slightly higher percentage of female deaths relative to males during the adolescent years (Owsley and Bass 1979). At age 15-19 years, both sexes experienced increased numbers of deaths, but the rise was especially marked for females. In fact, the actual peak in female mortality occurred during this interval, and the percentage remained higher than that of males through the early twenties. In a combined sample totaling nearly 1,500 individuals (Figure 53), 31.5% of the deaths occurred during the first year of life (Owsley and Bradtmiller 1983). The number of adult female deaths was greater than that of males between the ages of 15 and 30 years, especially during the teenage years (Figure 54).

This difference in sex-related mortality could be due to complications in pregnancy and childbirth, an association supported by analysis of the Larson burial configuration. In cases of multiple interments within graves, the only consistent pattern involves the pairing of infants with "young to middle-aged females, probably childbirth mortalities" (Bass and Rucker 1976). On a case by case basis, however, the presence of a newborn in the grave of an adult female does not necessarily reflect a mother-infant relationship. Without genetic testing, definite familial association is confirmed only when fetal remains are found in utero. Such an event is rarely documented in archeological context on a worldwide basis, and this is also true in the Great Plains.

For the Arikara, Owsley and Bradtmiller (1983) have reported only two cases out of 221 females (0.9%) with fetal skeletal remains in the abdomen or pelvis. One individual from Larson was aged 17 to 19 years. The other, aged 30-34 years, from Mobridge (39WW1) was pregnant with twins. The femur lengths of the fetuses measure 31 and 33 mm, indicating that one twin was slightly larger than the other, a common occurrence in twins, and that the gestational age was about 24 weeks. An Omaha female, aged 15.5 to 17.5 years, from Big Village (25DK5) also died while pregnant (Reinhard et al. 1994). Except for the increased risk incurred with a multiple pregnancy, examination of the skeletons did not provide conclusive evidence that these deaths were caused by the hazards of childbearing. However,

Table 48. Abridged Life Table Values for 1650-1733 (Sully) and 1758-1832 (Four Bear, Leavenworth, Leavitt) (from Owsley 1992:81).

	Distributions of Deaths				Survivors		Probability of Death	
	1650-1733		1758-1832		1650-1733	1758-1832	1650-1733	1758-1832
Age	N(Dx)	%(dx)	N(Dx)	% (dx)	(lx)	(lx)	(qx)	(qx)
0-4	193	37.99	198	48.81	100.00	100.00	.380	.438
5-9	45	8.86	53	11.73	62.01	56.19	.143	.209
10-14	22	4.33	29	6.42	53.15	44.46	.081	.144
15-19	28	5.51	29	6.42	48.82	38.04	.113	.169
20-29	69	13.58	49	10.84	43.31	31.62	.314	.343
30-39	73	14.37	56	12.39	29.73	20.78	.483	.596
40-49	45	8.86	17	3.76	15.36	8.39	.577	.448
50+	33	6.50	21	4.65	6.50	4.63	1.000	1.000
Total	508		452					

Dx-number of deaths reported in each age interval; dx-percentage of deaths in each age interval; lx-number of survivors entering each age interval; qx-probability of dying in an age interval.

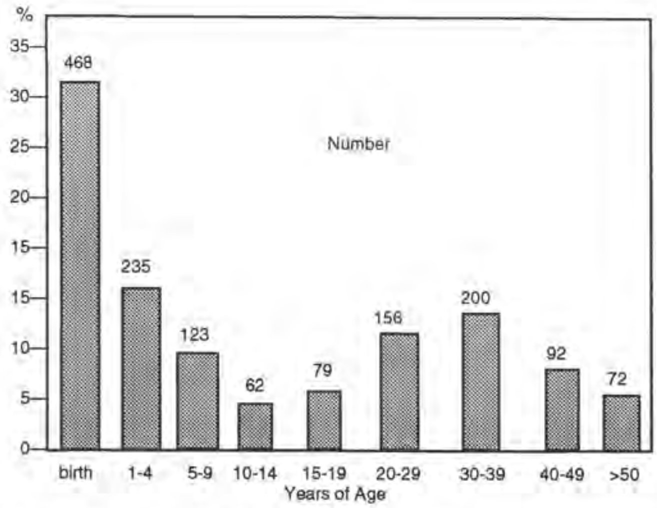


Figure 53. Age-at-death distribution of a combined Coalescent tradition series from Larson, Leavenworth, and Sully (N = 1487).

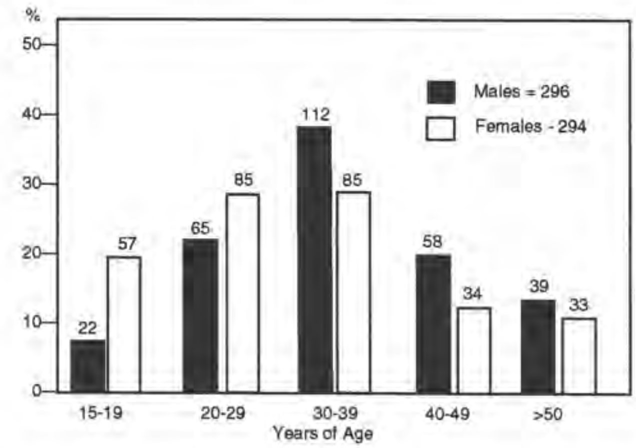


Figure 54. Male and female mortality distributions for adults from Larson, Leavenworth, and Sully.

this lack of evidence is not surprising, as antepartum complications such as toxemia or premature rupture of membranes do not affect the skeleton.

With traditional health care practices, postpartum complications, including hemorrhage, hypertensive disorders, and puerperal sepsis, undoubtedly caused large numbers of deaths of young adult females and their babies. Whether such complications were responsible for the differential mortality noted in the age-sex distribution needs further investigation through comparative analyses of mortality distributions through time and across different geographical regions. If pregnancy and obstetrical problems were not the primary factor, other variables, both cultural and biological, need to be considered. Some evidence suggests that Plains Indian participation in the fur trade had an especially negative effect on female health.

A review of the ethnographic literature for the Omaha, a group heavily involved in the fur trade, suggests that this commitment increased workloads for women (Reinhard et al. 1994). Females were largely responsible for household construction and maintenance, farming and gathering wild foods, raising children, cooking, processing foods and jerky for later use, preparation of hides and animal skins, making clothing, collecting firewood, and bead and quill work. Garden crops were raised for local consumption and for trading. Females were kept especially busy processing hides and skins. As noted by Fletcher and LaFlesche (1911:615), "one woman could scarcely give proper attention to all the skins secured by a good hunter; still less could she do the additional work occasioned by the pressure of trade."

Reinhard et al. (1994) have demonstrated the effects of higher activity levels and physical strain on historic period villagers. Comparisons of small numbers of precontact St. Helena and postcontact Omaha and Ponca skeletons from northeastern Nebraska show more severe vertebral lipping (osteophytosis), even in a younger aged sample, and higher frequencies of Schmorl's depressions and spondylolysis in the later period. Moreover, vertebral pathology was more severe in Omaha and Ponca females than in males and spondylolysis was more common. Separate neural arches represent fatigue fractures in the spinal column, a condition partially triggered by stooped-over postures employed while scraping hides. Differences were also detected in dental attrition. Omaha females show increased anterior tooth wear relative to the prehistoric period and to contemporaneous males, a trait probably due to softening hides by chewing. "Such tasks placed women at greater risk to other dental diseases and hence, lowered the quality of their lives" (Reinhard et al. 1994:74). Traditional female tasks combined with labors associated with the fur trade led to more pronounced degenerative disease and dental pathology. Heavy work loads contributed to early deaths and perinatal mortality.

Perinatal Infant Mortality

Village populations experienced increased rates of morbidity and mortality during the Postcontact period. Prenatal growth was also adversely affected. Figure 55 shows the distribution of femur diaphysis lengths of 375 perinatal infant skeletons in four Arikara cemeteries (Owsley and Bradtmiller 1983). Long bone lengths are linearly correlated with gestational age (from the last menstrual period) and can be used to estimate the age of the fetus or neonate. In this series, mortality was greatest for babies with femur lengths measuring 75 to 79 mm, the size of most term infants at birth, and the time of greatest neonatal mortality. Smaller infants, not found in utero, represent premature births or infants that were small for gestational age (SGA).

Comparative analysis of age-at-death distributions based on long bone lengths of nearly 500 Arikara infants dating from A.D. 1600-1733 and 1760-1835 shows a significant change during the Postcontact period (Owsley and Jantz 1985). Differences in the cumulative proportions reflect higher percentages of smaller sized infants in the later period (Figure 56). The age frequency distribution for the earlier sample has its mode at 39 weeks, which compares favorably with the mean gestational age of live-

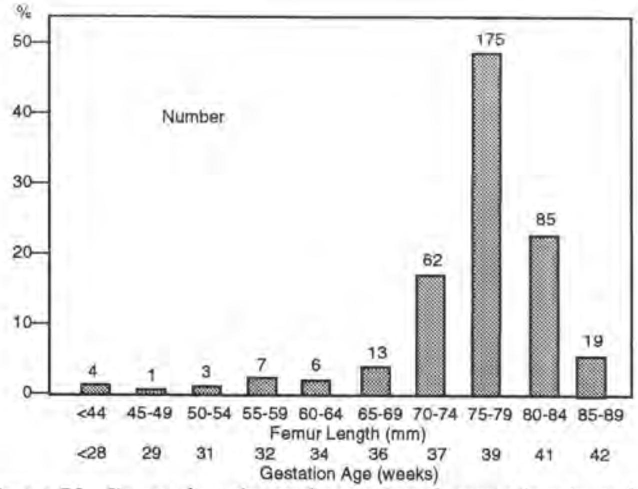


Figure 55. Femur lengths and gestational ages of perinatal infants from four Coalescent tradition sites: Larson, Leavenworth, Mobridge, and Sully

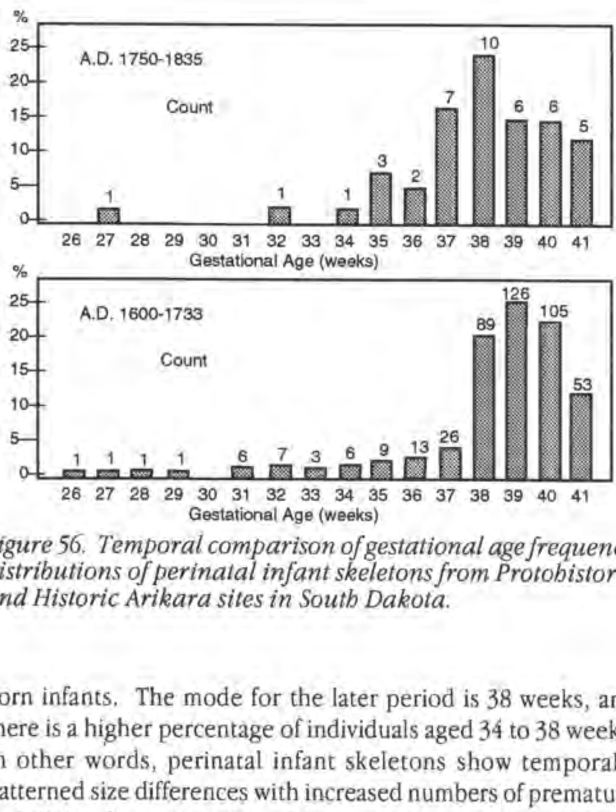


Figure 56. Temporal comparison of gestational age frequency distributions of perinatal infant skeletons from Protohistoric and Historic Arikara sites in South Dakota.

born infants. The mode for the later period is 38 weeks, and there is a higher percentage of individuals aged 34 to 38 weeks. In other words, perinatal infant skeletons show temporally patterned size differences with increased numbers of premature and SGA infants, as indicated by younger age assignments, in the later series. Mothers had a harder time carrying babies to term and full size. Overwork, malnutrition, and maternal illness are important factors in the etiology of premature deliveries and SGA infants.

While it is valid to expect that these samples might also show differences in older infant and childhood mortality rates, relatively little work has been done in this regard. Jantz and Owsley (1985) have examined mortality differences during the first two and a half years of life among Extended, Postcontact, and Disorganized Coalescent villagers from South Dakota. Dental calcification ratings for the deciduous teeth were used to delineate small age categories in order to test for microdemographic variation. The distributions for the three variants show significant heterogeneity along with some features in common. Following birth, secondary modes are seen in all samples between the age of 7 to 12 months. This period possibly indicates the introduction of whole foods, which could have resulted in gastrointestal infections and increased mortality from weanling diarrhea. Mortality from one to two and a half years represents a period of generally declining mortality.

One of the most puzzling differences concerns rates of mortality at birth. Although both the Extended and Postcontact Coalescent samples show high mortality peaks at birth, the Disorganized Coalescent does not, but otherwise, it shows fairly high mortality throughout infancy. The small number of deaths at birth in the Disorganized variant, where one would expect high mortality, is of particular concern. This inconsistency could be a sampling effect, however, Disorganized Coalescent samples from Nebraska show a similar pattern. Perhaps this effect relates to the deaths of so many young adult females with concomitant loss of their potential fecundity.

Longevity

The adult mortality profiles for this region pertain primarily to young to middle-aged adults, as there are relatively few older individuals represented in the cemetery collections. Undoubtedly, elderly individuals were present, although their numbers may be slightly underrepresented either as a result of cultural practices involving burial in other locations or differential preservation of fragile (e.g., osteoporotic) remains. More likely, perhaps, is that the use of standard osteological criteria for age determination resulted in underestimation of the age of some older individuals in these population samples. (Underestimation can be a problem because the older an individual is, the more difficult the accurate determination of chronological age.)

Undernumeration of the older portion of a population could result from preferential mortuary treatment and special burial. However, there is little archeological or ethnohistorical evidence of alternative burial practices or locations (i.e., away from village cemeteries) for elderly individuals. Furthermore, bone preservation at many archeological sites in the Plains is quite good, permitting recovery of remains of both infants and the elderly.

The skeleton of one especially old individual is that of a woman recovered from a small mound near the Crow Creek village (39BF11) (Willey and Mann 1986). The burial dates to the Plains Village period, but it could represent either the Middle Missouri or Coalescent occupations of the site. Age was determined by using standard morphological criteria such as degenerative features in the pubic symphysis, nearly complete fusion of endocranial sutures, an obtuse (120°) gonial angle of the mandible, thin cranial vault, loss of trabecular bone and open medullary cavities in the humeri, and arthritic lipping of the right femoral head. The skeleton showed several pathological conditions in the spinal column that are related to advanced age, including anterior osteophytosis, severe osteoporosis, and marked spinal kyphosis. The bodies of the scapulae are thin, pleated, and distorted, and the glenoid cavities show arthritic lipping. Other degenerative conditions attributable to old age occur in the distal ulnae and radii, which are bilaterally eburnated, and the navicular and first cuneiform of each foot, which are ankylosed. The ribs have a distorted "shepherd's crook" form as a result of severe osteoporosis and spinal kyphosis. Based on these traits, estimated age at death was well over 70 years. After Owsley examined more than 2,000 skeletons from Plains Village sites in South Dakota and Nebraska, he found no others, with the exception of one incomplete Crow Indian skeleton from Montana, that showed evidence of such an advanced age as this one from Crow Creek.

Determination of trends in population longevity through time and in different geographical regions in the Central and Northern Plains should receive a high priority in future research. At present, there is little information available on average life span, longevity, or number of elderly individuals in early populations. Few individuals of advanced age have been identified, and, in spite of the aforementioned caveats, this assessment probably represents reality for many Plains groups.

Epidemic Diseases, Tuberculosis, and Treponemal Infection

Epidemics

In the eighteenth and nineteenth centuries, epidemic diseases led to marked changes in the demographic and cultural patterns of Central and Northern Plains populations (Deetz 1965; Lehmer 1971, 1977; Oliver 1962; Ray 1974, 1976; Sharrock 1974). However, only recently have studies begun in the Plains on the effects of epidemic diseases on, for example, the size of Native American populations and the resulting cultural changes. The combined use of epidemic disease models, ethnohistorical literature, and archeological and osteological data are leading to a better understanding of the impacts of such epidemics. Historical circumstances associated with the more recent epidemics provide a foundation for analysis of osteologically derived demographic data.

In crowded living conditions, acute infections, specifically measles, smallpox, influenza, whooping cough, and cholera, had a generally devastating effect on Plains tribes, although rates of morbidity and mortality differed among them. These diseases are typically restricted to one species, produce immunity in survivors, and are not viable for an extended time outside the host, thus a large population is necessary for their maintenance and spread (Black 1966, 1975; Burnet and White 1972). In addition, for a disease to continue at full strength in a given community requires an ongoing influx of previously unexposed persons, such as newborns and migrants. Typically, there is initially a low incidence of such diseases, which is succeeded by periodic epidemics in which morbidity and mortality are high among those who are susceptible. In a small population under acutely crowded conditions, the infections will run their course and die out. However, with the addition of susceptible individuals, the same disease may begin anew. In communities such as those on the Plains, in which all individuals initially lacked immunity (so-called "virgin soil" populations), infectious diseases decimated tribal populations.

The episodic pattern is apparent in the incomplete ethnohistorical records for the eighteenth and nineteenth centuries. At least eight major epidemics of smallpox or measles are documented between the early eighteenth and mid nineteenth centuries, in 1735, 1750, 1780-1782, 1801-1802, 1831-1832, 1837-1838, 1845-1846, and 1856 (Deetz 1965; Truteau 1952; Spalding and Smith 1958; Teit 1930; Thompson 1915; Hyde 1959; Mitchell 1842; Stearn and Stearn 1945; Denig 1961; Chardon 1932; Moore 1846). Trimble (1989) compiled an extensive list of historically documented epidemics among Plains Indians and other North American groups. The lack of disease resistance and consequent high mortality during the smallpox pandemic of 1780-1782 suggest that many groups such as the Arikara, Mandan, and Hidatsa were "virgin soil" populations. This pandemic apparently originated in New Mexico and moved north among migratory hunters and villagers along the intertribal trade route (Lehmer 1977). A drastic reduction in population size of the affected tribes followed, with an accompanying decrease in the number of villages and amount of territory controlled. For example, estimates based on number of villages, number of houses per village, and average number of individuals per household suggest a pre-epidemic population amounting to roughly 19,000 (7,500 Arikara, 6,000 Mandan, and 5,500 Hidatsa). The postepidemic estimate for the three tribes is 5,950, a loss of 13,000 (68%) (Lehmer 1977). As Lehmer (1977) notes, these estimates are consistent with the data on mortality in the subsequent 1837-1838 epidemic. Prior to it, the estimated combined population of the three tribes was about 7,000, of whom 5,000 died (a mortality rate of 70%), with the greatest loss of life among the Mandan.

As an example of the consequent drastic reduction in the number of villages and amount of territory controlled, of 24 large, late-eighteenth-century Mandan and Hidatsa towns in a 60-mile area along the Heart and Knife rivers, only five small villages remained by the early 1800s, and none of these was more than 4 miles from the mouth of the Knife River (Lehmer 1977). The cultural impact, that is, the loss of specialists in crafts such as pottery and of tribal leaders, resulted in intratribal and intertribal disorganization and conflict, thereby affecting physical well-being, as reflected in osteological data.

An outbreak of smallpox that swept through the Central Plains in 1831 primarily affected the Pawnee of south-central Nebraska but did not reach the Northern Plains (Trimble 1992). More than 3,000 Pawnee (roughly 50% of the population) died. The subsequent passage of the Vaccination Act of 1832 resulted in innoculation of some 3,500 Iowa, Omaha, Otoe, Pawnee, Teton, Yankton, and Yanktonai individuals (Trimble 1992, 1994). However, none of the groups along the Missouri River north of Fort Pierre (in mid South Dakota) were vaccinated.

The diffusion of epidemics of smallpox, measles, whooping cough, and other such infectious diseases along the Missouri River trench was directly related to patterns of social interaction, as only humans can carry and transmit the so-called "acute crowd infections." The ethnohistorical record shows three time periods associated with the introduction of such diseases. The first began with European contact in the Southwest (ca. A.D. 1650) and ended about 1800. During this interval, the only acute infectious diseases to reach the Middle Missouri trench were smallpox and, possibly, measles (Stearn and Stearn 1945). The 1780-1782 epidemic was the most widespread and severe. The Northern Plains groups had relatively little contact with Euro-Americans at this time, although there was probably contact with the Arikara as early as 1714 (Berry 1978; Holder 1970). The first recorded visit to them by Euro-Americans was in 1738 (Lehmer 1971), and contact during the La Verendrye expeditions of 1742 and 1743 is well documented (Wood and Thiessen 1985). Osteological evidence shows that direct contact (i.e., Euro-Americans living in Arikara villages) with the Arikara occurred several decades earlier than the archival sources indicate, specifically at the Swan Creek site (39WW7) near the Grand River (Jantz and Owsley 1994).

Historical accounts also indicate that French traders were living among the Pawnee as early as 1700 and that a Frenchman lived in the Middle Missouri area in 1742 (Lehmer 1971; Nasatir 1952; Beauregard 1912; Wedel 1979a). Between 1742 and 1800, direct links were well-established, and many European traders resided in tribal villages (Lehmer 1971). Such contact undoubtedly facilitated the introduction of disease pathogens into the susceptible native population.

A second era of contact resulting from the extension of the Canadian fur trade into the Upper Missouri River Valley began in the late 1790s and ended about 1820. During this period, contact between Europeans and the horticulturists in the area increased. Wishart (1975) estimates that in 1807 there were fewer than 50 traders on the Upper Missouri but that by the 1820s there were nearly 1,000. (See Holder [1970] and Deetz [1965] for chronological reviews of the major expeditions into the Missouri Valley.) As a result, infectious diseases thus introduced devastated the non-immune populations.

The creation of permanent trading posts along the Upper Missouri in the 1830s marks the third period in which the transmission of epidemic diseases followed frequent contacts between the traders and the Native Americans who settled near these outposts. The smallpox epidemic of 1837-1838, which was spread along the Missouri River by personnel on the steamboat *St. Peters,* was catastrophic. In a seven-week interval, the disease was transmitted to nearly every tribe living in or near the Missouri Valley and, through intertribal contacts, became pandemic across the Plains (Trimble 1992). The more northern populations, which had been little affected by the epidemic in 1831, were especially hard-hit. Estimates of eyewitnesses suggest that 50% of the Arikara, Assiniboine, and Hidatsa, two-thirds of the Blackfeet, and 87% of the Mandan succumbed to the disease.

Using archival data on the 1837-1838 epidemic, Trimble (1979) developed an epidemiological paradigm incorporating such variables as disease ecology, human biology, culture, and environment to explain the spread of the disease and differential morbidity and mortality among tribes (Trimble 1992, 1994). Transmission of the disease was greater among the large, densely populated, semisedentary, horticultural communities, in which an infectious disease could sweep through an entire village in a matter of days, than it was among small, fragmented, nomadic groups. The disruption of planting and harvesting schedules in a horticultural community led to nutritional stress and further mortality (Trimble 1992). In nomadic bands, the group dispersed into scattered family units (in effect, a kind of quarantine) to avoid the disease. Though not entirely preventing transmission, this strategy diminished the impact and often prevented the spread to other nomadic groups. The loss of all specialists in a craft vital to the well-being of a tribe was one of the most devastating impacts in sedentary communities, but was virtually unknown among nomadic tribes (Trimble 1992).

The substantial decrease in Plains populations, such as the Mandan, Hidatsa, and Arikara, changed the balance of power, with shifts in tribal allegiances and boundaries. Reduction in manpower resulted in inability to defend traditional territories. Villages became isolated garrisons that could not effectively defend themselves and their crops from the nomadic Sioux, who increasingly raided the horticultural settlements (Trimble 1994). The few surviving Mandan had to join with the Hidatsa and later the Arikara. Further, as the Mandan and Hidatsa were the principal brokers of the intertribal trading system on the Upper Missouri River, with their decline the system deteriorated and dependence on white traders and their goods increased.

From the ethnohistorical record and Trimble's (1979, 1992, 1994) epidemiological analysis of the 1837-1838 epidemic, it is evident that:

- Native Americans of the Plains had little or no immunity to smallpox and other such infectious diseases, thus exposure to these diseases resulted in massive epidemics and a drastic increase in morbidity and mortality among tribes of the Central and Northern Plains.
- Periodic outbreaks of disease recurred as individuals entered an affected group (though birth and migration).
- The greatest impact of infectious diseases occurred in densely populated horticultural centers, with small, scattered nomadic groups having higher rates of survival and less cultural disruption.
- The Vaccination Act of 1832 benefitted both sedentary and nomadic tribes in the lower Missouri River Valley, but the Arikara, Assiniboine, Blackfeet, Cree, Hidatsa, and Mandan were not vaccinated and were decimated by the epidemic of 1837-1838, with a consequent shift in the balance of power to nomadic tribes such as the Sioux, as well as increased intertribal strife and loss of cultural heritage.

Nineteenth century records on epidemics can contribute to the interpretation of osteologically derived demographic data on, for example, Arikara, Omaha, and Pawnee villages such as Leavenworth (39CO9), Big Village (25DK5, 25DK2, and 25DK10), and Pike Pawnee Village (25WT1). These communities experienced epidemics, and the mortality distributions undoubtedly include fatalities resulting from infectious diseases. Demographic evidence of these episodes should be reflected in high crude death rates, a large number of deaths during infancy, increased numbers of deaths during adolescence (a time in life when death was relatively uncommon), and short life spans. Leavenworth, for example, had a much higher crude death rate (63 per 1,000) than that (53 per 1,000) estimated for the earlier Extended/Postcontact Coalescent Sully site (39SL4) (Bass et al. 1971). Relative to Sully, the mortality distribution of a late eighteenth and early nineteenth century series (39CO9, 39DW2, and 39ST215) shows higher percentages of deaths for all ages less than 20 years and proportionally fewer individuals older than 40 years (Table 48 ; Owsley 1992).

To assess the effects of earlier (seventeenth and eighteenth centuries) epidemics on Plains populations will require the combined approaches of archeology, skeletal biology, and historical demography. A central question yet to be resolved is whether the dramatic change in population size began—even in remote areas like the Plains—immediately after European settlement of the New World and far in advance of direct contact.

Ramenofsky (1987) used number and area of settlements and amount of roofed area to document changes in the population size in the Middle Missouri subarea. She argues that disease-induced depopulation began as early as the 1600s. Archeological evidence suggests a succession of early outbreaks of infectious disease during the seventeenth century. Thereafter, historical records provide evidence of epidemics in the late eighteenth and early nineteenth centuries.

Paleodemographic data exhibit particularly high mortality rates early in the seventeenth century, thus suggesting the early impact of epidemics on Extended and Postcontact Coalescent populations like Mobridge and Sully (Owsley 1992). These sites have multiple cemeteries, and those that date to the last half of the century have fewer subadults. These internal differences in demographic profiles are probably linked to early introductions of communicable diseases such as measles and smallpox. Individuals who survived the high mortality experienced by the first generation exposed to the disease were immune to subsequent outbreaks, leaving a smaller pool of susceptible hosts and, in effect, less mortality, at least in relation to a particular disease. In spite of these early epidemics, the Arikara population increased until late in the seventeenth century when disease pressure intensified again, accompanied by an escalation in the level of warfare. Irreversible population decline began about A.D. 1700, as evidenced in sites like Larson (39WW2) (Owsley and Bass 1979). Larson had an extremely high infant death rate and high rates of childhood mortality. The peak age of adult female mortality was between the ages of 15 and 19 years.

Archeological excavation of the Larson village produced evidence of depopulation. Successive rebuilding of earth lodges showed that the later structures had smaller perimeters and were reduced in size. In addition, the site had two fortification ditches, of which the inner one was stratigraphically more recent, thus reflecting a marked contraction in the size of the village. Larson eventually reached a threshold below which defense was no longer possible. It was destroyed by intertribal warfare and its inhabitants massacred (Owsley et al. 1977). For the Arikara, population decline continued through the eighteenth and nineteenth centuries, as illustrated by changes in age-specific mortality rates.

Efforts to identify and model the effects of infectious diseases, as manifested in the mortality distributions derived from Plains skeletal collections, have just begun. The well-documented, relatively large, Plains Village samples spanning the Prehistoric and Postcontact periods offer demographers one of the best available opportunities in North America for this type of analysis. Accumulating the data for these samples is a formidable task, and analysis will require sophisticated demographic models, simulations, and collaboration with paleodemographers to interpret distributions of age at death over time. The potential contribution of an osteological approach to the understanding of Plains paleodemography is yet to be realized, although the initial steps have been taken by Moorhead (1992), Owsley and Bass (1979), Owsley (1992), and Palkovich (1981).

Tuberculosis and Treponemal Infection

Although the existence of pre-Columbian tuberculosis has been documented for the Americas, this disease was probably relatively uncommon among early Plains populations. Examination of a large number of commingled skeletons from Crow Creek (39BF11) revealed no indications of skeletal tuberculosis in this Initial Coalescent village (Gregg and Gregg 1987; Zimmerman et al. 1980). Williams (1993, 1994) has identified six cases of probable tuberculosis from Woodland sites in the Northern Plains, including the DeSpigler site (39RO23) in South Dakota.

Tuberculosis was a major health problem during the Postcontact period. Palkovich (1978b) identified two individuals of 246 (0.5%) at Mobridge (39WW1) and eight individuals of 621 (1.3%) at Larson (39WW2) with skeletal lesions suggesting tuberculosis. The effect on morbidity and mortality would have been pronounced, as clinical studies reveal that only a small percentage of tuberculosis cases exhibit skeletal lesions (Morse 1969; Steinbock 1976). Palkovich (1978b) estimates that these counts represent only 2-3% of all cases. If relative numbers of diagnosed cases are a guide, and as Mobridge predates Larson, tuberculosis became more prevalent during the Postcontact period.

Cases of tuberculosis involving the skeleton show various loci of bone destruction—the spinal column, hip, knee, sacroiliac joint, and ankle. A case from the Larson cemetery, a young woman 16 to 18 years old, displays diffuse osteolytic lesions in the lower thoracic and lumbar vertebral bodies, the medial surface of the left innominate, one rib, both distal radii, and a proximal tibia (Gregg and Gregg 1987). The authors describe the case as follows (Gregg and Gregg 1987:60):

> The extensive involvement of more distant parts of the skeleton indicates hematogenous dissemination of the infection throughout the victim's body. Death in this instance was from overwhelming general sepsis, with pulmonary or central nervous system complications being its most likely cause. Had this individual survived, the affected vertebrae would have collapsed with the resultant hunchback deformity. In addition, after vertebral collapse, she would very likely have been paralyzed in the lower part of her body due to spinal cord compression.

Burial 33a from Mobridge, Feature 302, provides a classic example of Pott's disease (spinal tuberculosis). This skeleton of a female, 18 to 22 years old, shows destruction of the bodies of lumbar vertebrae 2-5, which resulted in kyphosis of the spine. Bone lesions are also present on the left and right radii, one lower left and two lower right ribs, the proximal metaphyseal regions of the right and left tibiae, and the left calcaneus and talus. Bony growths occur on the left innominate above the acetabulum. Changes in the pelvic area reflect the spread of the infection from the vertebral bodies through formation of an abscess that ruptured through the anterior longitudinal ligament of the spine into the psoas muscle, allowing migration of infection into the pelvis. Additional examples of psoas abscess infection of pelvic structures were found at Mobridge (Rose, Marks, and Kay 1984) and Leavitt (39ST215) (Cleaves 1994) (Figure 57).

In 6.2% of the skeletons examined from the cemeteries of Mobridge, Sully (39SL4), Larson, and Leavenworth (39CO9), Kelley et al. (1994) reported periosteal reactions on the visceral surfaces of the ribs as a result of pulmonary disease (Table 49). Site comparisons did not show a statistically significant difference in the percentages of individuals with rib lesions; however, there was a slight decrease in the number of ribs affected per individual in the Postcontact Coalescent samples. Most cases (87%) exhibited unilateral involvement and tended to be localized in the middle and upper ribs. Adolescents were most often affected, with a subsequent decline in incidence among young adults, followed by an increase among middle aged to older individuals. A majority of these cases can be attributed to pulmonary tuberculosis, as indicated by the relative ages of the individuals affected, the location, frequency, and appearance of the rib lesions, and the correlation of these results with current medical literature and the pathogenesis of tuberculosis versus other respiratory illnesses such as pneumonia.

Village density and close quarters inside an earth lodge facilitated the spread of tuberculosis among the semisedentary horticulturists. However, the equestrian nomads of the nineteenth century also suffered from this disease, as paleopathology cases found among the Crow from Montana (Figure 58) and the Sioux of South Dakota show. For example, skeletons of two males (NMNH 380272, 380273), 20-24 years of age, found on the Crow Creek Sioux Reservation (when exposed by erosion) show rib pathology caused by periosteal inflammation. Although the frequency of pulmonary tuberculosis has decreased markedly during the twentieth century, it continued to be a serious health problem for some Native American groups in the Northern Plains (Gregg and Gregg 1987).

Yaws, pinta, venereal syphilis, and endemic syphilis (bejal) are syndromes of the infectious disease known as treponematosis. The presence of treponematosis in prehistory has been widely debated, with the argument centering on whether the condition (primarily venereal syphilis) existed in the New World prior to European contact. However, advances in paleopathological analyses, resulting in criteria for identification of the skeletal changes related to the onset of the disease (Hackett 1976), and chemical testing have led to documentation of treponemal infection in the Americas prior to European contact (Baker and Armelagos 1988), thus resolving the controversy.

Reports of treponemal disease in the paleopathological literature are relatively rare for Plains groups despite historic accounts frequently mentioning the presence of venereal disease in tribes such as the Arikara (Abel 1939; Beauregard 1912).

Table 49. Rib Periostitis in Extended, Postcontact, and Disorganized Coalescent Sites from South Dakota (from Kelley et al. 1994).

Site	Ribs Affected Mean N (SD)	Rib Lesions /Individuals	%
Mobridge F1	2.8 (0.82)	5/76	6.6
Mobridge F2	5.4 (3.40)	10/152	6.6
Sully A, D	3.4 (1.67)	9/128	7.0
Sully B, E	5.7 (4.46)	6/70	8.6
Larson	6.0 (2.73)	12/244	4.9
Leavenworth	4.0 (1.00)	3/70	4.3
All Sites	4.6	46/740	6.2

Palkovich (1978b) reports treponemal-like infection in skeletons from Mobridge, thus offering support for the historic accounts of disease in the region following European contact. In their analysis of frontal bone lesions and the presence of treponemal disease in Native North Americans, Stewart and Quade (1969) report a relatively low frequency of frontal lesions in Plains skeletons. Only eight cases of cranial lesions were found in the six Postcontact Arikara sites included in their analysis (Mobridge [39WW1], Nordvold sites 1, 2, and 3 [39CO31, 32, and 33], Leavenworth [39CO9], and Sully [39SL4]), and of these most were single, small depressions of probable traumatic, rather than infectious, origin.

Several studies suggest that treponemal disease was present in prehistoric Plains groups. Bass and Phenice (1975) describe a possible case of acquired syphilis in an adult female from the Middle Woodland Period site of Swift Bird. The skeleton displayed osteomyelitis on both tibiae, the left fibula and ulna, the distal ends of both radii, and the left malar. Schermer et al. (1994) describe several examples of periostitis and osteitis resulting from probable treponemal infection in Woodland period sites in western Iowa, and Gregg and Gregg (1987) report possible evidence of syphilis in Initial Coalescent skeletons from Crow Creek. Tuross and Owsley (unpublished data) tested for treponemal antigens in a study of molecular preservation in ancient North American human bone. Their positive results confirmed the presence of treponemal infection in prehistoric South Dakota skeletons of the Woodland period.

The inability of anthropologists to recognize and report treponemal infection may have contributed to the apparently relatively low incidence in Plains samples. As techniques for identification of diseases in prehistoric populations develop, for example, chemical analysis of bone, there may be clearer evidence of treponemal disease among Plains Native Americans. Such has been the case in regard to the presence of other diseases in prehistoric samples.

Periostitis, Osteomyelitis, and Cranial Infections and Tumors

Skeletons from the Central and Northern Plains show low to moderate frequencies of periostitis and osteomyelitis. Periostitis involves inflammation of the periosteum as evidenced by the deposition of new bone on the outer surface of the affected element (Mann and Murphy 1990). Osteomyelitis, which results from an acute or chronic infection, affects both the marrow and the bone cortex. Inflammation accompanies the infection and

Figure 57. Osteolytic destruction of the acetabulum suggestive of tuberculosis (39ST215, NMNH 382742).

Figure 58. Localized, mild periosteal reaction on the visceral surface of a left rib consistent with pulmonary tuberculosis (Crow, HF5341).

causes bone remodeling and expansion (thickening of the cortex), often with a draining sinus (cloaca) (Mann and Murphy 1990).

The primary causes of these conditions are difficult to determine. Especially in the case of periostitis, many factors (for example, trauma, blood-borne infection, venous insufficiency, and scurvy) contribute to localized or widespread dissemination throughout the skeleton. The severity of the response offers clues to the origin, and data on frequency of occurrence provide a basis for generalizations about the health status of past populations.

Localized periostitis is a response to an injury (traumatic or infectious) or to a hematogenous infection originating in another part of the body. It is the most commonly recorded form of the condition in human skeletons from the Plains and is usually found on the diaphyses of the tibiae or fibulae, as indicated by the specific examples shown in Table 50. Bilateral, or widespread, periostitis, which reflects a systemic hematogenous infection or other systemic disease, has also been documented in skeletons from the Central and Northern Plains, although at a lower frequency than for localized periostitis. A characteristic of treponemal infection is periostitis accompanied by saber-shin morphology, and periostitis on the visceral surface of ribs is consistent with pulmonary tuberculosis.

Although routinely recorded in Central and Northern Plains skeletal series, rarely have researchers conducted systematic studies of periostitis and osteomyelitis to discover possible relationships to regional patterns of nutrition, types of trauma, or diseases. In one of the few analyses of this type, Zimmerman et al. (1981) dealt with Crow Creek skeletons and found an association of osteomyelitis and periostitis with trauma and nutrition. The authors attributed two cases of secondary osteomyelitis to nonlethal scalping. Two cases of pyogenic osteomyelitis, both in tibiae and fibulae of subadults, were also present in the Crow Creek series. In all, 148 cases of periostitis and accentuated periosteal markings were noted (Zimmerman et al. 1981). These cases were widely disseminated throughout the skeletons, ranged from mild to severe, and were both generalized and localized. Some were associated with skeletal trauma. The most frequent sites were the proximal tibia, the distal and proximal femur, and the proximal humerus. Both children and adults suffered from the condition, and Zimmerman et al. (1981) indicate that the frequency and severity of periostitis among Crow Creek subadults were greater than in other Northern Plains skeletal series. They suggest that the relatively high rate resulted from disturbances in the nutrition or metabolism of these children.

Palkovich (1981) conducted an intrasite analysis of pathological conditions and noted differing levels of periostitis in earlier and later occupations of Mobridge. In skeletons from the earlier occupation (Feature 1), 1.2% of the individuals studied displayed localized periostitis. For Feature 2, the frequency was 6.1%, indicating a marked increase. Palkovich does not associate these cases with major systemic disease processes affecting the population but suggests instead that periostitis resulted primarily from localized infections.

Other studies, such as one conducted by Shermis (1969) on Leavenworth (39CO9) skeletal remains, found that a large number of the pathological conditions recorded (affecting 10.1% of the sample) were inflammatory, and half of these cases were osteomyelitis. However, Shermis failed to differentiate between cases of otitis media, mastoiditis, infections from intrusion of foreign bodies (such as gunshots), and localized periostitis. Thus, it is difficult to generalize with regard to causation or frequency of these conditions.

A major focus in paleopathology research on skeletons from South Dakota has been cranial pathology and anomalies. The biomedical research value of the William H. Over skeletal collection was first recognized by investigators from the Medical School and Speech and Hearing Clinic of the University of South Dakota. They examined crania in the Over collection for evidence of ear pathology, with special emphasis on otosclerosis and stapedial footplate fixation (Holzhueter et al. 1965; Steele et al. 1965; Gregg et al. 1965; Gregg, Steele, and Holzhueter 1965). Radiographic examination of the temporal bones showed high frequencies of abnormalities in mastoid air cell patterns, indicating significant amounts of infectious middle ear disease during childhood. Other studies reported on external auditory canal exostoses (Gregg and Bass 1970; Gregg and McGrew 1970), unusual osteolytic defects (Gregg, Steele, and Bass 1982), and tumors of the lacrimal gland (Gregg and Bass 1994).

Extreme cases of otitis media and mastoiditis have also been found in children from the Central and Southern Plains (Mann et al. 1994). One case, involving an Omaha child, 5 to 6 years old, from 25DK10, showed intramedullary lytic lesions in the ribs and long bones, resorptive lesions in the spine and both temporals, and porotic hyperostosis. Gross and radiographic examination of the lesions suggested that the child suffered from histiocytosis X, accompanied by otitis media and mastoiditis.

To adequately document the frequencies of specific types of bone pathology and corresponding changes in disease patterns over time and in different areas of the Great Plains will require much additional work. Although the studies mentioned have suggested patterns and relationships, many questions remain unanswered. A major limitation is the lack of standardization in data collection procedures and protocols, which would facilitate comparative analysis. Another problem is the lack of temporal depth, as most of the published reports concern Extended and early Postcontact Coalescent sites. In Circumcontact and Postcontact periods, shifts in the nature and incidence of disease often occurred, yet evidence of this transitional era and its disease impact as reflected in bone pathology has not been adequately examined through comparative studies of population samples from the Late Prehistoric through the Historic periods. Knowledge of prehistoric sites is especially limited. John Gregg initiated several studies that included prehistoric samples from the William H. Over series, with emphasis on cranial pathology and anomalies. The Initial Coalescent ossuary sample from Crow Creek (A.D. 1325) is the only large prehistoric collection that has been examined for cranial and postcranial pathology. For many of the Archaic, Woodland, Central Plains, and Middle Missouri tradition groups of this region, frequency data for periostitis and

Table 50. Selected Cases of Periostitis and Osteomyelitis in Central and Northern Plains Skeletons.

Variant	Site	Specimen	Description
Woodland	5AH244[1]	B2, Male, age 35-39	Mild periostitis on all major long bones
Middle Woodland/Central Plains	25D02[2]	S50, Adult	Possible healed infection on humerus & femur
Middle Woodland	25DW233[3]	Mdl, F2, Bl,#122, Adult male	Periostitis on both tibiae
		Mdl, F2, B2,#123, Child	Periostitis on distal right humerus
		Md2, #169 & 170,Child, age 6-10	Periostitis covering shaft of humerus & vertical border of scapula
		Md2, Bl, #166,Adolescent	Periostitis on shafts of both ulnae,radii, & femora, right humerus,fibula, ilium, & pubis, & left clavicle
		Md2, B2, #168,Adult female	Periostitis on anterior shafts of both tibiae
		Md2, B3, #169,Adolescent	Periostitis on anterior shafts of both tibiae
		Md2, B3, Adult female	Osteomyelitis on both tibiae, left fibula, distal ends of both radii, left ulna, & left malar (possible acquired syphilis)
		Md2, B4, #171(1),Adolescent	Periostitis on shafts of left tibia & fibula, & inner & outer surfaces of left ilium
		Md2, B5, #172,Adolescent	Severe periostitis covering tibia, metacarpals, metatarsals, & lateral border of left scapula
	39DW240[3]	Mdl, B2	Periostitis on 2 left fibulae
		Mdl, B8	Periostitis on right femur & left fibula
		Mdl, B9	Localized periostitis on right fibula
Middle/Late Woodland or Central Plains	140B401[4]	Female, age 25-30	Large area of periostitis along anterior edge of midshaft of right tibia
Middle/Late Woodland	14PH4[5]		Diffuse osteitis over the midshaft of left fibula
Woodland or Initial Middle Missouri	39LM57[6]	Exhibit T, #20b	Moderate to severe periostitis on posterior shaft on right femur along linea aspera
Woodland ?	39CH210[6]	Exhibit Y, #27, Female, age 30-40	Periostitis on midshaft of right tibia
Oneota or Central Plains	25RHI[7]	Individ. 11, Adult male	Pinpoint osteitis at midshaft of right tibia; both femora also show reaction
		Individ. 13,Subadult, age 14-17	Periostitis on right tibia
		Individ. 35, Adult male	Healed periostitis on right femur
		Individ. 37, Adult female	Osteitis on left fibula
Middle Missouri	39CA102[8]	6.3 91-112-4, Individ. 1, Male, age 21-46	Active thickened periosteal bone on anterior medial surface covering two-thirds of shaft of left tibia
		6.3 91-112-182, Adult	Nonspecific periostitis on distal third of diaphysis of fibula
		6.3 91-112-370, Individ. 5, Male	Distal half of right tibia symmetrically thickened with anterior bowing (saber shin); mild midshaft periostitis on left tibia with slight bowing
		6.3 91-112-1, Individ. 2, Male, age >23	Sclerous scar on posterior distal surface of right femur above medial condyle (inflammatory rerponse to injury of medial head of gastrocnemius muscle)
		6.3 91-112-186, Individ. 5	Sclerous scar, same area as above but on left femur
Plains Village	39BR13[6]	Exhibit X, #25, Individ. 2	Bilateral periostitis on posterior distal surface of both tibiae
	39LM227[9]	B1, Male, age 25-35	Swelling osteitis of midshaft of right tibia
Central Plains	25CU28[10]	Adult male	Periostitis on both tibiae (mild infectious response, well remodeled)
	25WN3[11]	Adult female	Active periostitis on both tibiae (possible treponema infection)
Extended Coalescent	39CA[6]	Exh. B, #2b, Individ. 2, Subadult, 16-19	Mild periostitis on popliteal area of left femur & on both tibiae
	39CA4[12]	B-A, Subadult	Subacute osteomyelitis on femur & sequestrum
	39WW203[13]	Burial 1, Male, age 40-50	Elliptical swelling on anterior crest of right tibia
Extended/Postcontact Coalescent	39SL4[12]	F211, Bla, #8750, Female, age 35+	Periostitis & lytic lesion on right fibula; periostitis on both tibiae
		F320, B13a, #9300,Female, age 40+	Mild periostitis (hematoma) on right tibia
		F320, B19b, #9342, Female, age 35+	Periostitis on proximal end of right tibia
		F420, B1, #9422, Female, age 50+	Periostitis on tibia
		F421, B23d, #9607,Child, age 4-6	Periostitis on proximal femur
		F421, B23h, #9612,Male, age 30	Severe periostitis on tibia
		F421, B24, #9618, Female, age 40+	Possible osteitis on pubis
	39WW1[14]	F101, B8b, Child, age 2-3	Periostitis on tibia
		F101, B9e, Female, age 23-38	Periostitis on distal right femur
		F101, B12b, Adult male	Periostitis on midshaft of left fibula
		F101, B26b, Infant, age 1.5-2.5	Periostitis on humerus
		F201, Bleghijk, Male, age 35+	Small inflammatory lesion on posterior distal left femur
		F201, B2a, Infant, age 6-12 mos.	Periostitis on rib
		F201, B16c, Child, age 6-7	Subperiosteal thickening on right humerus
		F201, B16e, Adult male	Periostitis on tibia fragment
		F201, B18a, Infant, age 6-12 mos.	Periostitis on long bones
		F201, B26e, Male, age 45+	Periostitis on left tibia
		F201, B36e, Female, age 45+	Periostitis on tibia
		F302, B21a, Male, age 20-22	Mild periostitis on fibula
		F302, B21d, Female, age 20-24	Mild periostitis on tibiae, radii, & ulnae
		F302, B27b, Female, age 40+	Mild periostitis on fibula
		F302, B27e, Female, age 40+	Severe fracture of right rib 4 with spicular periostitis
		F302, B38c, Female, age 19-21	Mild periostitis on proximal tibia
	39WW1[6]	Exhibit G, #7, Individ. 2	Moderate periostitis on left fibula
	39WW7[15]	Isolated adult	Osteomyelitis on right femur,
		B3, Male, age 20-24	Periostitis (2 small patches) on midshaft of left fibula
		B9, Subadult, age <15	Localized area of healed periostitis on medial aspect of distal tibia
	39WW7[16]	BGX-3, Element 4, Adult female	Healed periostitis on left tibia
Postcontact Coalescent	25PT1[17]	S3-C3-B2, Female, age 50+	Periostitis on tibiae and fibulae; osteomyelitis on dorsal left pubic symphysis, ramus, dorsal sacrum, &transverse processses of L5, T11-12, & neural spines of T10-11
	39CO34[6]	Exhibit A, #1	Moderate periostitis on popliteal area of posterior femur; mild periostitis on right tibial tuberosity

Table 50, cont.

Variant	Site	Specimen	Description
Postcontact Coalescent, cont.	39ST216[18]	NMNH #381162, Adult female	Severe periostitis on distal femur (possible septic arthritis)
		NMNH #381176, Male, age 23	Periosteal inflammation of the distal third of humerus
		NMNH #211158B, Female, age 20-23	Subperiosteal hematoma on femur
		NMNH #211158F, Female, age 19-21	Possible osteomyelitis on distal third of first metatarsal
Disorganized Coalescent	39CO9[19]	Child, age 2-5	Extensive reactive bone on left humerus, right scapula, distal left clavicle, & left scapula
		Sk. 92, Subadult, age 12	Pyogenic activity on right ilium & proximal femur; large areas of reactive bone with several cloaca (involucrum) on anterior surface of femur (i.e., new bone created during repair following acute inflammatory disease
		Sk. 202, Subadult, age 12-17	Osteomyelitis of the tarsal bones (2 calcanei, 1 talus)
		Sk. 228, Male, age 18-30	Healed osteomyelitis on distal third of right femur; active osteomyelitis on distal right fibula
		Sk. 87, Female, age 18-30	Osteomyelitis of ribs with swelling & perforations; pathological fracture & dissemination to spine of right scapula
Unknown	5MR3[20]	Bl, Female, age 45-55	Osteomyelitis related to fracture of clavicle; periostitis on both femora, tibiae, humeri, ulnae, & radii
	39BK9001[16]	Individ. 1, 54:01, Male, age 25-30	Active periostitis along most of shaft of left tibia & fibula

[1] Hummert (1982)
[2] Parker (unpublished data)
[3] Bass and Phenice (1975)
[4] Bass (1987)
[5] Bass (n.d.)
[6] Williams (1988)
[7] Wicklund (n.d.)
[8] Williams (1993)
[9] Bass and Jantz (1965)
[10] O'Shea and Bridges (1989)
[11] Owsley (unpublished data)
[12] Gregg (unpublished data)
[13] Smith and Jantz (1972)
[14] Kelley (unpublished data)
[15] Rose et al. (1984)
[16] Willey et al. (1987)
[17] Bellande and White (n.d.)
[18] Cleaves (1994)
[19] Shermis (1969)
[20] Scott and Birkedal (1972)

osteomyelitis are not available. The compilation of these data should be based on detailed skeletal inventories so that precise counts can be generated by age, sex, and cultural context for comparative analysis.

Cribra Orbitalia and Porotic Hyperostosis

Dietary disorders can result in pathological changes in the skeleton. Such changes often are limited to the skull and are characterized by lesions affecting the outer and inner tables of the parietal, occipital, and frontal bones and the superior orbital plates. Porotic hyperostosis appears as osteoporotic pitting and thinning of the outer table of the frontal, occipital, and/or parietals, accompanied by hypertrophy, or expansion of the cranial diploe ("hair on end" effect). Cribra orbitalia is osteoporotic pitting on the superior orbital plates and often occurs in combination with porotic hyperostosis (Mann and Murphy 1990; Ortner and Putschar 1981). Although iron deficiency anemia is most often cited as a cause of porotic hyperostosis and cribra orbitalia (Steinbock 1976; Stuart-Macadam 1985, 1987), the etiology of the two conditions is not yet fully understood. Diseases other than anemia that have been associated with this pathology include rickets, toxic disorders, and infection (Lallo et al. 1977; Mensforth et al. 1978; Ortner and Putschar 1981). In general, any condition leading to a vitamin or mineral deficiency, and in turn causing nutrient loss, could be a cause.

Evidence of cribra orbitalia in Central and Northern Plains skeletons is limited. Individual descriptions of the condition for skeletons dating from the Woodland through the Disorganized Coalescent periods appear in Table 51, and frequency data compiled for a few sites in South Dakota are presented in Table 52. Variation in scoring methods and interobserver error complicate assessment of the frequency of the condition in Plains samples. For example, in frequency data compiled for Mobridge (39WW1 F01, F02, F03), three researchers each reported different frequencies of cribra orbitalia for a single site (Table 51).

Table 51. Frequencies of Cribra Orbitalia in Central and Northern Plains Skeletal Series.

	Site	N	With Cribra Orbitalia	%
Late Woodland	39RO23[1]	50	0	0.0
Late-Late Woodland	39CL2[1]	40	0	0.0
Initial Coalescent	39BF11[1]	392	18	4.8
Exended/Postcontact	39WW1[1]	55	2	3.6
	39WW1-F01[2]	122	7	6.0
	-F02	33	1	3.0
	-F03	22	5	23.0
	39WW1-F01[3]	163	0	0.0
	-F02	200	2	1.0
	39WW7[1]	82	1	1.2
Postcontact	39DW2[1]	41	1	2.4

[1] Gregg and Gregg (1987)
[2] Rodriguez (n.d.)
[3] Palkovich (1981)

Although the data are limited, some patterns are evident. Reported data concur with previous findings on the prevalence of cribra orbitalia in young individuals (Mann and Murphy 1990). As Table 53 shows, in Plains skeletons cribra orbitalia occurs most frequently in children or young adults, which is consistent with iron deficiency being most common in children and women of child-bearing age.

The frequencies of cribra orbitalia in Central and Northern Plains skeletal series also suggest a temporal trend from rare examples of the condition in early Woodland peoples to increasing frequencies in Initial and Postcontact Coalescent periods in South Dakota. In an analysis of Archaic and Woodland skeletons from the Northern Plains, Williams (1994) reports low frequencies of cribra orbitalia in the early series and proposes a correlation of the condition with the emergence of horticulture in the region. The transition from a hunter-gatherer mode of subsistence, affording a varied diet, to horticulture and the consumption of corn, would be conducive to an increase in nutritional stress, manifested, for example, in iron deficiency anemia, as corn, with its high phytic acid content, inhibits the absorption of iron (Mollgaard et al. 1946). To correlate the incidence of cribra orbitalia with subsistence patterns and

Table 52. Selected Cases of Cribra Orbitalia in Central and Northern Plains Skeletal Series.

Variant	Site	Specimen	Description
Woodland	39LN10[1]	Ind. 1 B6, 9-20-60, Child, 10-12 years	Bilateral cribra orbitalia (slight)
Late Woodland	39RO23[2]	Juvenile	Slight cribra orbitalia
Central Plains	14WY7[3]	Lab. 10, Child, age 9 mos.	Cribra orbitalia with beginning porotic hyperostosis
		Lab. 11, Child, age 3 years	Cribra orbitalia with probable porotic hyperostosis (hydrocephalus?)
		Lab. 12, Child, age 4 years	Cribra orbitalia
		Lab. 21, Child, age 6 mos.	Beginning cribra orbitalia and porotic hyperostosis
		Lab. 31, Child, age 3-7 years	Cribra orbitalia
		Lab. 47, Child, age 4 years	Severe cribra orbitalia
		Lab. 48, Child, age 5-6 years	Cribra orbitalia
		Lab. 53, Child, age 3 years	Beginning cribra orbitalia with slight cranial osteoporosis
		Lab. 54, Child, age 18 mos.	Cribra orbitalia with beginning porotic hyperostosis
		Lab. 61, Child, age 7 years	Small area of healed cribra orbitalia
Extended Coalescent	39WW203[4]	Exhibit 2 #29	Bilateral cribra orbitalia (healed)
Extended/Postcontact	39SL4[5]	F320 B21 #9346, Subadult, age 12-14	Cribra orbitalia
Coalescent	39WW1[6]	F201 B16b, Child, age 3-4 years	Mild cribra orbitalia
Postcontact Coalescent	25PT1[7]	Oc 12W, Infant, age 6 mos.	Cribra orbitalia
Disorganized Coalescent	25PK1[8]	Sk. 19, Child, age 2-3 years	Cribra orbitalia (healing)
Unknown	14RW310[9]	UBS 1989-03, Female, age 36-44 years	Porotic lesions on orbit roof—cribra orbitalia
	25CC62[8]	Burial S1a, Child, age 5 years	Eye orbits with pitting

[1] Willey et al. (1987)
[2] Williams (1994)
[3] Barnes (1977)
[4] Williams (1988)
[5] Gregg (unpublished data)
[6] Kelley (unpublished data)
[7] Bellande and White (n.d.)
[8] Owsley (unpublished data)
[9] Moore-Jansen (1990)

nutritional health of Plains groups from the Archaic through the Historic periods will require additional data and systematic analyses. These conditions are less prevalent in Plains Indians than is the case for many groups in the Americas.

Congenital and Developmental Anomalies

The types of anomalies present in Plains Native American skeletons are similar to those found in other skeletal series and contemporary populations. The incidence of such abnormalities has probably not changed appreciably over the past millennium (Gregg and Gregg 1987). In their overview of congenital and developmental disorders, Gregg and Gregg (1987) list the common loci for human skeletal abnormalities, viz: the skull, spine, sacrum, hip, hands, and feet. Congenital or developmental anomalies recorded in Plains skeletons at these and other loci included macrocephaly, microcephaly (and various degrees of craniosynostosis), abnormalities of the basicranium and craniovertebral junction, facial maldevelopment, and disorders of the axial skeleton (some of which [e.g., spondylolysis] are discussed in other sections of this report). Anomalies of the hands and feet are rarely documented as a result of circumstances of field recovery, mortuary practices, and poor preservation.

Cranial Abnormalities

The most fully described of the congenital and developmental abnormalities documented in Plains skeletons are those of the cranium. Such abnormalities (not including facial maldevelopment or basicranial anomalies), although rare, occur in both prehistoric and historic series (Table 54). Gregg and Gregg (1987) report five cases (two adults and three children) of macrocephaly (abnormally large skull) among 2,500 crania from the Dakota Territory, all of which displayed supranormal intracranial capacity. One of the two adults showed evidence of gigantism, which would have resulted in a larger than normal cranial capacity consistent with enlarged elements of the postcranial skeleton. The provenance of neither of the adult skeletons is known, thus their ethnic affiliation is also unknown.

The archeological context of the three children with forms of macrocephaly, reported by Gregg and Gregg (1987), is known. One child is classified as hydrocephalic, a condition that can be congenital or can result from, for example, brain tumor, meningitis, or injury with a subsequent buildup of cerebrospinal fluid and intracranial pressure (Gregg and Gregg 1987). The specific cause in this child and the other two children with macrocephaly could not be determined, but severe forms of the condition prevent survival beyond early childhood. The hydrocephalic child did not survive past seven years of age.

Microcephaly, or premature closure of the cranial sutures resulting in an abnormally small skull, also occurs in Plains skeletons. A child 1.5-2.5 years old from the Sully Site (39SL4) in South Dakota shows a severe form of microcephaly (Figure 59), with near complete closure of all cranial sutures. This child undoubtedly died from complications related to the condition.

Less severe forms of craniosynostosis (premature suture closure) reported for the region include a clear case of scaphocephaly (Eiseley and Asling 1944) in an adult female who was approximately 30 years old at death. Unlike the microcephalic child, or instances of oxycephaly (premature closure of both the coronal and occipital sutures), scaphocephaly results from premature closure of only the sagittal suture, which leads to an antero-posterior rather than transverse increase in the size of the skull. The subsequent narrowing of the skull results in a lack of parietal tuberosities. In spite of these changes, a scaphocephalic skull is bilaterally symmetrical and shows less extensive deformation than do oxycephalic skulls.

Postcranial Abnormalities

Among other congenital and developmental deformities that are not life-threatening and that have been found in Central and

Table 53. Selected Cases of Ectocranial Porosis/Porotic Hyperostosis in Central and Northern Plains Skeletal Series.

Variant	Site	Specimen	Description
Woodland (?)	39HL4[1]	6.6 92-13, Individual 1	Mild ectocranial porosis on occipital, right parietal, & posterior frontal
		6.7 92-200, Individual 1	Mild ectocranial porosis on parietals & occipital; slight bossing and "hair on end" effect
Late Woodland	39RO23[2]	Juvenile	Porotic hyperostosis
Late Woodland or Initial Middle Missouri	39BK20[2]	6.4 92-10, Individual 1	Moderate to severe ectocranial porosis on occipital, parietals, & frontal
Woodland or Plains Village	39HU205[3]	Adult female	Bilateral porotic pitting on cranium
Central Plains	14WY7[4]	Lab. 8, Child, age 5 years	Severe porotic hyperostosis with premature synostosis of coronal, sagittal & occipital sutures
		Lab. 10, Child, age 9 mos.	Beginning porotic hyperostosis
		Lab. 11, Child, age 3 years	Porotic hyperostosis with cribra orbitalia (probable hydrocephalus)
		Lab. 14-18 Children, age 1.5-8 years	Varying degrees of porotic hyperostosis on several skull fragments
		Lab. 20, Child, age 8-9 years	Slight, healed ectocranial porosis on occipital & frontal
		Lab. 21, Child, age 6 mos.	Porotic hyperostosis and beginning cribra orbitalia
		Lab. 22, Child, age 10-12 years	Healed porotic hyperostosis
		Lab. 23, Child	Porotic hyperostosis
		Lab. 42, Female, age 59-61	Healed ectocranial porosis
		Lab. 45, Adult, age 31-32	Healed porotic hyperostosis
		Lab. 47, Child, age 4 years	Beginning porotic hyperostosis
		Lab. 53, Child, age 3 years	Slight cranial osteoporosis with beginning cribra orbitalia
		Lab. 54, Child, age 18 mos.	Beginning porotic hyperostosis and cribra orbitalia
		Lab. 61, Child, age 7 years	Small area of healed porotic hyperostosis on occipital
Plains Village	39BR13[5]	Exhibit X #25, Individ. 2, Female, age 16-23	Ectocranial porosis along midline on parietals & frontal
		Exhibit X #26, Individ. 1, Male, age 35-40	Ectocranial porosis along midline on parietals & frontal
		Exhibit X #26, Individ. 2, Male, age 40+	Ectocranial porosis along midline on parietals & frontal
	39HU5[6]	I. 2, 10.71.5; 22,23,27, Male, age 40+	Porotic hyperostosis on parietals near bregma
Extended Coalescent	39WW203[5]	Exhibit Z #28, Male age 35-40	Ectocranial porosis along midline of skull on parietals & frontal
Extended/Postcontact	39SL4[7]	F420 B2a RBS #9532, Male, age 22-28	Cranial porosity; "hair on end" effect
		F421 B9c RBS #9571, Female, age 23-28	Cranial porosity; "hair on end" effect
		F421 B16 RBS #9585, Male, age 24	Cranial porosity; "hair on end" effect
		F421 B39 RBS #9674, Female, age 24-28	Cranial porosity; "hair on end" effect
		F421 B96 RBS #9820, Male, age 18-24	Cranial porosity; "hair on end" effect
		F421 B105a RBS #9887, Male, age 35-40	Cranial porosity; "hair on end" effect
		F421 B117a RBS #9917, Male, age 30+	Cranial porosity; "hair on end" effect
	39SL4[5]	Exhibit C #3, Ind. 1, Male 30-35	Ectocranial porosis along midline of skull on parietals & frontal
	39WW1[8]	F201 B5b, Infant, age 1-1.5 years	Porotic hyperostosis on parietals with endocranial reaction
		F301 B2b, Infant, age 6-12 mos.	Mild porotic hyperostosis on parietal
	39WW7[3]	B3, Male, age 20-24 years	Extensive porotic pitting on frontal, parietals, & occipitals
Postcontact	39HU7[6]	Ind. 1, H2, F4B1, Female, age 25-40	Slight porotic hyperostosis on parietals & occipital
	39LM27[3]	Blb, Female (?)	Porotic pitting on parietals
		Ex. L#13, Individual 1	Ectocranial porosis along posterior midline of cranium
		Exhibit I #13, Individual 2	Ectocranial porosis on frontal at glabella
	39WW3[9]	B2/15, Child, age 7 years	Ectocranial porosis
Disorganized	39CO9[10]	3 males, age 18-30	Healed ectocranial porosis
		2 males, age 31-40	Healed ectocranial porosis
		1 male, age 40+	Beginning porotic hyperostosis
Unknown	39HN129[6]	Individual 1 PU10-4, L 1, Female, age 40+	Porotic hyperostosis on parietals near bregma & on frontal
	39WW98[5]	Exhibit J #11, Child, age 12	Spongy periosteal reaction along midline of parietals and frontal

[1] Williams (1993)
[2] Williams (1994)
[3] Rose et al. (1984)
[4] Barnes (1977)
[5] Williams (1988)
[6] Willey et al. (1987)
[7] Gregg and Gregg (unpubished data)
[8] Kelley (unpublished data)
[9] Owsley (unpublished data)
[10] Shermis (1969)

Northern Plains skeletons are bifurcated ribs and synostoses of the proximal radius and ulna and the distal tibia and fibula. Gregg and Gregg (1987) describe a number of these conditions.

In general, of the postcranial anomalies recorded in Central and Northern Plains skeletons, few were life-threatening. Some would have been accompanied by cosmetic defects or minor physical disabilities. Individuals with these kinds of disorders survived well into childhood and even to adulthood. Babies with serious birth defects did not survive, either because of intrinsic complications or the practice of infanticide when infants were born with physical deformities (see, for example, Morton 1839).

Spina Bifida

Spina bifida is an anomalous condition of the lower spine involving incomplete closure of the neural canal. The condition is most common in the sacrum and occurs in varying degrees ranging from incomplete fusion of several spinous processes (spina bifida occulta) to complete division of the spinous processes resulting in the absence of the vertebral arch (complete spina bifida or spina bifida cystica) (Ortner and Putschar 1981). Severe forms of the condition are noticeable at birth and result in the protrusion of the spinal cord or meninges through the vertebral defect. The occult form of spina bifida is not visible at birth and has minimal to no effect on the individual, allowing normal survival into adulthood. It is this form of the condition that is usually scored in analyses of skeletal pathology in archeological series.

Numerous studies of skeletal material from archeological contexts report the presence of spina bifida. There is, however, no consensus about what constitutes spina bifida occulta versus a sacral hiatus (Barnes 1994). Because of the lack of consensus on the scoring criteria for spina bifida occulta, comparisons of

Table 54. Macrocephaly and Craniosynostosis in Central and Northern Plains Skeletal Series.

Variant	Site	Specimen	Description
Woodland	14DP9003[1]	Skull #3934, Female, age 30 years	Complete synostosis of sagittal suture; characteristic of scaphocephaly
	39HT2[2]	Child, age 3-4 years	Possible macrocephalic with cranial capacity of 1335 cc
Late Woodland	39RO23[3]	Pit 40, Child	Skull very thin with premature closure of sagittal suture
Central Plains-Middle Ceramic	14WY7[4]	Lab 8, Child, age 5 years	Premature synostosis of coronal, sagittal, and occipital sutures;
		Lab 11, Child, age 3 years	Probable case of hydrocephaly with cribra orbitalia and porotic hyperostosis
Plains Village	39HU5[5]	Ind. 3, 10.71.5, Spec. 20, 21, Young adult	Craniostenosis of posterior portion of right squamosal suture
Extended/Postcontact Coalescent	39SL4[2]	F421 B119e, #9926, Child, age 6-7 years	Hydrocephalic
	39SL4[6]	RBS #5683, NMNH #381373,Child, 1.5-2.5 yrs.	Microcephalic; complete closure of all cranial sutures
Postcontact Coalescent	39ST215[7]	NMNH #382744, Child, age 10 years	Premature closure of sagittal suture; scaphocephaly
	39WW2[2]	F201 B100, Child, age 4 years	Macrocephalic with cranial capacity of 1325 cc
Disorganized Coalescent	25HW1[8]	B185, Child, age 2-3 years	Craniostenosis of posterior right squamosal, parietal, mastoid, and occipito-mastoid sutures

[1]Eisley and Asling (1944)
[2]Gregg and Gregg (1987)
[3]Johnson (1973)
[4]Barnes (1977)
[5]Willey et al. (1987)
[6]Owsley (unpublished data)
[7]Kelley (unpublished data)

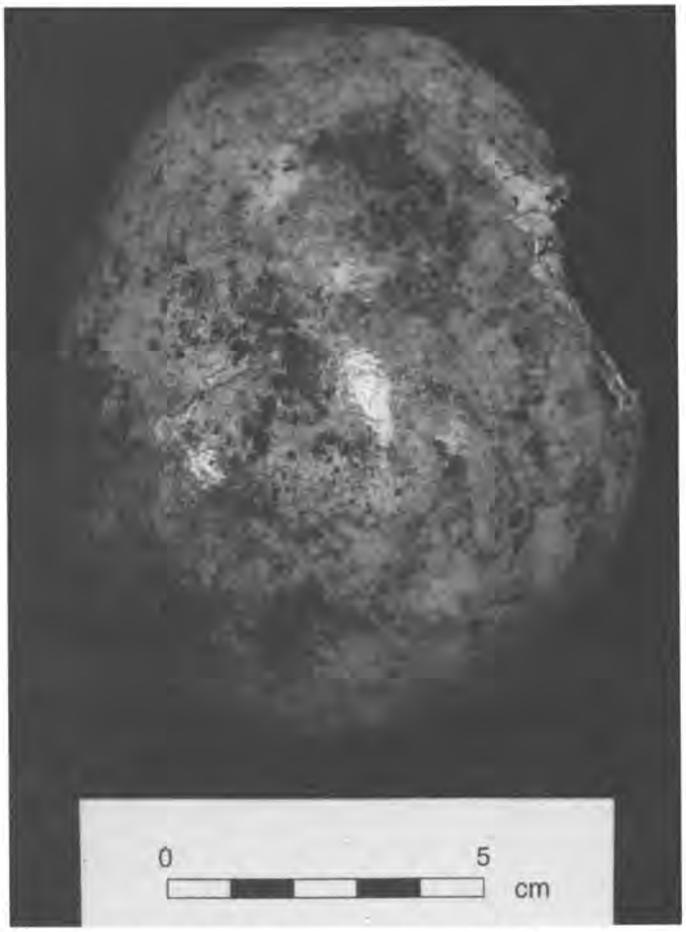


Figure 59. Superior view of cranial vault of a child (39SL4, NMNH 381373) aged 1.5-2.5 years, with premature closure of the coronal, sagital, and lambdoidal sutures (cranial length = 125 mm; cranial breadth = 102 mm; cranial circumference = 375 mm)

Table 55. Spina Bifida Occulta in Plains Village Skeletal Series.

Variant	Site	Individuals	Individuals with SBO	%
Central Plains Tradition				
Nebraska Phase	25DK13[1]	44	22	50.0
Initial Coalescent	39BF11[2]	396	42	10.6
Extended/Postcontact	39SL4[3]	100	2	2.0
Coalescent	39WW1[4]	161	1	0.6
Postcontact Coalescent	39WW2[3]	75	7	9.3

[1] Wolley (1988)
[2] Zimmerman, Gregg, and Gregg (1980)
[3] Bradtmiller (1984)
[4] Kelley (1980)

the frequency of the condition in archeological samples are difficult at best and can lead to extreme variation in the frequency of occurrence among samples and erroneous interpretations. The wide variation in the incidence of spina bifida occulta recorded for Central and Northern Plains skeletal series shown in Table 55 provides an example. Although some degree of variation in frequency is expected as a result of a combination of genetic and developmental factors, the extremely high incidence shown for 25DK13 (50%) probably results from interobserver differences in the identification of the condition.

Wolley (1988) sought consistency with previously conducted studies of spina bifida in Plains skeletons by following the criteria outlined by Bradtmiller (1984), which specified that failure of closure above the union of the third and fourth sacral vertebrae is scored as spina bifida occulta. Wolley interpreted this criterion as including cases of failure of segments one through three even when closure was complete at segments four or below. Bradtmiller's definition did not mention failure of closure of the superior sacral segments and probably limited his samples to those exhibiting an open spinal canal from the inferior segments of the sacrum upward.

Frequencies of spina bifida occulta in different groups as determined by a single observer are useful for comparative studies, for example, Bradtmiller's (1984) analysis of this defect in Arikara skeletons from the Larson (39WW2) and Sully (39SL4) sites in South Dakota. The results of his analysis show that individuals from Larson have a 7.3% greater incidence of the condition than those from Sully. In addition to the difference in the frequency of spina bifida occulta in the two skeletal series, Bradtmiller also records differences in the incidence by age: all Larson cases occurred in individuals under 39 years of age, and the two cases from Sully were in individuals in the third and sixth decades. Bradtmiller cites these differences in frequency and in age as evidence that the populations of Sully and Larson are biologically distinct (assuming that these samples accurately represent actual population frequences and that spina bifida is a congenital anomaly, with a genetic/biological factor playing a large part in the frequency of occurrence).

Other studies (e.g., Wolley 1988, 1992) have attempted to equate the condition with nutritional deficiencies. Wolley (1988) examined the frequency of spina bifida and its relationship to diet and subsistence strategies in skeletal series from Nebraska and South Dakota. Her study, based on evidence that suggests spina bifida is a congenital anomaly resulting from maternal zinc deficiency, uses chemical, archeological, and ethnographic evidence to reconstruct the diets of groups from sites 25DK13, 39BF11, 39SL4, and 39WW1. She calculated the risk of zinc deficiency in hunter-gatherer versus horticultural populations. As the protein consumption in hunter gatherers is higher than that of horticulturists, the former groups tend to have a low risk for zinc deficiency and a correspondingly low risk for spina bifida. Samples from mixed economies are moderately at risk for zinc deficiency, and groups engaged in intensive agriculture show the highest risk. The results of Wolley's study supported her theory that groups with a higher risk of zinc deficiency display a higher incidence of spina bifida; however, the study is inconclusive because of the differences in scoring criteria, which resulted in a frequency of 50% at site 25DK13. Further study of the possible relationship between nutritional deficiencies and spina bifida in archeological populations is required.

Trauma

Analysis of osseus defects and their frequency by age, sex, and location on the skeleton provides evidence of the physical trauma experienced by a population. Such data, in turn, lead to a better understanding of cultural and social developments throughout a geographic region and over time.

A review of the current literature on Native American skeletons from South Dakota, Nebraska, and portions of Colorado and Kansas showed low frequencies of traumatic defects in nearly all Plains series. However, there are but few systematic studies of antemortem injury for this region, and even fewer attempts to combine the collected data for a holistic approach to trauma in Plains populations. In one of the few such analyses, Deitrick (1980) examined the occurrence of antemortem and perimortem injury in skeletons from the Larson village and cemetery site (39WW2). Gregg and Gregg (1987) also discussed examples of trauma, mainly at the Crow Creek site (39BF11) in South Dakota. The authors of both studies attempted to integrate their observations into the broader context of trauma in Native Americans of the Plains, but were limited by not only a general lack of published data for the region, but by differences in the documentation and reporting of the few available data.

In spite of the lack of systematic studies, some inferences can be drawn in regard to trauma for the Central and Northern Plains by analyzing the data on three types of osseous defects—fractures, heterotopic ossifications (i.e., bone spurs or enthesophytes), and dislocations—in relation to age, sex, and site (Table 56).

Table 56. Comparisons of Antemortem Trauma in Three Northern Plains Skeletal Series

		Traumatic Defect					
		Fr		Dis		Enth	
Variant(Site)	Individuals	N	%	N	%	N	%
Extended(39WW1 Feature 1)[1]	162	1	0.6	0	0.0	-	-
Extended/Postcontact (39WW1 Feature 2)[1]	230	5	2.2	1	0.4	-	-
Postcontact(39WW2 Cemetery)[2]	628	124	20.1	9	1.4	36	6.1
Disorganized (39C09)[3]	261	16	6.1	0	0.0	5	2.1

Note: Fr = Fractures; Dis = Dislocations, Enth = Enthesophytes
[1]Palkovich (1981)
[2] Deitrick (1980)
[3] Shermis (1969)

Fractures

Excluding perimortem trauma associated with massacre sites or directly related to the cause of death of an individual, the most common type of trauma recorded for the Central and Northern Plains is fracture. Given the relative ease with which fractures can be identified and the extensive remodeling characterizing repair of such an injury, this result is not surprising. The types of fractures identified in Plains skeletons include depressed lesions on the cranial vault, facial bone fractures, postcranial bone fractures, and vertebral compression fractures. Fractures of the cranium (vault and face) were not only the most commonly recorded in individual descriptions (Table 57), but in studies of trauma in South Dakota skeletal series (Deitrick 1980; Zimmerman et al. 1980), skull fractures (especially nasal bone fractures) also had the highest frequency (Table 56). The second most common type was fracture of an upper limb, usually of the ulna and radius, with fracture of the humerus and clavicle also having a relatively high frequency.

Table 57. Selected Central and Northern Plains Sites with Reported Cases of Fracture.

Variant	Site	Specimen	Pathology
Woodland	5JF959[1]	Male, age 30-35	Healed fracture of left ulna; small healed depression fracture on frontal
	39LM256[2]	Exhibit V #22	Healed Colles' fracture with severe osteoarthritis
Middle Woodland	39DW233[3]	Md2 B3 #169(3), Adult male	Healed fracture of left rib
	39DW240[3]	Md1 B2 Male, age 19-20	Healed depression fracture on skull
	S.D.U.[4]	#15109 Female, age 21-25	Partially healed depression fracture on left parietal
Late/Middle Woodland	14PH4[5]	Adult	Left radius with area of roughening & slight deformation (possible healed fracture
		Adult	Possible fracture of distal radius with articular area deformed
		Adult	Healed fracture of three left ribs (3, 4, 11?)
		Child	Possible healed fracture or trauma resulting in fusion of proximal ulna & radius
Late Late Woodland	25KX12[6]	Adult male	Healed fracture of right proximal femur
Central Plains	14WWY7[7]	Lab 3 Female, age 45-53	Healed nasal fracture
		Lab 5 Female, age 17	Healed depression fracture on left superciliary arch
		Lab 9 Male, age 60+	Healed fracture of right tibia & fibula with chronic osteomyelitis
		Lab 20 Child, age 8-9	Small healed depression fracture over left superciliary arch
		Lab 45 Male, age 31-32	Healed nasal fracture
		Lab 46 Female, age 27-32	Healed fracture of left humerus
		Lab 57 Female, age 41-47	Healed nasal fracture
	25HW2[8]	Female, age 20-30	Healed nasal fracture; healed depression fracture on left parietal
Middle Missouri	39CA102[9]	6.3, 91-112-8, Adult	Healed fracture of proximal radius
		6.3, 91-112-519	Possible healed fracture of distal third of right radius
		6.3, 91-112-650,289,301, 1 Adult	Possible fracture of distal humerus resulting in malformed articular surfaces of humerus, ulna, & radius
	39LM59[2]	Exhibit S #20A, Individ. 11	Compression fracture of second lumbar vertebra
Oneota	39CL1[10]	Individ. 1, Male, age 45+	Number of ribs with possible perimortem fractures
Initial Coalescent	39BF11[11]	Adult male	Healed overriding fracture of
		Adult male	Large healed depression fracture on left frontal
		Adult	Probable healed fracture of right parietal resulting in avascular necrosis of bone (incomplete repair & cyst formation)
Extended Coalescent	39CA4[2,10]	Exhibit B #2B	Possible fractured left clavicle resulting in sclerous reactive bone on scapular articular surface
		Individ. 3, Male, age 35-39	Compression fracture of first lumbar vertebra
	39LM1[12]	Female, age 40-49	Healed fracture of right rib; healed fracture of left proximal femur
	39WW203[13]	BI, Male, age 40-50	Pseudoarthrosis on acromial process of right scapula with failure to unite due to fracture
Extended/Postcontact	39SL4[14]	320 BI #9270, Male, age 35-40	Nasal fracture
		F320 B20 #9345, Infant, age 0.5-1.5	Possible greenstick fracture of right tibia, about 75% healed
		F320 B26A #9363, Male, age 50+	Healed depression fracture on left parietal; fractured left ulna
		F420 BI #9422, Female, age 50+	Healed depression fracture on left parietal; healed fracture of left clavicle
		F420 B7b #9437, Female, age 40+	Healed fracture of right radius
		F420 BIIb #9459, Female, age 24	Healed fracture of left clavicle
		F420 B2a #9532, Male, age 22-28	Healed nasal fracture
		F421 B23g #9610, Female, age 30+	Healed fracture of right radius with lateral development
		F421 B114 #9909, Male, age 40-50	Healed nasal fracture; healed depression fractures on right supraorbital margin & left parietal
		F421 B122b, #9940 Male, age 35-40	Depression fracture on right frontal with osteitis
	39WW1[15]	F101 B10e, Adult female	Compression fracture of fourth lumbar vertebra
		F101 B27f, Male, age 18-20	Compression fracture of first lumbar vertebra
		F302 B27c, Male, age 35-40	Fracture of right rib (8 or 9)
		F302 B27e, Female, age 40+	Severe fracture of right rib 4 with spicular periostitis; severe fracture of right clavicle
	39WW7[10]	F302 B44f, Male, age 30-40	Colles' fracture of left radius
		6.2 87-95	Possible healed fracture of right rib
Postcontact Coalescent	25PT1[16]	OC11, Adult male	Healed fracture of left ulna
	39ST215[17]	NMNH #382747, Male, age 50+	Healed depression fracture on left superciliary arch
		NMNH #382750, Male, age 25	Healed nasal fracture
	39ST216[17]	NMNH #381178, Female, age 15-19	Healed depression fracture on right parietal
	39WW3[18]	B 2/14, Female, age 60+	Healed nasal fracture
Disorganized Coalescent	25DK2[19]	F17 00100	Healed fracture on left clavicle, scapula, & ulna
	25DK10[19]	00900, Adult male	Healed fracture of proximal left tibia
		F27 01200, Adult female	Trauma resulting in fusion of rightknee (tibia/femur); fused sacroiliac joint; healed fracture of right radius; avulsion fracture of left transverse process of second lumbar vertebra
	25HW1[20]	Adult male	Healed fracture of proximal right femur
	25KX1[21]	Sk. 15, Male, age 55-65	Healed depression fracture on left frontal
		Sk. 16 Female, age 17-20	Trauma to right frontal resulting in well-healed groove
		Sk. 22, Adult male	Healed depression fracture on right frontal
		Sk. 47, Male, age 40-47	Three small depression fractures on left parietal
	25KX9[21]	Sk. 46, Male, age 17-18	Small healed depression fracture on right frontal
	25KXI3[22]	Male, age 30-41	Healed nasal fracture
	39CO9[23]	Sk. 19, Adult male	Overriding fracture of blade of scapula
		Sk. 68, Adult male	Healed fractures of left & right clavicles; healed Colles' fracture; possible fracture of acromion

Table 57, concluded.

Variant	Site	Specimen	Pathology
Disorganized Coalescent, cont.	39CO9[23]	Sk. 71, Adult female	Nasal fracture
		Sk. 98, Adult male	Healed fracture of spinous process resulting in fusion of thoracic vertebrae
		Sk. 102, Age 12-17	Healed fracture on anterior border of talus
		Sk. 169, Adult male	Healed fracture of spinous processes of second & third lumbar vertebrae
		Sk. 176, Adult male	Depression fracture near orbit
		Sk. 195, Adult female	Healed fracture of maxilla; fracture of ulna resulting in pseudoarthrosis
		Sk. 232, Adult female	Healed fracture of coccyx; healed fracture of two ribs
		Sk. 262, Adult male	Badly healed overriding fracture of femur
Historic	14SH338[24]	F6, Adult male	Possible fracture of right clavicle
	14WY402[25]	Female, age 20-30	Healed nasal fracture

[1] Nickens (1977)
[2] Williams (1988)
[3] Bass & Phenice (1975)
[4] Steele et al. (1965)
[5] Bass (n.d.)
[6] Parker (unpublished data)
[7] Barnes (1977)
[8] Bubniak & Verano (1993)
[9] Williams (1993)
[10] Willey et al. (1987)
[11] Gregg et al. (1981)
[12] Rose et al. (1984)
[13] Smith & Jantz (1972)
[14] Gregg (unpublished data)
[15] Kelley (unpublished data)
[16] Ludwickson (1978)
[17] Cleaves (1994)
[18] Owsley (unpublished data)
[19] Owsley et al. (unpublished data)
[20] Molczyk (1969)
[21] Burgess (1994)
[22] Bass (unpublished data)
[23] Shermis (1984)
[24] Good (1986)
[25] Moore (1990)

Lower limbs (femur, tibia, and fibula) were less frequently fractured, and flat bones (innominate, scapula, sternum) had the lowest incidence of injury.

The proportionately high rate of craniofacial fractures suggests participation in violent activities conducive to head injury. Although fractures of the skull and facial bones can occur as a result of a fall, a blow to the head by, for example, a fist or a club, is more often the cause. Fractures of the forearms, which were relatively frequent in Plains samples, also suggest violence, as such injuries in the distal ulna (referred to as parry fractures) are typically defensive, being sustained when attempting to shield the body from a blow (Mann and Murphy 1990). Violent games, warfare, and horseback riding are documented in the ethnohistoric literature on Native Americans of the Plains, and all would be consistent with the types of fractures most frequently occurring in this region.

Although fractures were found in all age groups, there was a correlation between increasing rates of fracture with age in Plains skeletons. Deitrick (1980) reported that a majority (65.2%) of the fractures in remains from the Larson cemetery occurred in individuals over 30 years of age. Young adults (15-29 years) had the second highest frequency (22.8%), and children a relatively low rate (12%). Shermis (1969) reported a similar increase in rate of fracture by age for the Leavenworth site (39CO9). The incidence of fractures in individuals 31-plus years old in this sample was nearly double (63.3%) that of individuals in the 12-30 year age range (36.4%). A higher fracture rate among older individuals could be expected as a result of increased exposure to traumatic episodes with increasing age and the more rapid healing of fractures in children and subadults.

Differential rates of fracture for males and females have been little studied in Central and Northern Plains samples; therefore, only limited conclusions are possible. In his Leavenworth study, Shermis (1984) noted that males had a slightly higher incidence of fractures than females. He also found that fractures in females generally occurred on facial and upper limb bones and on the upper ventral aspect of the body, whereas in males, fractures were more generally distributed throughout the body. He suggested that the data on differential fracturing by sex was consistent with patterns of domestic violence and assault. Deitrick (1980), who also examined the incidence of fractures by bone and sex, observed a similar pattern of injury in the Larson cemetery sample, with adult males having a majority of the fractures (52%), which were widely distributed, and females having slightly higher frequencies of forearm fractures. In both studies, sample sizes were small. Further systematic analyses are needed to validate a difference in the incidence and location of fractures in males and females.

Changes in fracture rates and patterns over time are poorly documented for the Central and Northern Plains. Deitrick (1980) provides one of the few intersite comparisons of fracturing and reports an increase over time for the Missouri River region of South Dakota, with the highest incidence in the Postcontact Coalescent period site of Larson (Table 58). The frequency for Larson was substantially higher than that reported for the Initial Coalescent period Crow Creek site, for which the overall fracture rate was 6.2% (Zimmerman et al. 1980). The fracture rate at Crow Creek was comparable to the later Disorganized Coalescent site of Leavenworth. Fracture incidence at Mobridge (F1 and F2) was somewhat lower than at either the earlier or later sites in this region (Palkovich 1978a).

Data on regional differences in the incidence of fractures, and on trauma more generally, are lacking for the Plains. The virtual absence of fractures in Pawnee skeletons from central Nebraska (broken bones were found in only four individuals) and the relatively widespread incidence of fractures in contemporaneous South Dakota series (Deitrick 1980; Gregg and Gregg 1987; Palkovich 1978a; Shermis 1969; Zimmerman et al. 1980) suggest that regional differences are likely. Burgess (1994) reported a relatively high rate of aggressive trauma (12% of the skeletal sample) in Ponca remains from northeastern Nebraska and noted a statistically significant difference between the Ponca and the neighboring Omaha of east central Nebraska (Reinhard et al. 1994), who had a lower rate.

Table 58. Frequencies of Cranial and Postcranial Fractures in Skeletons from Crow Creek (39BF11) and Larson Cemetery (39WW2).

Variant	Site	Bone	N	Fractured	%
Initial Coalescent	39BF11[1,2]	Frontal	—	4	—
		Parietal	—	3	—
		Nasal	129	5	3.9
		Rib	—	2	—
		Clavicle	233	1	0.4
		Humerus	413	3	0.7
		Radius	206	2	1.0
		Ulna	244	4	1.6
		Femur	734	1	0.1
		Tibia	531	2	0.4
		Fibula	299	1	0.3
Postcontact Coalescent	39WW2[3]	Cranial vault	540	19	3.5
		Facial bones	540	21	3.9
		Sternum	253	1	0.4
		Scapula	786	1	0.1
		Rib	1002	22	2.2
		Clavicle	748	8	1.1
		Humerus	892	6	0.7
		Radius	779	10	1.3
		Ulna	796	6	0.8
		Innominate	862	2	0.2
		Sacrum	246	1	0.4
		Femur	975	0	0.0
		Tibia	921	0	0.0
		Fibula	777	5	0.6

[1] Antemortem fractures only
[2] Zimmerman, Gregg, and Gregg (1980)
[3] Deitrick (1980)

Future in-depth analyses relating data on skeletal trauma to archeological and ethnohistoric data on warfare, trade, and social discontinuity for the various Native American groups of the Plains are needed to permit geographic and temporal comparisons of intensity of conflict and levels of interpersonal violence in Plains populations.

Enthesophytes

Enthesophytes (including bone spurs, heterotopic bone formations, myositis ossificans) form in response to torn ligaments or muscles and other types of injury and biomechanical stress and result in calcification of the inflamed tissue. They are the second most common skeletal indicator of trauma recorded for Central and Northern Plains samples. They are typically present on the appendicular skeleton and commonly result from such trauma as blows or sprains—any injury involving extravasated blood and fibrous tissues undergoing ossification and calcification. The most usual sites are the fibula and tibia.

Selected descriptions of enthesophytosis in Plains skeletons (Table 59) and a list of sites of enthesophytes in skeletons from Crow Creek (Table 60) and Larson (Table 61) document their occurrence throughout the postcranial skeleton. The tibia and fibula show the highest rate of occurrence, with lower rates characterizing the radius, ulna, humerus, femur, patella, innominate, scapula, and clavicle.

Few data on the frequency of occurrence of enthesophytes have been collected for Plains samples. The majority of the documented instances occurred in males. In Deitrick's study (1980) of the Larson skeletal series, 19 males and 10 females more than 20 years of age from the cemetery sample showed

Table 59. Selected Central and Northern Plains Sites with Reported Cases of Enthesophytosis.

Variant	Site	Specimen	Pathology
Middle Woodland	39DW240[1]	Mdl B2, Male, adult	Exostosis on femur; myositis ossificans (?)
Central Plains	14WY7[2]	Lab 52, Female, age 30-35	Osteophyte on anterior crest of greater trochanter of left femur
Middle Missouri	39CA102[3]	6.3 91-112-295	Enthesophyte on medial margin of rhomboid fossa of left clavicle
	39HS1[3]	Individ. 1 980, Female, age 20-34	Enthesophyte along proximal surface of linea aspera and greater trochanter
		Individ. 3, Male, adult	Slight enthesophytosis along linea aspera
Extended Coalescent	39CA4[4]	Exhibit B #2A	Ossified ligament on popliteal line of right tibia
Extended/Postcontact Coalescent	39SL4[5]	F320 B9 #9289, Female, age 35	Proximal bone spur on left fibula
		F320 B10 #9295, Female, age 22-25	Small bone spur on proximal left tibia
		F481 B8c #9415, Male, age 35-40	Bone spur on proximal left fibula
	39SL4[5]	420 B1 #9422, Female, age 50+	Acromial spur on left & right scapulae
		F420 B8c #9449, Female, age 30-35	Lateral spur on left tibia
		F421 B34 #9648, Male, age 35-40	Bone spur on proximal fibula
	39WW1[3,4,6]	Exhibit G #7,Individ. 2,	Bilateral spurs on left & right calcaneal tubercles
		F101 B22d, Male, age 32	Small exostosis on fibula
		38F101, B27c,Female, age 35-40	Ossifying ligament on proximal fibula
		B302 B32, Male, age 22-28	Large exostosis on right ilium below crest
		F302, B37A, Male, age 40+	Bone spur on linea aspera
	39WW7[3]	Individ. 1, 4613(190), Male, age 25-35	Bony spicule on anterior medial surface of ilium
Postcontact Coalescent	39HU7[3]	Ind. 1, House 2, F4, B1, Female, 25-40	Small bone spurs on proximal ends of left & right fibulae
	39HU26[3]	Individ. 2, Female, age 45-50	Enthesophytes along linea aspera
	39LM34[3]	Individ. 1, Male, age 50-60	Large enthesophyte along popliteal line; small enthesophytes on right fibula & left & right femora
	39ST215[6]	NMNH #382745, Male, age 50+	Enthesophytes on left & right fibulae
Disorganized Coalescent	25DK10[7]	00900, Male adult	Large enthesophyte on proximal tibia, related to fracture of fibula
	39CO9[8]	Male	Enthesophyte on crest of ilium
		Male	Enthesophyte on distal humerus
		Male	Enthesophyte on distal femur
		Sk. 10, Male, age 30-40	Enthesophyte on linea aspera

[1] Bass & Phenice (1975)
[2] Barnes (1977)
[3] Willey et al. (1987)
[4] Williams (1988)
[5] Gregg (unpublished data)
[6] Cleaves (1994)
[7] Owsley et al. (Unpublished data)
[8] Shermis (1969)

Table 60. Enthesophytes in Skeletons from the Crow Creek Site (39BFll), South Dakota (from Zimmerman, Gregg, and Gregg 1980).

Trauma	Bone	N Present	Affected	%
Bone spurs	Clavicle	233	1	0.4
	Femur	734	1	0.1
	Tibia	531	4	0.7
	Fibula	299	1	0.3
Heterotopic bone	Humerus	413	2	0.4
	Innominate	1133	2	0.1
	Tibia	531	4	0.7
	Fibula	299	1	0.3

Table 61. Occurrence of Enthesophytes by Bone and Sex in Skeletons from the Larson Cemetery Site (39WW2), South Dakota (from Deitrick 1980).

		Male			Female	
Bone	N	NE	%	N	NE	%
Left clavicle	84	1	1.2	74	0	0.0
Right clavicle	105	0	0.0	74	0	0.0
Left scapula	84	0	0.0	74	0	0.0
Right scapula	82	1	1.2	75	0	0.0
Left radius	80	0	0.0	75	0	0.0
Right radius	77	0	0.0	75	1	1.3
Left ulna	82	0	0.0	76	1	1.3
Right ulna	84	0	0.0	76	0	0.0
Left innominate	82	1	1.2	82	0	0.0
Right innominate	80	0	0.0	80	0	0.0
Left femur	90	1	1.1	83	0	0.0
Right femur	93	0	0.0	83	0	0.0
Left patella	67	0	0.0	65	0	0.0
Right patella	76	1	1.3	66	0	0.0
Left tibia	94	3	3.2	84	1	1.2
Right tibia	91	6	6.6	82	2	2.4
Left fibula	84	3	3.6	78	1	1.3
Right fibula	85	8	9.4	74	5	6.8

Note: NE = number of bones showing enthesophytes

heterotopic bone development. In the village sample, six males from 10 to 40-plus years of age and one individual whose sex could not be determined had enthesophytes. Shermis (1969) records four individuals, all males, with enthesophyte development in the Leavenworth skeletal series and notes the absence of the condition in females from this site.

Gender-based activities in Plains populations favor the more frequent development of enthesophytes in males than in females. For example, horseback riding, hunting, violent games, and raiding would predispose males to a higher incidence of trauma involving torn muscles and other biomechanical stress conducive to the development of enthesophytes.

A lack of systematic analysis of the incidence of enthesophytosis in Plains samples limits inferences about occurrence over time and in different geographic regions. Although enthesophytes are routinely recorded in skeletal inventories, variation in occurrence over time has not been considered, except minimally by Deitrick (1980:68), who noted a decrease in frequency of occurrence from the Postcontact Coalescent site of Larson (6.1%) to the Disorganized Coalescent site of Leavenworth (2.1%). This decrease corresponds to a similar decrease in the occurrence of fractures at these two sites and suggests a relationship of the two conditions to similar traumatic episodes. However, many more data and their systematic analysis will be necessary for a better understanding of patterns of traumatic injury in populations of the Plains.

The association between metacarpal entheses and specific activity patterns has been systematically studied using a Plains Indian sample. Goldsmith (1990) compared development of entheses on metacarpals of nonagricultural Archaic samples from Tennessee and Kentucky and agriculturists from Tennessee and South Dakota. The South Dakota sample was from Larson (39WW2) and included 18 females and 18 males. The agricultural sample had larger metacarpal entheses for seven of eight muscle insertion points. Cross-sectional dimensions also differed and showed increased length of the fourth and fifth metacarpals in the agriculturists. Goldsmith attributes these differences to subsistence-related activity patterns with larger hands and enthesophytes associated with power-grip types of activity.

Dislocations

Dislocations, involving joints out of articulation or alignment as a result of force, are relatively rare in Central and Northern Plains samples. As bone remodeling and repair can occur when the dislocation is relatively minor, the few cases recorded could reflect either a lack of skeletal evidence or low incidence of the condition in Plains populations.

Although numerous joints can suffer dislocation, it is most commonly noted for the articulation of the femoral head and acetabulum. Current literature on the Central and Northern Plains shows five cases of hip dislocation (Table 62). Of these, two appear to be the direct result of trauma. Both cases occur in adult males with other pathological indicators of injury. Of the other three, one is a child, 7-9 years of age, with a deformity of the femoral neck and marked attrition of the femoral head and acetabulum. Because of the young age and apparently abnormal bone development, Gregg and Gregg (1987) describe the child as having congenital hip dislocation rather than having experienced trauma. Meadows (1988) classifies the other two cases of hip dislocation, both found in young adults 15-21 years of age, as probably resulting from congenital dislocation as the acetabula were markedly more shallow than those of other individuals in the skeletal series.

Spondylolysis

Spondylolysis occurs as a vertebral fracture, typically in the region of the pars interarticularis. Although the presence of certain anatomical variations in individuals affected by the condition suggests a genetic predisposition to it (Cyron et al. 1976; Roche and Rowe 1952; Stewart 1956), a "triggering mechanism" in the form of sustained stress or trauma is usually required for fracturing to occur (Merbs 1983, 1989).

Table 63 shows a fairly wide variation in the occurrence of spondylolysis in Central and Northern Plains skeletons. With the exception of the single male from 25KX12, sites dated to the Precontact and early Contact periods display relatively low frequencies of the defect. In their analysis of the remains from the Precontact Initial Coalescent site, Crow Creek (39BF11), Zimmerman et al. (1981) reported 40 instances of spondylolysis in a total of 1,694 lumbar vertebrae examined. The frequency of the condition for the population sample could not be determined because the bones were recovered from an ossuary; however,

Table 62. Selected Northern Plains Sites with Reported Cases of Dislocations.

Variant	Site	Specimen	Pathology
Woodland	39LM256[1]	Exhibit V, #22, Individ. 7	Dislocated mandible
Initial Coalescent	39BF11[2]	Child, age 6-7	Angulation & deformation of femoral neck; attrition of femoral head; destruction of acetabulum (congenital)
Extended Coalescent	39CA4[2,3,4]	F301 B6b, Male, age 18-21	Left femoral head completely resorbed; acetabulum totally destroyed & replaced by accessory articulation
		Individ. 3, Male, age 35-39	Trauma to left hip resulting in flattening of femoral head & deformation of acetabulum
Extended/Postcontact Coalescent	39SL4[2,3]	F302 B26a, Male	Right sacroiliac joint fused; right femoral head dislocated superiorly, with secondary acetabulum formed; fractured right patella; pseudoarthrosis in left ulna
Postcontact Coalescent	39WW2[3]	F201 B133C, age 15-19	Erosion of femoral head & acetabulum of right hip & of vertebrae (possible congenital dislocation)

[1] Williams (1988)
[2] Gregg and Gregg (1987)
[3] Meadows (1988)
[4] Willey et al. (1987)

Table 63. Spondylolysis in Central and Northern Plains Skeletal Samples from Nebraska and South Dakota.

Variant	Site	Males Individuals	Males w/spondyl.	%	Females Individuals	Females w/spondyl.	%	Total Individuals	%
Woodland	25KX12[1]	1	1	100.0				1	100.0
Central Plains,	25DK13							13	0.0
Nebraska Phase	25DK9							3	0.0
Extended/Postcontact Coalescent	39SL4[2]	73	9	12.3	47	5	10.6	120	11.7
Postcontact	39WW2[2]	46	13	28.2	43	10	23.3	89	25.8
Coalescent	39HU7[3]				1	1	100.0	1	100.0
Disorganized	25DK10[1]	3	1	33.3	8	2	25.0	11	27.3
Coalescent	25DK2	1	0	0.0	4	1	25.0	5	20.0
	25KX1	3	1	33.3	3	1	33.3	6	33.3

[1] Sandness & Reinhard (1992) and unpublished data
[2] Bradtmiller (1984)
[3] Willey et al. (1987)

the recovery of 396 partial and complete sacra suggests a minimum of at least that many individuals. The number of individuals represented by lumbar vertebrae is unknown. Consequently, only an approximate frequency of occurrence of 10.1% in the Crow Creek sample can be estimated. One elderly man from the Calovich Mound (14WY7), a Central Plains tradition Steed-Kisker site in eastern Kansas, had spondylolysis of the fifth lumbar vertebra (Barnes 1977).

The incidence of spondylolysis increased over time for Plains groups. Bradtmiller (1984) reports an increase of more than 100% between the Extended/Postcontact Coalescent site of Sully (39SL4) and the later Postcontact site of Larson (39WW2), that is, from 11.7% to 25.8%. Sandness and Reinhard (1992) report similar frequencies of 27.3, 20.0, and 33.3% for the historic Omaha and Ponca skeletal collections from northeastern Nebraska, although prehistoric skeletal series from this region (25DK13 and 25DK9) showed no instances of spondylolysis. In addition, continuing surveys of pathology in prehistoric Nebraska skeletons (sites 25CD7, 25DX4, and 25KX12) revealed only one case of spondylolysis (at 25KX12) (K. Reinhard, personal communication 1992), suggesting that the condition was not a problem for the prehistoric peoples of Nebraska, though it was for the Historic period groups in this region (Sandness 1992).

In his comparison of the Sully and Larson skeletal remains, Bradtmiller (1984) not only demonstrates that individuals from the later Larson site (39WW2) more frequently had separated

Table 64. Incidence of Separate Neural Arches at Two South Dakota Sites (39SL4 and 39WW2) (after Bradtmiller 1984:330).

Age	Sully Individuals	Sully %/Pathology	Larson Individuals	Larson %/Pathology
16-20	11	0.0	11	18.2
21-29	29	6.9	18	22.2
30-39	32	15.6	34	20.6
40-49	16	31.3	17	47.1
50-59	14	14.3	9	22.2
60+	8	0.0	—	—

Note: Individuals indicate the number of individuals in the samples with L4 or L5 present

Table 65. Incidence of Osteophyte Formation and Spondylolysis at Two South Dakota Sites (39SL4 and 39WW2) (after Bradtmiller 1984:331).

Stage[1]	Sully N[2]	(%)	Sully N[3]	(%)	Larson N[2]	(%)	Larson N[3]	(%)
0	28	(100.0)	0	(0.0)	12	(92.3)	1	(7.7)
1	45	(88.2)	6	(11.8)	30	(66.7)	15	(33.3)
2	26	(86.7)	4	(13.3)	15	(93.8)	1	(6.2)
3	8	(66.7)	4	(33.3)	4	(40.0)	6	(60.0)
Total	107		14		61		23	
	G = 4.08				G = 13.34[4]			
	df = 3				df = 3			

[1] of osteophyte formation
[2] Frequency of individuals in each stage of osteophytosis development without a separate neural arch
[3] Frequency of individuals who show separate neural arches for each stage of osteophytosis development
[4] Significant at the .01 level

neural arches than did the earlier population from Sully (39SL4) but that spondylolysis occurred in younger adults (Table 64) and was related to vertebral arthritic changes (Table 65). This finding suggests that the Larson individuals were experiencing increased biomechanical stress, leading to vertebral fractures, compared to the Sully individuals who had lower frequencies of spondylolysis, a lower correlation with spinal arthritis, and an absence of the condition in younger adults. Spondylolysis continued to be a common problem for the Arikara during the last quarter of the eighteenth century. Several individuals from the Leavitt site (39ST215), including a seven-year-old with unilateral separation of the left pars interarticularis, had this condition (unpublished data). The fifth lumbar vertebra of an adult female from the Doniphan site (14DP2), a Historic Kansa village, has a similar arch defect on the right side (Stewart 1959).

As in the samples from South Dakota, the incidence of spondylolysis in Historic Nebraska skeletons appears to be associated with increased physical stress and trauma. Sandness and Reinhard (1992) recorded spondylolysis in four females under 25 years of age. In addition, they noted higher frequencies of Schmorl's nodes (disc herniation associated with heavy labor or trauma) in the Historic skeletal series, as well as the early onset of spinal osteophytosis and arthritic changes. The presence of these types of spinal pathology in Historic period skeletons and the absence of spondylolysis in prehistoric Nebraska samples further suggest increased biomechanical stress as a cause of this defect.

Several activities could have led to increased biomechanical stress and incidence of trauma in Historic Plains peoples. For women, such activities might include the arduous task of tanning and dressing skins, which required hours of scraping in a bent posture, similar to the 90° stance Merbs (1983) cites as a factor in the development of spondylolysis in Arctic peoples. In addition, with increased trade and the resulting increase in hunting, the labor of women in preparing skins for the market would have become much greater. Women also were responsible for many of the duties associated with lodge construction and with farming and would have suffered disproportionately with transience or demands for increased horticultural production for trading purposes. For men, the introduction of the horse and activities fostered by increased trade would have increased the incidence of vertebral pathology, including spondylolysis. Further study of this pathology should include testing for differences in frequency of occurrence between the sexes.

The differing frequencies for the Prehistoric and Historic period skeletal samples have been cited as support for claims of the biological distinctness of the earlier and later Native American groups in the Plains (Bradtmiller 1984). However, the relationship of spondylolysis to spinal arthritic changes and trauma in later Historic samples from South Dakota and Nebraska, as well as its presence in young adults in these samples, would seem to provide strong support for theories of increased levels of physical stress and different patterns of activity for Native Americans of the Plains after contact.

Evidence of Warfare

Warfare occurred in the Great Plains from the Prehistoric through the Historic eras, with the nature and prevalence of conflict varying over time (Owsley 1994). Culturally patterned violent conflict among different social groups extends back in time for at least a thousand years. Except for a few examples (Tiffany et al. 1988; J. A. Williams 1991), there is little evidence of warfare during the Archaic and Woodland periods. The dispersed and unfortified Central Plains tradition settlements also suggest that group conflict was not a pervasive concern. However, the osteological findings indicate that small-scale feuding and raiding occurred and resulted in fatalities.

Early large-scale conflicts resulted from migration and competition for territory and scarce resources as Central Plains tradition villagers moved northward into the Middle Missouri Valley onto lands held by people of the Middle Missouri tradition. Warfare that resulted in the destruction of entire villages and the massacre of the inhabitants occasionally occurred. Ultimately, representatives of the Middle Missouri tradition retreated into North Dakota.

Small-scale warfare was common during all variants of the Coalescent tradition, and this pattern, which included raiding, scalping, and the taking of other physical trophies, continued into the Historic period. Conflict during the Protohistoric and Historic periods continued as the Sioux and other groups migrated into the Plains from the east. The ethnohistoric record contains numerous accounts of intertribal conflict that involved small-scale raiding for horses, scalps, captives, trade goods, and agricultural products.

Patterns of warfare varied geographically as well. Most of the physical evidence derives from sites in present-day South Dakota, and to a lesser extent from Nebraska and North Dakota. Within South Dakota, the frequency and intensity of warfare (based on evidence of scalping, as well as settlement patterns and the presence or absence of fortifications) differed between the Grand Moreau region, extending northward toward the North Dakota/South Dakota border, and the more southern Bad-Cheyenne region where the effect of the Pax La Roche was apparent (Owsley 1994). The more northern Arikara faced greater risk of violent death than those who lived farther south.

As Tables 66 and 67 show, the data on warfare and trophy taking in the Central and Northern Plains from the Late Woodland through the Central Plains tradition was widespread geographically but sparse. Most examples come from Coalescent and Middle Missouri tradition sites. The osteological evidence for warfare includes:

- cuts around the cranial vault associated with scalping;
- exfoliation of the outer table and diploe, infection of the outer table, and increased vascularity characterizing survival of scalping (see, for example, Miller 1994);
- blunt force trauma to the cranium apparent in depressed fractures, both unhealed (perimortem) and healed (antemortem);
- cranial trauma caused by sharp instruments (e.g., ax or hatchet);
- traumatically induced dental evulsions;

Table 66. Plains Village Sites in Nebraska and South Dakota with Evidence of Warfare.

Variant	Site	Osteological Evidence
Late Woodland	25DX4[1]	1 healed & 2 partially healed scalpings
Central Plains	25CU28[2]	Multiple scalpings; cuts around 1 foramen magnum
Itskari	25HW2	Scalping
	25HW3	Scalping
	25HW8	Scalping
Nebraska	25DK9[1]	Partially healed scalping
	25SY67[3]	Partially healed scalping
Upper Republican	25FT13[4]	Multiple (>1) scalpings
Oneota	25RH1	Multiple scalpings
Coalescent		
Initial	39BF11[5]	Commingled remains in mass grave in fortification trench; village burned; massacre of at least 486 people; perimortem trauma; mutilations, including scalpings (2 healed), dismemberment, and decapitation
Extended	39CA4[6]	Multiple scalpings (1 healed); perimortem trauma; knife and arrow wounds; disarticulation
Extended/Postcontact	39SL4[3]	Partially healed scalping
	39WW1[6]	Multiple scalpings; perimortem trauma
Postcontact	25NC1	Scalping
	25NC3[7]	Village burned; 85 skeletons in 3 lodges; probable dismemberment and decapitation
	39LM26[6]	Dismemberment and mutilation of 9 individuals; intentional fragmentation; multiple scalpings
	39PO207[6]	Multiple scalpings
	39ST1[9]	Arrow wound
	39ST215	Gunshot wound
	39WW2[6]	Multiple scalpings, 1 partially healed; decapitation; perimortem trauma; knife or arrow wounds; (Cemetery) disarticulation
	39WW2[10]	Village burned; commingled remains of 61 individuals in 3 lodges; 10 found in village perimeter; scalpings, decapitation, and dismemberment
	39WW3[11]	Healed scalping
	39WW7 [6]	Multiple scalpings; knife or arrow wound; disarticulation
Disorganized	25KX1[12]	Scalping; perimortem trauma
	25KX5[12]	Scalping
	39CO9[6,13]	Multiple scalpings; arrow and gunshot wounds; disarticulation
Middle Missouri		
Initial	39ST11[3]	Village burned; 5 skeletons in 2 lodges; decapitation; projectile injury; probable dismemberment; partially healed scalping
Southern Extended	39AR201	Dismemberment and mutilation of 10 individuals; intentional fragmentation
Unknown	14PA—[14]	Scalping

[1] Miller (1994)
[2] O'Shea and Bridges (1989)
[3] Hollimon and Owsley (1994)
[4] Bubniak and Verano (1993)
[5] Willey (1990)
[6] Olsen and Shipman (1994);Owsley (1994); Owsley, Mann, and Baugh (1994)
[7] Montgomery (1986)
[8] Rose et al. (1984)
[9] Bass (1964)
[10] Owsley, Berryman, and Bass (1977)
[11] Hamperl and Laughlin (1959)
[12] Burgess (1994)
[13] Shermis (1969)
[14] Willey and Bass (1978)

Table 67. Central and Northern Plains Sites with Trophy Skulls and Intentionally Modified Crania.

Variant	Site	Description
Late Woodland, Schultz Focus	14CY32[1]	Openings with polished edges cut into the occipitals of 4 crania, possibly for mounting
Schultz Focus	14GE4[1]	Openings with polished edges cut into the occipitals of 4 crania, possibly for mounting
Central Plains, Itskari	25CU7[2]	Incised skull fragment with 5 perforations
Upper Republican	25FT13[3]	Partially prepared skull bowl
Upper Republican	25HN36[3]	Cut and drilled calvarium
Coalescent		
Initial	39BF11[4]	4 skull bowls
Extended/Postcontact	39SL4[5]	Trophy skull with 2 drilled perforations
Postcontact	25CX1[6]	Etched cranial fragment with a human figure on the endocranial surface
Disorganized	39WW3[7]	Trophy skull
	25DK2[5]	Trophy skulls
	25WT1[5]	Trophy skull

[1] Phenice (1969)
[2] Philips (1960)
[3] Wedel (1986)
[4] Willey (1990)
[5] Owsley, Mann, and Baugh (1994)
[6] Carlson, G. (1994, personal communication)
[7] Hamperl and Laughlin (1959)

- trauma resulting from projectiles (arrows or gunshots), found in association with human remains or in some instances embedded in bone (Figures 60a, b, and c);
- decapitation;
- dismemberment and green bone fractures; and
- trophy taking (e.g., skulls, hands, and other postcranial bones), sometimes with intentional modifications such as a cranial vault made into a bowl (Wedel 1986; Owsley et al. 1994).

Osteological evidence has revealed the destruction of entire villages and the massacre of inhabitants, as at the Initial Coalescent site (A.D. 1325) of Crow Creek (39BF11) (Willey 1990) and the Extended Middle Missouri site of Fay Tolton (39ST11) (Hollimon and Owsley 1994). Approximately 500 people were killed at Crow Creek and their bodies mutilated and scalped. At Larson (39WW2) (Owsley et al. 1977), a Postcontact Coalescent site inhabited until about A.D. 1733, commingled and partially disarticulated human skeletons were found inside earth lodges

Figure 60a. Musket ball wound to the posterior external surface of the right ilium of a male aged 25-29 years from the Leavitt site (39ST215, NMNH 382750b).

that had collapsed when burned. There were musket balls and copper arrow points in association with some remains; others showed evidence of scalping, depressed fractures, dental evulsions, and mutilation. Victims of scalping included men, women, and children (the youngest about five years old), and several males had been decapitated.

Though the data are often compelling, as at Crow Creek, they are often less than clear-cut. For example, were the burials in the Sargent Ossuary (O'Shea and Bridges 1989) victims of a raid, persons who died a violent death away from the village, or examples of a particular type of mortuary practice? One site (Fremont I [25SY1]) that was long interpreted as evidence of violence and cannibalism may have been a charnel house in which remains were processed for burial according to cultural rites and practices (Cook 1977).

Examples from many prehistoric sites show the antiquity of scalping in the Central and Northern Plains, and scalping was also a common practice among Plains Indians during the Historic period. Scalps were taken as trophies and regarded as emblems of victory. The process often resulted in cuts on the frontal, parietal, and occipital bones that can be detected through close examination under high illumination. A number of reports

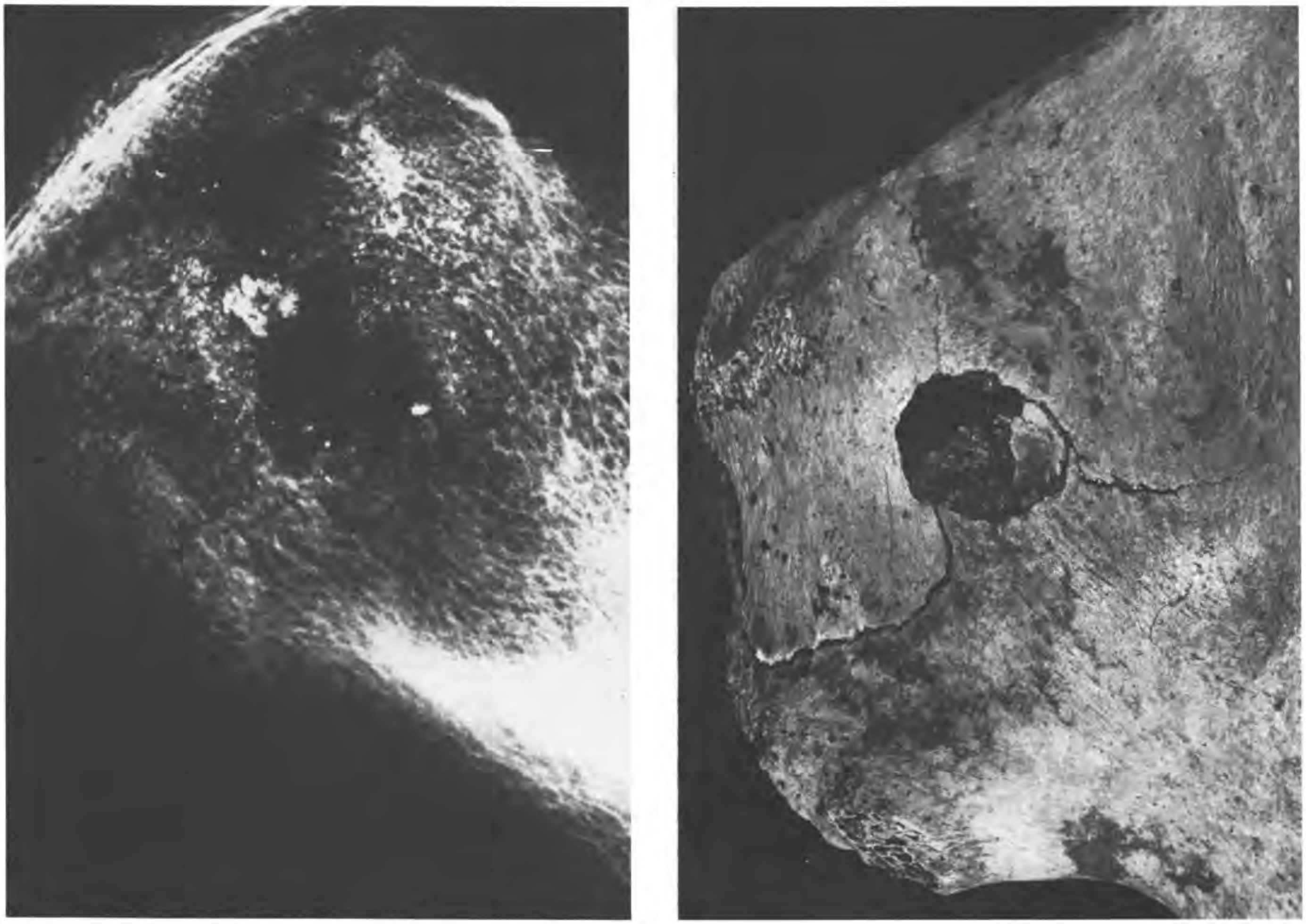


Figure 60b-c. Close up views of musket ball wound to the posterior external surface of the right ilium (39ST215, NMNH 382750b).

provide detailed information about the number, patterning, and distribution of cuts on scalped skulls (Owsley 1994; Owsley et al. 1977; Owsley et al. 1994; Willey 1990). A systematic survey of adult crania from 15 Coalescent tradition sites in South Dakota (A.D. 1600-1832) showed evidence of scalping in 5.5% of the sample (Owsley 1994). The risk of being scalped was about the same for males and females, although the age distribution of scalped individuals differed in relation to sex. One-fifth of the deceased males between the ages of 20 and 29 years showed cuts resulting from scalping, thus illustrating the negative impact of warfare on this segment of the population. Further, the risk of being scalped increased for males during the early Historic period.

Willey (1990) described and compared the kinds of mutilations observed in massacre victims of prehistoric Crow Creek and protohistoric Larson village. Although the same types of modifications (e.g., burning, depressed fractures, dental evulsion, scalping, dismemberment, and decapitation) were present, the frequencies of specific mutilations differed, with all types of mutilations occurring more frequently in the Crow Creek sample. The majority (>90%) of the Crow Creek crania were scalped; only 37.5% of the Larson sample had cuts on the cranium indicating scalping. The difference might be related to the use of metal knives at Larson, compared to the less efficient stone knives used at Crow Creek. Many of the Crow Creek skulls showed cuts on the occipital bone from decapitation (14.3%), and a few had cuts on the maxillae from removal of the nose (4.5%). Decapitations in the Larson sample involved separation through the cervical vertebrae, thereby avoiding damage to the basilar portion of the occipital. Although not observed in the Larson village series, Owsley is aware of skulls from Extended and Postcontact Coalescent cemeteries with cuts indicating removal of the nose (e.g., at Mobridge).

Olsen and Shipman (1994), working from cast molds of bones and using scanning electron microscopy, have investigated distinctions between evidence of conflict and characteristics of secondary burial practices and have also distinguished among the variety of weapons and implements with which cuts, scrapes, and fractures were inflicted. In research on evidence of warfare, they emphasize the need for careful recording of the presence or absence of all skeletal elements and whether these are in articulation, the identification of fractures as antemortem, perimortem, or postmortem, and the recording of any natural or artificially induced alterations of bone that are present.

Systematic research on evidence of warfare in the Central and Northern Plains is a paramount need. The questions are many and varied, and the lack of adequate data to answer them is apparent. Among the highest priority needs are the following:

- Documentation of temporal trends and geographic patterns of warfare, including comparisons of areas both within a state and among states;
- Systematic investigation of skeletal trauma: lethal and nonlethal, perimortem and healed or partially healed; nature of the weapon (e.g., spiked club, arrow, gunshot) or tool (stone or metal knife) that inflicted the injury; and objective of skeletal modification (e.g., killing and trophy taking, dismemberment and defleshing for secondary burial or cannibalism);
- Determination of the relationship, if any, of mortuary treatment to particular circumstances of death;
- Examination of cemetery samples to discover any additional evidence of traumatic injury resulting from violence;
- Documentation of the sex, age, and geographical distribution of victims of warfare;
- Comparisons of patterns of warfare between eras and geographic areas within a state and among states; and
- Collection of data on warfare in states such as Kansas where at present none have been reported or described, or where such data are as yet sparse, as in Nebraska (Burgess 1994; Montgomery 1986).

Indicators of Physiological and Environmental Stress

Cortical Bone Thickness

In bioarcheological investigations of subsistence patterns, cortical bone growth and thickness have been used as indicators of nutritional status (Cook 1979; Hummert 1983; Pfeiffer and King 1983). The rationale for this approach derives from research showing that the sex, age, and diet of an individual influence the amount of cortical bone mass (Frisancho et al. 1970; Garn 1970, 1972). The effects of mild to severe malnutrition on the subperiosteal and endosteal surfaces of tubular bone have been demonstrated in controlled feeding studies of laboratory animals and in longitudinal and cross-sectional comparisons of a large number of poorly nourished and well nourished children in the United States and Central America (Garn 1966, 1970, 1972; McCance 1960; Platt and Stewart 1962; Platt and McCance 1964; Fleagle et al. 1975; Garn et al. 1969; Himes et al. 1975; Himes 1978). Garn (1972:503-504) indicates:

> Bone growth in undernutrition and simple malnutrition is somewhat like normal growth, but slower, with less bone formed. Bone growth in protein-calorie malnutrition (like bone growth in some malabsorption states and in some disorders of oxygen transport) is slower growth, subperiosteally, but with excessive bone loss at the endosteal surface.

Kwashiorkor (a severe protein-deficiency type of malnutrition) and marasmus cause excessive endosteal resorption in which as much as 40% of the bone can be lost (Garn 1970; Garn et al. 1969; Garn et al. 1964). Endosteal loss reduces the bony cortical wall to a thin shell with a greatly enlarged marrow cavity. This loss occurs even though the external bone size, or even the time of ossification, remains relatively unaffected. Catch-up growth by bone replacement during the period of recovery from kwashiorkor and marasmus is minimal (Garn 1966). Medullary enlargement and decreased cortical thickness also occur in a variety of malabsorption states, in the osteopenias, in hyperparathyroidism, and at ages greater than 40 years (Garn 1970). To compare age-related variation requires that the age distribution of the samples be controlled, with older adults excluded. The femur has been used in most studies of archeological samples, including systematic surveys of a number of village samples from the Central and Northern Plains (Cashion 1987; Owsley 1985, 1991; Tiffany et al. 1988). Two basic midshaft cross-sectional measurements, total subperiosteal diameter (T) and width of the medullary cavity (M), were obtained from high-resolution radiographs of the femur, which was x-rayed in a standardized posterior-anterior position. From these measurements, other variables can be obtained, including medial-lateral cortical thickness (C), Nordin's Index (NI), and cortical area (CA). Cortical thickness, calculated as $C = T-M$, represents the combined or net thickness of the medial and lateral walls of the bone at the midshaft. Nordin's Index, $NI = C/T$, represents the proportion of the total width attributed to the cortex. Cross-sectional area indicates the potential calcium reserve and absolute bone mass, calculated as $CA = 0.785(T^2-M^2)$ (Garn 1970). The underlying assumption for this formula is an approximately circular cross-sectional geometry of both the endosteal and subperiosteal surfaces, which seems to be valid for the femora of subadults and is also reasonable for many adults from the Northern Plains. However, the cylindrical model is less applicable in some Southern Plains groups that show extreme anterior-posterior elongation of the femur cross-section (Owsley and Jantz 1989; Ruff 1994). In his study, Ruff (1994) determined tubular bone shape, cortical thickness, and related biomechanical characteristics of the long bone diaphysis from transverse sections of the femur.

Cortical bone thickness is a sensitive indicator of changes in Arikara nutritional status during the Postcontact period. Owsley (1985) compared measurements of femoral cortical thickness in Extended, Postcontact, and Disorganized Coalescent samples of males and females, 18-30 years of age, from South Dakota. The age range was restricted to avoid the inclusion of individuals with age-related endosteal resorption. Because the samples were from Arikara villages along the Missouri River, they represented genetically related populations from a limited geographical area over a time interval of 230 years (A.D. 1600 to 1832), a period of rapid change.

The femora were x-rayed in a standardized posterior-anterior projection, using a special film and a single lanex, fine screen cassette. Table 68 presents the resulting means and standard deviations for the variable C (i.e., cortical thickness). The means, ranging between 11.9 and 14.6 mm, were larger for males than females, and statistically significant temporal differences were present. Cortical thickness values were larger for the Postcontact Coalescent samples than for the Extended and Disorganized Coalescent samples. Values for M and T showed that the differences in cortical thickness resulted primarily from variation in the diameter of the medullary cavity. Femora of the Postcontact Coalescent samples had smaller medullary cavity diameters than did those of the Extended and Disorganized Coalescent samples. Although the general pattern was the same for both sexes, females showed the largest amount of endosteal cortical thinning during the Disorganized Coalescent time period.

Table 68. Mean Cortical Thickness and Diaphyseal Lengths of Femora of Young Adults from Three Coalescent Tradition Variants in South Dakota (from Owsley 1985:203).

Sex and Variant	Bone Cortex N	Mean	SD	Diaphyseal Length N	Mean	SD
Male						
Extended	18	13.49	2.00	18	433.22	20.33
Postcontact	41	14.55	1.27	41	431.73	23.15
Disorganized	14	14.03	1.42	14	439.64	22.26
Female						
Extended	28	13.00	1.45	28	401.82	20.46
Postcontact	65	13.52	1.56	64	401.41	15.19
Disorganized	14	11.93	1.14	14	405.14	15.92

These data suggest an improvement in the nutritional status of the Arikara during the Protohistoric period, as reflected by an increased amount of cortical bone and relatively narrow diameters of medullary cavities in Postcontact Coalescent young adults. Reduced cortical thickness in the Disorganized Coalescent samples is evidence of nutritional problems after A.D. 1780. Dietary stress and undernutrition became more common with the spread of infectious diseases, internal and external strife, and crowding, which strained available resources in the few remaining horticultural villages. These shortages especially affected females. The reasons for a differential effect on the two sexes are complex. Their clarification will require a better understanding of various biocultural factors such as sex differences in diet, differential access to food, effects of pregnancy and lactation, and different types and amounts of work.

Increased cortical bone among Postcontact villagers indicates relative success in meeting nutritional needs. An improved climate conducive to farming and the introduction of the horse, which facilitated bison hunting, are likely causes. A follow-up study that compared samples representing specific periods of short duration examined patterns and the timing of changes in cortical bone thickness (Owsley 1991). Table 69 shows the measurements of cortical thickness and maximum lengths of femora for samples representing Late Prehistoric (A.D. 1600-1650), Early Protohistoric (1650-1740), Late Protohistoric (1740-1795), and Historic (1795-1832) period sites. Differences among the samples showed fairly similar patterning for both sexes and were statistically significant for all cortical bone measurements. (In contrast, comparison of the diaphyseal and maximum lengths of the femora of these same groups showed no significant differences [Tables 68 and 69].)

The increase in the means of C, NI, and CA during the early Protohistoric period indicates more cortical bone. In females, a reduction in the width of the medullary cavity was the cause. After 1740, Late Protohistoric and Historic period females showed incremental increases in the diameter of the medullary cavity (Figure 61). The diameters of medullary cavities of males during the Late Protohistoric and Historic periods were larger than those representing the Early Protohistoric period. Thus, cortical thickness increased in both males and females during the transition from the Late Prehistoric to the Early Protohistoric period (Figure 61). However, this increase was transient, with midshaft cortical thickness beginning to decrease in the Historic period, and the reduction was particularly apparent in females.

Nutrition in late seventeenth and early eighteenth century populations was good, with a positive change in nutritional status characterizing the transition from the Late Prehistoric to the Early Protohistoric periods. The improvement resulted in part from increased emphasis on horticulture to acquire surpluses for trade (and/or environmental conditions leading to increased productivity). Greater reserves of food provided a buffer against lean times. Although acquisition of the horse (ca. 1740) facilitated the hunting of wild game and the transport of larger quantities of meat to a village, this factor apparently had little effect, the greatest impact being on the post-1750 economy of the Arikara.

Little has been published on cortical bone thickness of subadult samples from archeological sites, although such data would provide a sensitive indicator of health and nutritional

Table 69. Mean and Standard Deviations for Femoral Cortex and Maximum Length Measurements by Sex and Time Period (from Owsley 1991:106).

Variable	Late Prehistoric 1600-1650 N	Mean	SD	Early Protohistoric 1650-1740 N	Mean	SD
Male						
Medullary cavity diameter	11	11.79	1.37	76	12.24	1.92
Total subperiosteal diameter	11	25.29	2.12	76	26.94	1.55
Cortical thickness	11	13.50	2.15	76	14.69	1.55
Nordin's index	11	0.53	0.06	76	0.55	0.06
Cortical area	11	394.84	79.92	76	450.94	51.85
Maximum length	8	466.13	13.93	66	466.85	22.22
Female						
Medullary cavity diameter	15	11.44	1.68	88	10.57	1.60
Total subperiosteal diameter	15	24.01	2.32	88	24.12	1.54
Cortical thickness	15	12.57	1.38	88	13.55	1.51
Nordin's index	15	0.52	0.04	88	0.56	0.06
Cortical area	15	351.79	62.59	88	368.76	49.07
Maximum length	12	431.83	21.77	76	429.47	17.01

Variable	Late Protohistoric 1740-1795 N	Mean	SD	Historic 1795-1832 N	Mean	SD
Male						
Medullary cavity diameter	10	13.50	2.20	13	13.42	1.95
Total subperiosteal diameter	10	28.09	1.20	13	27.64	1.51
Cortical thickness	10	14.59	1.67	13	14.22	2.04
Nordin's index	10	0.52	0.07	13	0.51	0.06
Cortical area	10	473.92	44.18	13	457.27	63.98
Maximum length	9	481.22	20.21	12	470.75	24.07
Female						
Medullary cavity diameter	18	11.58	2.10	13	12.95	1.53
Total subperiosteal diameter	18	24.84	1.94	13	25.00	1.32
Cortical thickness	18	13.26	1.95	13	12.03	1.62
Nordin's index	18	0.53	0.07	13	0.48	0.06
Cortical area	18	378.51	64.17	13	358.17	51.08
Maximum length	17	431.71	17.34	11	433.45	18.69

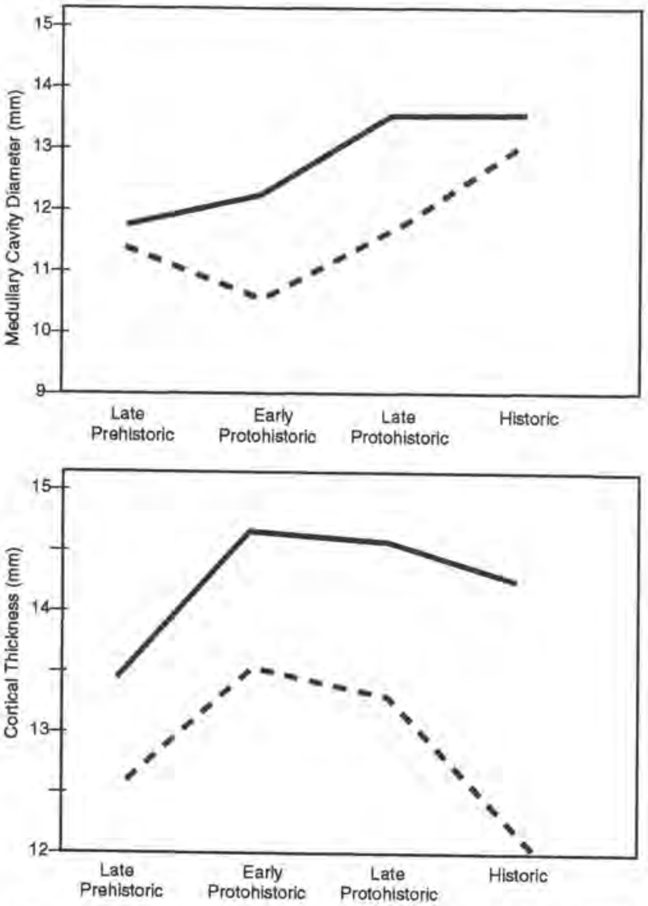


Figure 61. Temporal change in medullary cavity width and cortical thickness of femora of Arikara adults aged 18-30 years.

status. One study (Mann et al. 1994) used plain-film radiography, computerized tomography, and quantitative densitometry to assess the level of osteoporosis evident in an Omaha child (from 25DK10) with histiocytosis X and otitis media. Relative to nine other children of the same age with femora of similar lengths, the child showed marked osteopenia as a result of cortical thinning accompanying expansion of the medullary cavity. Photon absorption densitometry was used to quantify the degree of loss of mineral content, as measured at the midshaft and neck of the femur. The density of the child's femur was nearly two standard deviations less than the average of the reference sample. Using computerized tomography, the investigators evaluated the magnitude of this difference through individual variations in the cross-sectional areas of the cortical bone and the medullary cavity. The 25DK10 femur had a thinner cortex, sparse cancellous bone trabeculae, and diminished mineral content relative to the other children. As a result of limited muscular exertion and inactivity, the child's femur was virtually circular, there being a lack of development of the linea aspera (normally a prominent muscle attachment site on the posterior surface). Progression of the disease affecting the child caused a loss of appetite, thus reduced food intake, undernutrition, and immobilization, resulting in muscle atrophy and osteoporosis.

That cortical bone thickness is responsive to changes in nutritional status has been demonstrated in the Postcontact Arikara. Osteological examinations should include systematic x-raying of the femora and tibiae of both young adults and children to augment the data base and make comparisons with other population samples possible.

Harris Lines

Among the indicators of stress and morbidity in the human skeleton are transverse lines or bands of increased opacity (called Harris lines) that occur on the diaphyses of long bones when longitudinal growth of epiphyseal cartilage is stunted during episodes of disease or malnutrition in the first 18 years of life (Martin et al. 1985; Steinbock 1976; Wells 1967). A period of delayed growth results in a thin layer of bone called the primary stratum. When growth resumes, this stratum thickens, producing a dense layer of horizontally arranged trabeculae that is visible in sectioned bone and roentgenograns (radiographs).

Most Harris lines develop during early childhood, when susceptibility to illness is greatest (Garn and Schwager 1967; Gindhart 1969), and many of these lines persist into adulthood, making analysis based on mature populations possible. Because of the nonintrusive nature of such analyses, Harris line studies have been very useful in providing insights into health and morbidity in archeological populations (Allison et al. 1974; Goodman and Clark 1981; McHenry 1968; Wells 1967; Woodall 1968). Among the factors cited as likely causes of the development of Harris lines are shifts in subsistence strategy (McHenry 1968) and contact with European settlers, which led to social change and economic upheaval (Woodall 1968), as well as to disease (Allison et al. 1974).

Few systematic studies of Harris lines have been conducted on Central and Northern Plains skeletons. Sandness and Green (1993) recorded Harris lines in four skeletal collections from northeastern Nebraska spanning a period of approximately 800 years and incorporating Woodland to Disorganized Coalescent populations. Symes (1983) conducted a detailed evaluation of Harris lines in individuals from the Initial Coalescent site of Crow Creek (39BF11), South Dakota. Owsley (1983) and Cashion (1987) documented the occurrence of Harris lines in Extended, Postcontact, and Disorganized Coalescent Arikara skeletons from the Middle Missouri Valley in South Dakota and a small number of Pawnee from Nebraska. Others (Langdon, Willey, and Cummins 1993; Nickens 1977; Scott and Birkedal 1972; Wanner and Brunswig 1992) studied Harris lines in isolated skeletons collected from the Plains region but offered no conclusions about the causes of these lines other than their representing an episode of childhood nutritional stress or disease.

To evaluate the presence of Harris lines in Plains Native Americans prior to and after European contact, the findings from these various studies are brought together in Table 70. The sites are arranged by temporal context and archeological variant, and the data for specific sites are combined based on their temporal, cultural, and regional similarities.

The percentages of males and females having at least one Harris line are about equal in studies by Cashion (1987), Owsley (1983), Sandness and Green (1993), and Symes (1983), with no statistically significant differences found. However, these analyses show that males have higher numbers of Harris lines, with a majority of lines developing in early childhood, compared

Table 70. Lines of Arrested Growth in Tibiae from the Central and Northern Plains.

Variant	Sites	Indiv.	NL	%NL	ML	Mean
Archaic	5WL2055[1]	1	1	100.0	13	
Woodland	5MR378[2]	1	1	100.0	4	
	5JF959[3]	1	1	100.0	14	2.8
	25DK4[4]	13	11	84.6	10	
Plains Village						
Central Plains	25DK13[4]	60	32	53.3	7	1.1
Initial Coalescent	39BF11[5]	122	92	75.0	10	1.3
Extended Coales.	39BF206[6]	1	1	100.0	9	
	39CA4, 39WW17[7]	42	28	66.7	7	1.1
Postcontact Co.	39DW2, 39WW2,39WW7[7]	94	67	71.3	4	0.9
Disorganized Co.	39C09,39ST215[7]	24	16	66.7	6	0.8
	25DK2,25DK10[4]	24	11	45.8	6	0.8
	25BU1[8]	14	12	85.7	12	3.0
Historic	Crow[9]	20	13	65.0	3	0.9
Total		417	286	68.6	14	

Note: NL = number of individuals with lines of arrested growth;
ML = maximum number of lines observed

[1] Wanner and Brunswig (1992)
[2] Scott and Birkedal (1972)
[3] Nickens (1977)
[4] Sandness and Green (1993)
[5] Symes (1983)
[6] Langdon, Willey, and Cummins (1993)
[7] Owsley (1983)
[8] Cashion (1987)
[9] Sandness (1994)

to females, who have fewer lines that developed later in childhood and during puberty. These findings correlate with the findings of Gindhart (1969) and Goodman and Clark (1981), who suggest that males are more susceptible than females to frequent episodes of stress in early childhood.

There is no clear trend in the percentages of tibiae showing at least one line, with this value fluctuating from 45.8% in Disorganized Coalescent sites of Nebraska to 100% in isolated Archaic and Woodland burials of Colorado. However, line frequency tends to decrease through time, as reflected in the decreasing maximum numbers of lines observed in individual tibiae and in the decreasing mean values for Woodland to Historic period skeletal series. Several factors, including diet, disease, and life expectancy probably contributed to the differential patterns in lines of arrested growth. As experimentation with animals (Harris 1933; Wolback 1947) and clinical studies of children (Caffey 1967; Jones and Dean 1959; Park 1964) demonstrate, a decrease in line frequency is correlated with improved nutrition. Current dietary analyses of the skeletal remains from the Central and Northern Plains suggest that nutritional stress during childhood was less severe in the later Prehistoric and Historic periods. Changing climatic conditions and shifts in subsistence from hunting and gathering to horticulture apparently resulted in improved overall nutrition and less frequent episodes of malnutrition than during the Archaic and Woodland periods. With the introduction of the horse in the Historic period, increased reliance on hunting and decreased reliance on maize agriculture, as indicated in carbon and nitrogen isotope data (Reinhard et al. 1994; Tuross and Fogel 1994), would have led to increased consumption of animal protein and greater dietary diversity, thus improving nutrition among Plains tribes. With improved diet, fewer lines indicating arrested growth would be expected over time, as shown in the data on the Postcontact and Disorganized Coalescent skeletal series.

Childhood disease has also been cited as a factor in the development of Harris lines (Caffey 1967; Harris 1933; Gindhart 1969). Increased trade and interaction with European explorers and traders brought an influx of epidemic diseases throughout the Historic period. Lowie (1954) and Trimble (1994) document several epidemics during the Postcontact and Disorganized Coalescent periods. Repeated episodes of disease would be expected to increase the incidence of lines of arrested growth in Historic period samples, yet the data do not reflect such a trend. However, such lines would be evident only if the victims of disease survived their illness. High infant and subadult mortality reported in demographic studies (Moorhead 1992; Owsley 1983) and in ethnohistorical documentation suggest that epidemic diseases had a devastating effect on Historic Plains Native Americans, greatly reducing population size. Those individuals who survived probably were the hardiest and healthiest. As a result, the data on incidence of Harris lines are not good indicators of the frequency and severity of acute infectious disease stress in Central and Northern Plains Historic period populations.

To summarize, differences in Harris line counts for males and females are small and generally show no patterns that provide clues to factors or events differentially affecting line formation in the two sexes. However, they do suggest that line formation occurred somewhat earlier in males than females. More research comparing Harris line formation in males and females representing different populations and time periods is needed.

That the average number of Harris lines is higher in Archaic and Woodland populations than in later Plains Village horticulturists and Plains nomad bison hunters (i.e., the Crow) is probably the result of nutritional factors, such as the greater likelihood of seasonal shortages (winter/spring) among Archaic and Woodland populations. Village horticulturists could rely on stored crops supplemented by bison hunting to get them through seasonal shortages. Further, Historic period nomadic groups—mounted hunters—could follow the food sources, moving when necessary as food in one location was depleted or affected by seasonal climate.

The Historic Pawnee site (25BU1) does show a higher frequency of Harris lines than do contemporaneous Arikara and Omaha sites. Thus, there is an indication of possible differences in stress leading to arrested growth among populations of late Historic period sites—a finding that calls for further investigation.

More notable in research on Harris lines is the general lack of a difference in numbers of lines counted in relation to archeological variant of the Coalescent tradition. If Harris lines accurately reflect childhood morbidity levels, differences should appear. Disorganized Coalescent samples should have higher average numbers of lines, but the data do not support this expectation. Harris lines observed on adult tibiae only marginally reflect actual stress levels affecting temporally sequential samples. The Protohistoric and Historic populations (i.e., Postcontact Coalescent, Disorganized Coalescent, and Crow) do not show an increase in line frequency that can be linked to the introduction of infectious diseases (e.g., measles and smallpox). The mortality rate was probably high, with lines indicating arrested growth found only in individuals who recovered and resumed normal growth. Thus, Harris lines do not provide a reliable indication of the level of disease stress affecting these populations.

The most pressing research needs are systematic studies to document temporal trends and population differences and, especially, more data on Archaic and Woodland samples. Both femora and tibiae should be used in such studies, with routine x-rays made in a standardized format. When Owsley (1983) investigated transverse line formation on the proximal and distal sections of tibiae, he found a low correlation between proximal and distal counts and locations of lines. Further research should explore these differences and their implications; for example, are sex differences in proximal tibial values indicators of male/female stress differences, or do they merely reflect differential rates of growth and remodeling?

Enamel Hypoplasia and Fluctuating Dental Asymmetry

Hypoplastic lines are transverse bands or pits in the enamel of deciduous or permanent teeth resulting from malnutrition and diseases with high fever occurring in early childhood during enamel apposition. Diseases such as tuberculosis, rickets, and congenital syphilis have been associated with enamel hypoplasia (Ortner and Putschar 1981). Unlike Harris lines, hypoplastic lines are not obscured by remodeling in adulthood, thus providing a better indication of physiological or environmental stress. However, they are subject to loss as a result of dental attrition, and teeth with defective enamel (e.g., hypocalcification and severe hypoplasia) are more likely to become carious and to be lost antemortem as a result of tooth decay.

Data on the occurrence of enamel hypoplasia in samples from the Great Plains are limited. For example, there are no systematic studies of enamel hypoplasia in skeletal samples from Kansas or northeastern Colorado. Although several reports on skeletal samples from South Dakota (Rose, Marks, Kay and Riddick 1984; Willey and Swegle 1980) indicate the presence of hypoplastic lines, they fail to identify the teeth in which these occurred or to relate the data on hypoplasia to other data representing different time periods or geographic areas. Without knowledge of the teeth affected, the results of these studies are difficult to interpret or to integrate into the Plains skeletal data base. An urgent need, therefore, is to record data on enamel hypoplasia in relation to specific teeth and to indicate the age at which the stress episode(s) occurred. Only one study of samples in this region (Cashion 1987) fulfills this requirement.

Cashion's study deals with Harris lines, hypoplastic lines, and cortical bone thickness as indicators of stress in skeletons from seven archeological sites in South Dakota, Oklahoma, and Nebraska. Table 71 presents the data on hypoplastic lines in one mandibular and three maxillary teeth for samples collected at four archeological sites in South Dakota and Nebraska. These data pertain to Plains Village, Coalescent tradition Arikara and Pawnee sites dating from A.D. 1600-1850.

The data on enamel hypoplasia provide evidence of temporal and regional patterning. For example, Arikara males show a decrease in the mean number of hypoplastic lines over time from the Extended to the Disorganized Coalescent variants. Females in the Arikara sample, however, show a slight increase in enamel hypoplasia during the Postcontact period (39WW2), followed by a decrease in line frequency in the Disorganized Coalescent skeletal series from Leavenworth (39CO9). In general, line frequencies for both males and females decrease over time, with the Extended and Postcontact Coalescent sites having relatively similar values that are significantly higher than those of the Disorganized Coalescent sample. The same trends are apparent in the data on Harris lines. The decrease in frequency of enamel hypoplastic lines suggests that health improved during the Disorganized Coalescent variant relative to the preceding 150 years.

The reduction in enamel hypoplasia is difficult to reconcile with the historic context of the Leavenworth site (39CO9). Leavenworth represented an amalgamation of the remnants of previously autonomous villages following the 1781-1782 smallpox epidemic. Based on the historical record, the Leavenworth population was in decline, with a high mortality rate that has been attributed to diseases resulting from European contact, warfare, and periodic food shortages.

The frequency of enamel hypoplasia at the Linwood site (25BU1) in Nebraska, which corresponds temporally to the Leavenworth skeletal series, is the highest among these samples. Cashion (1987) proposes two hypotheses to account for the

Table 71. Enamel Hypoplasia in Coalescent Tradition Samples from Nebraska and South Dakota (from Cashion 1987).

	1st Incisors			2nd Incisors			Maxillary Canines			Mandibular Canines		
Variant, Site, Sex	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Extended/ (39WW1)												
Postcontact Male	19	5.0	2.3	24	4.1	2.3	25	4.0	1.7	23	4.2	1.4
Female	13	4.1	1.9	13	3.5	2.2	17	3.1	1.5	17	3.4	2.4
Postcontact (39WW2)												
Male	32	3.9	2.0	31	3.4	2.0	42	3.6	1.7	34	4.0	2.2
Female	29	5.0	1.7	29	4.2	2.2	34	4.2	1.9	35	4.1	1.8
Disorganized (39CO9)												
Male	12	1.8	1.4	10	1.0	0.8	16	2.0	1.5	17	1.9	1.5
Female	16	2.5	1.9	17	2.4	1.9	16	2.6	2.5	17	3.1	2.0
(25BU1)												
Male	5	6.2	2.8	4	4.5	3.1	5	5.4	2.9	6	4.2	3.1
Female	1	5.0	-	1	8.0	-	3	6.3	4.2	2	6.0	1.4

discrepancy between these two temporally corresponding samples: (a) a difference in the height of enamel (as a result of wear) between the Leavenworth and Linwood samples; and (b) differences in the level of European contact experienced by different Disorganized Coalescent groups. The Leavenworth samples have greater wear and lower enamel height, than those at Linwood. Thus, the possibility of detecting hypoplastic defects is greater for the Linwood than the Leavenworth samples. In regard to European contact, as Linwood was farther south, sustained European contact could have occurred earlier there than at Leavenworth, and the resulting stress reached a higher level than at the more northern contemporary site. Yet the Pawnee, being distant from the Missouri River "superhighway," were more isolated and insular; therefore, they should have experienced a lower level of stress than the population at Leavenworth. Numerically, the Pawnee remained intact longer than the Arikara.

The similarity between the high frequencies of enamel hypoplasia in the Linwood series and those of the Extended and Postcontact variants in South Dakota (e.g., Mobridge [39WW1]) suggests that these populations may have experienced somewhat comparable types of stress (e.g., seasonal food shortages, levels of childhood illnesses, or other events conducive to hypoplasia) even though they represent different time periods.

Types of stress, for example, nutritional or disease-related, might result in different frequencies of hypoplastic lines (and other indicators), a possibility that should be explored. Cashion's (1987) findings show how difficult it is to interpret temporal and geographic differences in indicators of stress. The problem is complex and cannot be solved without larger samples and more comprehensive analyses (e.g., line frequency by type of tooth, sex, site, and other variables) of these samples.

Nongenetic environmental factors can affect tooth enamel in other ways than hypoplasia, for example, by increasing bilateral fluctuating asymmetry in the size of corresponding antimeres. Perzigian (1977a, 1977b) included a Plains Indian sample in a comparison of the levels of fluctuating asymmetry among hunter-gatherers, horticulturists, and twentieth century whites. His results showed a significant difference between an Archaic hunter-gatherer sample from Indian Knoll and a horticulturist sample from Campbell and Larson, as well as between Indian Knoll and the twentieth century Hammon-Todd collection. The difference between the Campbell-Larson sample and the Hammon-Todd groups was not significant. These results are consistent with other evidence suggesting that some Archaic groups suffered greater levels of stress because of their precarious mode of subsistence than did later groups (e.g., Larson) who subsisted on horticulture as well as hunting.

Dental Caries and Antemortem Tooth Loss

Dental Caries

The relationship between diet and dental disease, particularly caries, is a central research issue in dental anthropology and oral biology. Caries, although a multifactor disease process, is predominantly influenced by the form and frequency of carbohydrate ingestion. Dental health and subsistence base are correlated; for example, a low frequency of caries has been found for groups that engage in hunting/fishing and gathering, and a high frequency among horticulturists (Turner 1979; Perzigian et al. 1984). This difference results from the larger proportion of carbohydrates in the diet of the horticulturists. Starches and sugars provide from 45 to 80% of the calorie intake of nonindustrialized horticultural societies (Guthrie 1979). Readily fermentable carbohydrates are characteristic of horticultural foodstuffs (e.g., maize), and their presence stimulates bacterial growth (*Lactobacillus acidophilus* and *Streptococcus mutans*) and plaque formation. Bacterial acids promote the decay of dental enamel (Gray et al. 1962). In contrast, meat protein has a cariostatic effect caused by raising the pH and by the relatively brief clearance time in the mouth, which limits use by plaque bacteria (Alfano 1980).

Food processing techniques, which affect texture, adhesiveness, rate of flow of saliva, and amount of grit in the diet, are also related to the frequency of dental pathology. Minimal processing and grit (introduced while cooking or from the use of grinding stones) cause attrition, which has a cleansing effect that limits the accumulation of plaque and bacteria and removes incipient caries. Diets rich in carbohydrates are typically soft and do not require extensive mastication. Boiling softens foods and removes grit. "Detergent" foods that help to cleanse the oral cavity of the foodstuffs that promote dental decay are often lacking (Guthrie 1979).

Several studies have examined the occurrence of dental caries, abscesses, and premortem tooth loss in Plains Indians. These studies provide information about patterns of dental disease in relation to age, sex, dental morphology, attrition, and subsistence pattern (e.g., Leigh 1925; Phenice 1969; Toth and Peterson 1992; Ubelaker 1971).

The pattern of dental disease can be used as an indicator of the shift from hunting and gathering to horticulture (Turner 1979). A few studies of Plains Indian dentitions have focused on the correlation of dental pathology with archeologically defined subsistence base and inferred diet (notably M.A. theses by Masters [1987] and Zitt [1992]). Zitt compared data on dental pathology for the Central (Lower Loup phase and Historic Pawnee) and the Northwestern Plains (Archaic, Late Prehistoric, Protohistoric, and Historic). Rates of caries for horticulturists were only slightly higher than for hunter-gatherers, a finding that suggests a mixed economy with heavy emphasis on hunting. Masters (1987) also found rates of caries in Central Plains and Middle Missouri populations that were surprisingly low for horticultural groups.

The frequency of dental caries in permanent dentitions varies geographically and temporally in the Great Plains. Tables 72, 73, and 74 give the incidence of dental caries by tooth type reported (or calculated from Owsley's data files) for Late Woodland, Southern Plains Village, Central Plains tradition, and Coalescent samples representing the Arikara, Pawnee, Omaha, and Ponca from Nebraska and South Dakota. Table 75 provides additional data and summarizes the findings in regard to caries.

Table 72. Dental Caries in Late Woodland and Southern and Central Plains Tradition Samples.

Tooth Type	Southern Plains Village[1] (Washita River Phase) [34GV2, 34WA5] N	C	%	Late Woodland[2] (Schultz Focus) N	C	%	Central Plains Tradition (Itskari Phase) [25HW3] N	C	%
Maxilla									
Incisors	37	2	5.4	134	1	0.7	8	1	12.5
Canines	21	8	38.1	94	2	2.1	5	2	40.0
Premolars	36	16	44.4	138	5	3.6	17	2	11.8
Molars	28	8	28.6	282	36	12.8	32	11	34.4
Mandible									
Incisors	41	4	9.8	91	0	0.0	18	0	0.0
Canines	28	2	7.1	78	1	1.3	11	0	0.0
Premolars	51	5	9.8	138	2	1.4	19	0	0.0
Molars	52	17	32.7	258	39	15.1	32	5	15.6
Total	294	62	21.1	1213	86	7.1	142	21	14.8

Note: N = Number of permanent teeth C = Number with caries % = Percent carious
[1] Owsley and Jantz (1989:150)
[2] Phenice (1969:62)

Table 73. Dental Caries in Extended, Postcontact, and Disorganized Coalescent Tradition Samples from South Dakota.

Tooth Type	Extended/Postcontact [39SL4][1] N	C	%	Postcontact [39DW2][2] N	C	%	Disorganized [39CO9] N	C	%
Maxilla									
Incisors	594	3	0.5	30	0	0.0	10	0	0.0
Canines	307	7	2.3	21	0	0.0	10	0	0.0
Premolars	610	16	2.6	44	4	9.1	15	0	0.0
Molars	888	50	5.6	52	7	13.5	27	0	0.0
Mandible									
Incisors	579	2	0.3	41	1	2.4	14	0	0.0
Canines	298	1	0.3	23	0	0.0	8	0	0.0
Premolars	592	16	2.7	41	5	12.2	20	1	5.0
Molars	875	43	4.9	61	12	19.7	40	2	5.0
Total	4743	138	2.9	313	29	9.3	144	3	2.1

Note: N = Number of permanent teeth C = Number with caries % = Percent carious
[1] Phenice (1969:62)
[2] Owsley and Jantz (1989:150)

Table 74. Dental Caries in Coalescent Tradition Samples from Nebraska.

Tooth Type	Protohistoric Pawnee[1] N	C	%	Historic Pawnee[1] N	C	%	Historic Omaha [25DK2, 25DK10] N	C	%	Historic Ponca [25KX1] N	C	%
Maxilla												
Incisors	98	0	0.0	157	0	0.0	27	0	0.0	21	0	0.0
Canines	51	0	0.0	81	1	1.2	24	0	0.0	21	0	0.0
Premolars	102	0	0.0	165	6	3.6	58	7	12.1	40	0	0.0
Molars	150	8	5.3	248	8	3.2	90	9	10.0	68	3	4.4
Mandible												
Incisors	188	0	0.0	156	0	0.0	43	0	0.0	19	0	0.0
Canines	93	0	0.0	79	0	0.0	26	0	0.0	13	0	0.0
Premolars	189	5	2.6	158	9	5.7	53	0	0.0	34	1	2.9
Molars	293	23	7.8	237	10	4.2	88	8	9.1	72	3	4.2
Total	1164	36	3.1	1281	34	2.7	409	24	5.9	288	7	2.4

Note: N = Number of permanent teeth C = Number with caries % = Percent carious
[1] Zitt (1992:96)

(As several investigators compiled the data, and for different purposes, there is some overlap or duplication of individuals represented by a few samples.)

Specific information for the Archaic period is lacking, and data for Woodland populations of the Central Plains are sparse. Caries were present, although the percentage of teeth affected was only around 5% or less. The frequency of caries in Late Woodland Schultz focus samples from north central Kansas was slightly higher and comparable to that of some of the later Central Plains tradition groups.

Overall oral health was better among Northern Plains Woodland period hunter-gatherers than among the later Plains Village horticulturists (Willey and Hofman 1994; Williams 1994). Southern and Central Plains tradition populations from Oklahoma, Kansas, and Nebraska show a similar trend, with frequency values for caries higher in later periods than during the Archaic and Woodland periods.

Most of the available data represent Plains Village populations that relied on mixed economies, emphasizing a subsistence pattern based on both hunting and farming. These samples show some heterogeneity, but there is consistency among comparable groups (e.g., Disorganized Coalescent samples). Variations among populations suggest differences in the relative contributions of these two activities to the diet.

The frequency of caries in Southern Plains horticulturists was considerably higher than in the Central and Northern Plains (Owsley and Jantz 1989). The highest value (21.1%) for caries occurred in Southern Plains villagers from Oklahoma, with an Itskari phase Central Plains tradition sample from Nebraska next (14.8%). Caries affected all types of teeth (including incisors and canines). This regional difference indicates greater reliance on maize in the Southern Plains. Although precise data on frequency are lacking, carious lesions were common in Steed-Kisker samples (e.g., 14WY7) from Kansas and Missouri (Barnes 1977; Stewart 1943).

Coalescent tradition samples show a lower rate of dental caries than the Central Plains tradition samples; however, there was heterogeneity among these samples. Although there was no change in the frequency of caries between the Protohistoric and Historic Pawnee (Table 74), the Postcontact Coalescent Arikara experienced higher frequencies of caries (suggesting greater dependance on maize) than did the earlier Extended and later Disorganized Coalescent Arikara (Tables 73 and 75). This pattern is consistent with archeological evidence indicating differences in the subsistence base of these variants (i.e., heavier emphasis on horticulture by Postcontact villagers).

Burial samples from the same Omaha village (i.e., 25DK2 and 25DK10) show differences in the frequency of caries (Table 76). Adults from 25DK2 were essentially free of dental caries (0.6%), compared to a much higher frequency of caries (9.0%) in those from 25DK10, a percentage similar to that found among the Postcontact Coalescent Arikara. The meaning of this internal variation is not yet understood: does it reflect dietary differences that are linked to trade (e.g., differential access to sugar), relatively greater dependence on maize among subsets of the same population, or a temporal effect involving a rapidly changing diet as a result of contact?

Among the horticulturists, the lowest frequencies of caries occurred in the Disorganized Coalescent Arikara, Pawnee, and Ponca, as a result, in part, of heavy reliance on bison hunting. No published data are available for late nomadic groups like the Cheyenne and Sioux, with the exception of an early study by Leigh (1925). This study found pronounced differences among the Zuni, Arikara, and Sioux, the latter having the lowest frequency, a difference attributed to the low proportion of carbohydrates and large amounts of animal protein in the Sioux diet.

Table 75. Dental Caries in Archaic, Woodland, and Plains Village Dentitions.

Variant	Site	Ind.	Teeth	Carious	%
Archaic/Woodland	Multiple[1,A]	21	–	–	5.0
Late Woodland	14PO14[2]	–	74	2	2.7
Central Plains	Multiple[1,B]	36	–	–	6.8
	14SA1[3]	–	252	10	4.0
	25DK9, 25DK13[4]	38	759	49	6.5
Extended Coales.	39WW1[1]	24	–	–	2.2
Postcontact Coales.	39LM27, 39WW7[5]	–	94	9	9.6
	39WW2, 39SL4	33	–	–	8.2
Disorganized Coales.					
Pawnee	Multiple[1,C]	32	–	–	3.5
Omaha/Ponca	Multiple[1,D]	11	–	–	3.4
Omaha	25DK2, 25DK10[4]	17	407	28	6.9
Arikara	39CO9[1]	22	–	–	1.8

Note: The percent column refers to the percentages indicated by the investigator(s) and some omitted reporting the data on which the percentage was based.
[1] Masters (1987)
[2] Cumming (1958)
[3] Finnegan (1990)
[4] Toth and Peterson (1992)
[5] Rose, Marks, and Kay (1984)
[A] Archaic: 25MP2, 25RW2, 25SY67; Woodland: 25CD21, 25DK2, 25DK4, 25FR2, 25HK13, and 25VY3
[B] Central Plains Tradition: 25CD4, 25DK9, 25DK13, 25D04, 25HW6, 25HW8, 25NC13, 25SY67
[C] Pawnee: 25BU1, 25BU2, 25NC20, 25PK1, 25SD2, 25WT1
[D] Omaha/Ponca: 25CD7, 25DK2, 25DK10, 25KX1

Most studies tabulate the data without regard for the age or sex distribution of the sample. In the case of the Protohistoric and Historic Pawnee, a group with a low frequency of caries, this approach is valid, as the basic statistics for age-stratified adults and for males and females are comparable (Table 77; Zitt 1992). Sex-specific data for additional samples appear in Table 78. Only the Omaha show a pronounced difference, with nearly all carious lesions found in females (from 25DK10). This observation does not fit a time-based model but is indicative of differential access to certain foods (through trade or by farming) by groups of related (?) females. Because the available information is limited, future evaluations of the data on dental pathology should include tests for differences related to demographic composition.

Table 76. Dental Caries and Alveolar Bone Pathology in Samples from Two Omaha Cemeteries.

	25DK2						25DK10					
Tooth	N	C	%C	S	P	%P	N	C	%C	S	P	%P
Maxilla												
Incisors	10	0	0.0	29	0	0.0	17	0	0.0	46	6	13.0
Canines	9	0	0.0	15	0	0.0	15	0	0.0	24	0	0.0
Premolars	21	0	0.0	33	1	3.0	37	7	18.9	48	8	16.7
Molars	38	0	0.0	44	1	2.3	52	9	17.3	68	23	33.8
Mandible												
Incisors	15	0	0.0	24	0	0.0	28	0	0.0	40	3	7.5
Canines	9	0	0.0	14	0	0.0	17	0	0.0	20	1	5.0
Premolars	17	0	0.0	26	0	0.0	36	0	0.0	40	1	2.5
Molars	35	1	2.9	41	0	0.0	53	7	13.2	57	3	5.3
TOTAL	154	1	0.6	226	2	0.9	255	23	9.0	343	45	13.1

Note: N = Number of permanent teeth; C = Number with carious lesions; %C = Percent carious; S = Number of tooth sockets; P = Number with alveolar bone pathology (antemortem loss & perimortem abscesses); %P = % with pathology

Table 77. Number of Carious Teeth in the Protohistoric and Historic Pawnee by Age and Sex (Zitt 1992:91, 93).

Tooth	15-29 Years N	C	%	30+ Years N	C	%	Male N	C	%	Female N	C	%
Maxillary												
Incisors	129	0	0.0	126	0	0.0	118	0	0.0	132	0	0.0
Canines	66	0	0.0	65	1	1.5	59	0	0.0	70	1	1.4
Premolars	134	2	1.5	133	4	3.0	119	4	3.4	142	0	0.0
Molars	197	4	2.0	201	13	6.5	172	6	3.5	209	9	4.3
Mandibular												
Incisors	198	0	0.0	146	0	0.0	130	0	0.0	206	0	0.0
Canines	97	0	0.0	75	0	0.0	64	0	0.0	103	0	0.0
Premolars	192	9	4.7	154	5	3.2	133	5	3.8	205	8	3.9
Molars	301	14	4.7	229	13	5.7	202	13	6.4	318	11	3.5
Total	1314	29	2.2	1129	36	3.2	997	28	2.8	1385	29	2.1

Note: N = Number of permanent teeth; C = Number with caries; % = Percent carious

Table 78. Frequency of Dental Caries in Plains Village Adults by Gender.

Variant, and Site	Males N	C	%	Females N	C	%
Southern Plains[1] (34GV2, 34WA5)	125	26	20.8	169	36	21.3
Postcontact Coalescent						
Arikara[1] (39DW2)	52	6	11.5	261	26	10.0
Postcontact and Disorganized Coalescent						
Pawnee[2] (multiple sites)	997	28	2.8	1385	29	2.1
Disorganized Coalescent						
Omaha (25DK2, 25DK10)	248	1	0.4	161	23	14.3
Ponca (25KX1)	116	2	1.7	172	5	2.9

Note: N = Number of permanent teeth; C = Number with caries; % = Percent carious

[1] Owsley and Jantz (1989:150)

[2] Zitt (1992:91)

In summary, previous studies and the data presented in these tables demonstrate:

• Variation in susceptibility to caries among the different types of teeth. The incisors exhibit the highest resistance to caries, followed in descending order by the canines, premolars, and molars.

• Variation in susceptibility to caries among different surfaces of the same tooth. Initially, most cavities involve either the occlusal or interproximal surfaces. The buccal surface is prone to caries when a buccal pit is present.

• Similar rates of dental caries in both sexes. Only the Omaha show a noticeable difference in incidence in relation to sex, with a higher frequency for females.

• Geographic and temporal differences among Plains populations. Some of the greatest variation occur within the horticultural groups, which indicates varying degrees of dependence on maize.

• Lower frequencies of dental caries among the Plains Village horticulturists than among the sedentary farmers in many other parts of the continent. (Populations with heavy emphasis on agriculture show frequencies of at least 10% or more for caries [Patterson 1984; Turner 1979].)

Although a few of these assessments are based on large samples, often sample sizes are quite small, and there are many gaps in the data base, with a number of cultural units not represented. Furthermore, some of the available data are of limited usefulness for comparative studies because they fail to provide precise information on the percentage of carious teeth. Additional samples, categorized by age when appropriate, and derived from systematic, controlled studies must be included to validate trends and comparisons among population samples representing different areas and eras.

The frequency of pathological conditions in deciduous dentition has not been systematically evaluated. In general, dental caries is rare among subadults in the Central and Northern Plains except during the late Historic period and among early Plains Village populations. In Owsley's experience, caries is rare in Woodland populations and in most Coalescent samples from Nebraska and South Dakota. For example, there are few cases of caries in deciduous teeth in a large sample of children from the Extended/Postcontact Coalescent Sully site (39SL4).

The Disorganized Coalescent Omaha in northeastern Nebraska are an exception, with carious lesions present in the teeth of several children. This anomalous condition may reflect a change in the diet (e.g., the introduction and consumption of sugar) as a result of trade with Euro-Americans, or heavier dependence on maize than was the case for the contemporary Arikara and Pawnee.

Late nineteenth populations experienced problems with deciduous dental caries that are linked to changes in dietary patterns, such as greater reliance on cariogenic foods, sometimes in combination with ontogenetic factors that disrupted dental development and resulted in defective (i.e., hypocalcified or hypoplastic) enamel. The deciduous lateral maxillary incisors of a Sioux child (39ST60), ca. 1880, show notches from circular caries (Willey and Swegle 1980). Dental development was disrupted prenatally when the affected portions of enamel were forming, and this disturbance predisposed the child to tooth decay. Late nineteenth century Crow and Blackfeet children from Montana show similar increases in the incidence of caries.

The data available for deciduous dentitions reinforce the evidence for higher frequencies of caries in the permanent teeth of Central Plains tradition populations (relative to later Coalescent tradition populations). Subadults from at least four Central Plains tradition sites (14SA1, 14WY7, 25FT1, and 25HW3) show deciduous dental caries. Two of 75 (2.7%) deciduous teeth (lost postmortem and recovered while screening the dirt prior to closing and backfilling the site) from the Indian Burial Pit (14SA1) were affected by caries (Finnegan 1990). Based on descriptive information provided for the Calovich burials (14WY7) (frequency data are not provided), deciduous dental caries was fairly common (Barnes 1977). Carious lesions affected both the deciduous teeth and the permanent molars during childhood.

To substantiate the suggested higher frequencies of caries in Central Plains tradition subadults, and also in more southern Plains populations, will require additional data. Deciduous caries is a particularly sensitive indicator of relative dependence on corn or other sources of carbohydrates and of sugar in the diet, as these teeth are present for only a limited number of years before exfoliation. Problems with tooth decay in children indicate a diet that is highly cariogenic. To date, however, the implications of deciduous caries have received little attention and investigation.

Alveolar Abscessing and Antemortem Tooth Loss

Many factors affect the interpretation of oral pathology profiles for various groups. Progressive dental caries and heavy attrition can result in abscessing and exfoliation of a tooth by exposing the pulp chamber to bacterial invasion. Periodontal disease, primarily due to the accumulation of plaque deposits, leads to inflammation and deterioration of the periodontium. This condition is indicated by gingival and alveolar bone resorption, which can result in tooth loss.

Observations of antemortem tooth loss and abscessing are commonly noted in bioarcheological reports; however, in most cases the information is descriptive and rarely is it synthesized in a format that facilitates comparison. Thus, comparable data for rigorous statistical evaluation of the occurrence of alveolar abscessing and antemortem tooth loss are limited. To compare selected Central and Northern Plains samples, counts in situ for teeth with periapical or periodontal abscesses (i.e., abscessing at the time of death) were combined with the numbers of teeth lost antemortem. This composite statistic provides a measure of the "frequency of serious dental pathology" in a few studies (Phenice 1969:60).

Table 79 shows the frequencies of alveolar bone pathology in two Woodland samples and a Southern Plains Village sample. Data for the protohistoric Arikara and Pawnee and the historic Omaha, Pawnee, and Ponca appear in Tables 80 and 81. Molars were more often affected than the incisors and canines.

The Southern Plains Village sample and the Middle Woodland Sonota complex sample from South Dakota had the highest frequencies of alveolar bone disease. Both caries and attrition were the primary causal factors in the Southern Plains sample, but attrition was the main cause in the Sonota series, which is consistent with the many older adults in this sample (Phenice 1969). In Middle Woodland burials from the Taylor Mound (14DP3), Klepinger and Bass (1971:185) describe teeth worn to the gum line as "a striking feature of the dentition." A high incidence of periodontal disease and a low incidence of caries characterized this group. Only three, or possibly four, teeth were carious, yet nearly all dentitions showed alveolar resorption and tooth loss from abscesses caused by the extreme degree of wear. In contrast, other Woodland samples (e.g., 14PO14 (Cumming

Table 79. Alveolar Bone Pathology in Woodland and Southern Plains Village Samples.

	Middle Woodland[1] Sonata Complex (39DW233, 39DW240, 39DW252)			Late Woodland[1] Schultz Focus (Multiple Sites)			Southern Plains Village[2] (34GV2, 34WA5)		
Tooth Type	N	P	%	N	P	%	N	P	%
Maxillary									
Incisors	75	19	25.3	157	10	6.4	52	12	23.1
Canines	37	6	16.2	94	3	3.2	27	9	33.3
Premolars	74	11	14.9	187	13	7.0	55	30	54.5
Molars	96	40	41.7	239	25	10.5	63	49	77.7
Mandibular									
Incisors	74	20	27.0	170	10	5.9	61	17	27.9
Canines	38	10	26.3	88	4	4.5	32	2	6.3
Premolars	74	18	24.3	183	19	10.4	62	11	17.7
Molars	112	54	48.2	267	55	20.6	91	47	51.6
Total	580	178	30.7	1385	139	10.0	443	177	40.0

Note: N = Number of tooth sockets; P = Number of tooth sockets affected by periodontal or periapical abscessing or antemortem tooth loss
% = Percent pathological
[1] Phenice (1969:61)
[2] Owsley and Jantz (1989:151)

Table 80. Alveolar Bone Pathology in Plains Village Samples from Nebraska.

	Protohistoric Pawnee[1] (Multiple Sites)			Historic Pawnee[1] (Multiple Sites)			Historic Omaha (25DK2, 25DK10)			Historic Ponca (25KX1)		
Tooth Type	N	P	%	N	P	%	N	P	%	N	P	%
Maxillary												
Incisors	93	4	4.3	157	7	4.5	75	6	8.0	60	4	6.7
Canines	49	0	0.0	81	9	11.1	39	0	0.0	30	0	0.0
Premolars	100	9	9.0	165	14	8.5	81	8	9.9	60	5	8.3
Molars	144	15	10.4	243	36	14.8	112	24	21.4	78	4	5.1
Mandibular												
Incisors	188	9	4.8	155	5	3.2	64	3	4.7	54	2	3.7
Canines	92	4	4.3	78	5	6.4	34	1	2.9	27	0	0.0
Premolars	187	12	6.4	157	18	11.5	66	1	1.5	56	1	1.8
Molars	288	43	14.9	235	34	14.5	98	3	3.1	81	2	2.5
Total	1141	96	8.4	1271	128	10.1	569	46	8.1	446	18	4.0

Note: N = Number of tooth sockets; P = Number of tooth sockets affected by periodontal or periapical abscessing or antemortem tooth loss
% = Percent pathological
[1] Zitt (1992:103)

Table 81. Alveolar Bone Pathology in Coalescent Tradition Samples from South Dakota.

Tooth Type	Postcontact Arikara[1] [39DW2] N	P	%	Extended/Postcontact Arikara[2] [39SL4] N	P	%
Maxillary						
Incisors	50	9	18.0	594	41	13.0
Canines	24	1	4.2	307	35	11.4
Premolars	55	8	14.5	610	108	17.7
Molars	77	35	45.5	888	222	25.0
Mandibular						
Incisors	52	10	19.2	579	64	11.1
Canines	27	1	3.7	298	14	4.7
Premolars	53	7	13.2	594	46	7.7
Molars	83	26	31.3	795	129	16.2
Total	421	97	23.0	4665	659	14.1

Note: N = Number of tooth sockets; P = Number of tooth sockets affected by periodontal or periapical abscessing or antemortem tooth loss; % = Percent pathological

[1] Owsley and Jantz (1989:151)

[2] Phenice (1969:61)

1958), 14MO314 (Bass and Head n.d.)) showed no evidence of abscessing, with retention of teeth into late life in spite of excessive wear. The incomplete mandible of a young adult female from a Late Archaic site (5WL2055) in the Northeastern Colorado High Plains was edentulous (Wanner and Brunswig 1992).

In the Late Woodland Shultz series from Kansas and the historic tribal groups from Nebraska, the incidence of alveolar pathology ranged between 4 to 10%. Consistent with the higher frequency of caries, infections and tooth loss were more common in the Arikara.

The age distribution of a study sample is a key factor in populations with significant rates of tooth wear, for when the diet is abrasive and mastication heavy, older individuals are more likely to suffer tooth loss resulting from pulp exposure. All individuals over 50 years of age from the Calovich Mound (14WY7) show extreme attrition, abscesses, antemortem loss of several teeth, alveolar bone resorption, and hypercementosis (Barnes 1977). In the case of the Pawnee, the frequency of alveolar bone pathology was more than four times greater in adults who were more than 30 years old compared to those between the ages of 15 and 29 (Table 82; Zitt 1992). Because of the low frequency of caries in this population, this difference is mainly attributable to the cumulative effect of tooth wear. Abscesses and tooth loss were twice as common in males as females in this sample. Both sex and age differences are statistically significant.

As in the case of caries, Omaha burials from 25DK2 and 25DK10 differ in the frequency of alveolar bone pathology (Table 79), thus providing further evidence of dietary divergence in a single village. The sample from 25DK2 has virtually no pathology (0.9%), as compared to 13.1% of tooth sockets showing pathology in the 25DK10 sample, with all tooth types affected.

McWilliams (1965) compared alveolar abscessing and periodontal disease in young (20-35 years) and older (35-50 plus) males and females in a sample from Sully (39SL4). He found the incidence of alveolar pathology the same for males (16.6%) and females (16.7%). In both sexes, the maxillary sockets were more frequently affected that the mandibular. As might be expected, for both sexes, alveolar pathology was greater for those of advanced age for both sexes than for the younger adults. Of 747 sockets of young adult males, 48 (6.5%) were affected, compared to 151 (33.5%) of 450 sockets of older males. For females the data were as follows: 7 (1.2%) of 565 sockets of the younger group showed pathology, compared to 158 (37.6%) of 420 sockets of older females. In regard to individuals, 28.1% of the 32 younger males had alveolar bone pathology compared to 86.4% of the 22 older males. Similarly, 29.2% of the 24 younger females had such pathology compared to 60% of the 20 older ones. Thus, McWilliams' data are consistent with the data from other samples showing an increase of alveolar bone pathology with age; however, he found no difference in incidence of such pathology in relation to sex.

Available data are too limited to provide a more comprehensive statement about differences in temporal or regional patterns in alveolar bone pathology. More thorough documentation of the incidence and causes of such pathology is necessary, with base counts indicated for the number of healthy, abscessed, and resorbed dental sockets for each tooth type per individual, as well as comparisons between sexes and for different age categories.

Table 82. Alveolar Bone Pathology in the Protohistoric and Historic Pawnee by Age and Sex (Zitt 1992:98, 100).

Tooth Type	15-29 Years N	P	%	30+ Years N	P	%	Male N	P	%	Female N	P	%
Maxillary												
Incisors	124	1	0.8	126	10	7.9	115	7	6.1	131	4	3.1
Canines	65	0	0.0	65	9	13.8	59	6	10.2	69	3	4.3
Premolars	132	1	0.8	133	24	18.0	118	11	9.3	142	14	10.0
Molars	192	7	3.6	195	44	23.0	171	36	21.1	206	15	7.3
Mandibular												
Incisors	198	2	1.0	145	12	8.3	129	7	5.4	206	5	2.4
Canines	96	1	1.0	74	8	10.8	64	6	9.4	103	2	2.0
Premolars	191	6	3.1	153	24	15.7	133	15	11.3	205	14	6.8
Molars	299	27	9.0	224	50	22.3	201	46	22.9	318	29	9.1
Total	1297	45	3.5	1115	181	16.2	990	134	13.5	1380	86	6.2

Note: N = Number of tooth sockets; P = Number of teeth lost from antemortem abscessing plus the number with perimortem abscesses. % = Percentage of sockets showing alveolar bone pathology.

Behaviorally and Culturally Induced Alterations in Dentition

Dental Attrition at the Macroscopic Level

Most bioarcheological research that includes information on dentition mentions—sometimes only in passing—the level of dental attrition as an indicator of chronological age, or more often, of type of food processing, subsistence pattern, or dental pathology. Colorado Plains Woodland complex burials, for example, generally have a low incidence of caries but occasional abscesses caused by rapid and extremely heavy wear that results from the use of soft sandstone milling stones and a diet including a substantial amount of wild plants and seeds (Scott and Birkedal 1972). Clearly, temporal and regional differences in rate of tooth wear must be present; for example, limited food processing techniques in Archaic and Woodland populations resulted in fairly heavy attrition. However, the nature of such differences is as yet poorly documented and primarily impressionistic. Quantitative data with which to compare populations are generally lacking, and some of the data that do exist have not been published.

Dental wear is difficult to score and analyze. It varies, in part, in relation to the age of an individual, so age composition of a sample must be controlled when making comparisons, which is not easy. Age determinations of bioarcheological samples can be influenced by observations of the level of tooth wear, resulting in circularity and bias in such research. One way to address this problem is to compare relative levels of occlusal surface wear between adjacent molars, which differ by an interval determined by the time of eruption. For example, the attrition gradient (i.e., differences between scores for the first, second, and third molars) for two individuals from Swan Creek (39WW7) indicated a rapid rate of tooth wear and an abrasive diet, even though the actual scores were not especially high (Rose, Marks, and Kay 1984).

Several coding systems (e.g., Murphy 1959; Scott 1979; Smith 1984) have been used to score dental attrition in individual Plains samples (cf., Masters 1987; Rose, Marks, and Kay 1984). The Scott (1979) system scores each quadrant of the occlusal surface of a molar according to the proportional area of enamel wear facets and the amount of remaining enamel when dentin is exposed. In the Murphy and Smith systems, the stage of dentin exposure is matched with standardized drawings arranged in ordinal scales. In addition, angles of occlusal wear and size of distal interproximal wear facets on first molars have been measured for a few groups (Masters 1984, 1987).

The severity of wear is determined by the vigor and amount of mastication required for food consumption, the presence of abrasive material, and individual variables such as oral pathology (e.g., abscesses and antemortem tooth loss) or malocclusion. With attrition, the occlusal surfaces of the posterior teeth can be worn flat or sloped (i.e., angled), with the mandibular and maxillary molars showing opposite wear planes. Patterns of oblique occlusal wear are common in Plains Village dentitions and are a progressive function of attrition, abrasion, and age. (Attrition refers to normal wear of the teeth from rubbing against each other; abrasion reflects the presence of grit in the diet.)

Age-related change in patterns of occlusal wear for the premolars and molars has been documented for Arikara dentitions from the Larson site (39WW2), a Postcontact Coalescent village. Up to about 18 years of age, the occlusal surfaces of the mandibular teeth and the maxillary premolars show lingual sloping and the maxillary molars show buccal sloping (Butler 1969, 1972). Attrition during the young adult years begins to reverse these wear planes in such a way that the maxillary first molars show increasing wear on the lingual halves of the crowns and the mandibular first molars show greater wear on the buccal cusps. These wear gradients gradually produce a lingual slope in the maxillary first molars and a buccal slope in the mandibular first molars. With increasing age, the mandibular premolars and second molars also develop buccal wear planes, and the maxillary premolars and molars show an increased lingual slope.

Plane angles of wear for Nebraska and South Dakota groups were compared in a test of Smith's (1984) hypothesis that hunter-gatherers exhibit flatter wear and that an oblique angle is more characteristic of agriculturalists (Masters 1984, 1987). The rationale was as follows:

> Hunter-gatherers eating tough fibrous food tend to use a vertical chopping type of mastication followed by a grinding and shearing across the teeth which requires more lateral movement of the jaw and a more robust craniofacial mastication morphology. Horticulturalists (sic), on the other hand, eating a more refined diet requiring less jaw movement, less robust mechanisms of mastication and smaller grinding tooth to tooth contacts develop a more buccally angled wear on the mandibular first molars and a lingually angled wear on the corresponding maxillary first molars. (Masters 1984:27-28)

Seven groups were compared:

- A combined Archaic and Woodland sample (N = 21)
- A Central Plains tradition sample (N = 36)
- Extended (N = 24), Postcontact (N = 33), and Disorganized (N = 22) Coalescent Arikara samples
- A Coalescent tradition Pawnee sample (N = 32)
- A Coalescent tradition Omaha/Ponca sample (N=11)

On a scale of 1-8, the Central Plains group had the least amount of wear (3.5) on first molars, and the Archaic/Woodland sample had the most (5.5). The Extended, Postcontact, and Disorganized Coalescent samples were similar, with the levels of wear ranging from 4.7 to 5.0. The Central Plains sample showed the least amount of slope on first molars, followed by the Archaic/Woodland sample. The Extended Coalescent and Disorganized Coalescent Arikara showed the highest plane angles of wear.

An index of the size of interproximal wear facets was developed. The smallest facet (0.16) size occurred in the Archaic/Woodland group; increases in size appeared in the Central Plains (0.22), Extended Coalescent (0.36), and Postcontact and Disorganized Coalescent Arikara and Omaha/Ponca (0.42-0.44) samples. This increase in the facet index was not anticipated, being the "opposite of what would be expected for groups with increasing reliance on horticulture" (Masters 1987:115). (The expected pattern was a decrease in size of facets among horticulturists as a result of their softer diet. Yet, the Postcontact Coalescent sample had the highest rate of caries and the largest facet index.) As noted in the section on "Subsistence in the Central and Northern Plains," the Plains Village horticulturists were unique in their ecological adaptation because of heavy dependence on bison hunting. Late Village populations varied in their emphasis on horticulture. Larger sample sizes, a refined temporal model, and alternative hypotheses will be necessary to achieve a better understanding of patterns of dental attrition over time. Cultural activities that required use of the teeth for specific processing tasks could be responsible in part for the increased interstitial wear found in groups representing later periods. Other limitations in the research design should also be considered. Separate Woodland and Archaic samples should be analyzed, as incipient horticulture among some Woodland groups suggests that the combined sample is not typical of hunter-gatherers. Further, possible variation in the demographic profiles of these samples should be controlled; for example, age differences in the composition of samples could affect values obtained for dental wear (cf. Butler 1972).

Nearly all of the available data concern the permanent teeth. However, deciduous teeth are also subject to wear. Finnegan's (1990) field examination of burials from the Indian Burial Pit (14SA1) showed that 20.8% of the deciduous incisors, 38.5% of the canines, and 42.2% of the molars displayed attrition, evidence of considerable grit in the diet.

Central and Northern Plains Indian dentitions show grooves in the occlusal surfaces of the anterior teeth (e.g., tailor's notch) (Symes, Case, and Thurston 1985), although examples are relatively infrequent and have not been systematically studied or reported. Most of these modifications can be attributed to the use of the teeth in specific task activities (e.g., working with fibers or sinew) that gradually abrade the dental enamel and underlying softer dentin of affected teeth.

More common, but also poorly documented, are noticeable differences that occur in some individuals in the levels of tooth wear between the anterior and posterior teeth. In these cases, the incisors and canines show more pronounced wear and occasionally also have rounded occlusal/facial surfaces. These features reflect use of the anterior teeth in tasks that accelerate the rate of wear above that which occurs in normal mastication. For example, both males and females from the Sargent site (25CU28), a Central Plains tradition ossuary, show a gradient of decreasing wear for the posterior teeth (O'Shea and Bridges 1989). Wear is moderate to heavy for the anterior teeth, becoming much lighter toward the back of the dental arcade. In the oldest individual, aged 40 to 50 years, the incisors are worn to the gum line.

Two historic tribal groups in the Central and Northwestern Plains that show noticeably heavy anterior tooth wear are the Omaha and the Crow. The dentition of females, in particular, tends to show this pattern, along with other features (e.g., pronounced development of the attachment sites of the muscles of mastication and a high frequency of temporomandibular pathology) that indicate heavy use of the anterior teeth for processing of materials. The level of anterior tooth wear in the historic Omaha (25DK2 and 25DK10), when compared to the Nebraska phase adults from 25DK9 and 25DK13, indicates a temporal difference; 58.8% of the Historic sample displayed extreme anterior wear in contrast to 34.2% of the prehistoric sample (Toth and Peterson 1992). Detailed documentation and scoring of observations are necessary in order to clarify individual and sex-related patterns resulting from specific activities and differences in these patterns among populations.

Molar Enamel Microwear

Microwear analysis of molar cusp surfaces with a scanning electron microscope (SEM) provides information about diet and food processing techniques (Blaeuer and Rose 1982; Rose, Marks, and Kay 1984). Photographs at low (15-30X) and high (1500X) magnifications make possible both qualitative and quantitative analyses of striations, compression fractures, gouges, and polish in enamel. For example, high magnification micrographs and proportional estimates of the surface area covered by each type of feature on a standardized grid yield data on the average width of striations, fractures, and gouges. These data, in turn, provide information about the coarseness of foods and the relative amounts of grit, hard seed particles, and unprocessed vegetable fiber in the diet. Large striations (i.e., elongated grooves cut into the enamel surface) indicate coarsely prepared, abrasive foods, with large amounts of grit, generally resulting from use of a grinding stone. Compression fractures (i.e., roughly circular depressions) occur when chewing hard particles embedded in a relatively soft food matrix. Large, hard objects compressed between the teeth produce gouges. Polished enamel, that is, smooth enamel without visible striations at 1500X, suggests unprocessed vegetable fiber in the diet or, possibly, the chewing of dried meat.

Rose, Marks, and Kay (1984) conducted a pilot study in which they examined a small number of molars from remains recovered during salvage operations from 1979-1982 at Lakes Oahe, Francis Case, and Sharpe in South Dakota. The sample included single molars from Bergner (39BR36), Crow Creek (39BF11), DeGrey (39HU205), Stricker (39LM1), Donahue (39LM27), and Mobridge (39WW1) and two molars from different individuals from 39GR21 and Swan Creek (39WW7). Because of the small sample, the results, summarized in Table 83, are only preliminary. Samples from Medicine Crow, a possible Archaic burial, and 39GR21 (Woodland?) display gouges, short striations produced when there is only a small amount of shear component during mastication. Specimens from Coalescent tradition sites lack polish and have numerous large striations and compression fractures. Only the tooth from Donahue shows extensive polishing. Comparison of the two specimens from Swan Creek with the one from Mobridge (matched as second mandibular molars of individuals of like age) demonstrated great similarity between the molar of Swan Creek Burial 3 and the Mobridge molar (Rose, Marks, and Kay 1984). The qualitative and quantitative differences between the two individuals from Swan

Table 83. Scanning Electron Microscopy of Molar Enamel Microwear (Rose, Marks, and Kay 1984)

Variant	Site	Description	Interpretation
Archaic?	39BF2	Numerous large, sharp-margined striations and gouges, a few compression fractures, no enamel polish.	Large striations indicate a coarsely prepared diet with considerable grit that required heavy mastication. No unprocessed fiber.
Woodland?	39GR21	Burial 4: A rough enamel surface with numerous large, sharp striations and a few small compression fractures.	The microwear pattern indicates a coarse, abrasive diet containing numerous grit particles and no vegetable fiber.
		Burial 5: Similar, but has more compression fractures and a small number of gouges.	The diet of Burial 5 included hard seeds.
Initial Middle Missouri	39BF11	Large sharp-margined striations, numerous compression fractures, no polishing.	Diet was coarse and gritty, prepared with stone utensils; contained hard seed particles, no unprocessed vegetable fibers.
Extended Coalescent	39BR36	Numerous large striations and a few compression fractures. The margins of many striations are smooth.	Grit in the diet indicates the use of grinding stones. Dental caries, a moderate rate of dental attrition, and the microwear pattern suggest a moderately refined diet high in carbohydrates from maize, and also the use of seeds.
	39LM1	Moderate and large-sized striations with sharp to rounded margins and numerous compression fractures.	Diet was coarse and included some nonabrasive polishing material and a few hard seeds.
Extended/Postcontact Coalescent	39WW1	A rough enamel surface with numerous compression fractures and striations at cusp margins. Large chatter marks from holding or crushing a large hard object.	Diet was coarse and prepared with stone utensils; also included fruits with hard seeds.
	39WW7	Burial 3: A rough enamel surface with numerous small compression fractures and gouges but few striations. Mandible A: Numerous large striations and a moderate frequency of compression fractures.	The pronounced difference between these patterns may indicate seasonal variation in diet.
Postcontact Coalescent	39LM26	Numerous large, sharp-margined striations and compression fractures, large chatter marks, extensive polish	Diet was coarse and included large numbers of seeds and, possibly, vegetable fiber.

Creek indicated different diets, perhaps reflecting seasonal changes in food availability. Other conclusions based on these Coalescent tradition samples are the following:

- The villagers consumed a coarse diet, with the primary source of abrasive grit derived from the use of grinding stones.
- The high frequency of compression fractures indicates the presence of hard seeds and nuts in the diet, such as chokecherries and hackberries.
- The diet included little vegetable fiber, and food processing techniques (e.g., grinding and extended boiling) reduced fiber content.
- Rates of dental attrition exceeded those of southeastern U.S. agriculturalists and approximated those of Southeastern hunter-gatherers.

This pilot study shows the usefulness of SEM analysis of enamel microwear in reconstructing dietary patterns and food processing techniques among Plains populations. Controlled studies with adequate sample sizes would contribute substantially to the understanding of temporal and regional patterns of subsistence and the technologies of food preparation.

Interproximal Grooves

Several studies have reported on the occurrence of artificial interproximal grooves in Plains Indian dentitions. A tubular alteration was first observed in the right maxillary second and third molars of an adult male from the Leavenworth site (39CO9) in South Dakota (Ubelaker et al. 1969). To determine possible causation and the temporal and spatial distribution of this feature, archeological collections from five states were surveyed. The survey showed that the occurrence of interproximal grooves was geographically widespread and extended from the Archaic to the Historic period, a time span of approximately 6,000 years. In North America, interproximal grooves have been reported in California (Schulz 1977), the Great Basin (Larsen 1985), the Southeast (Ubelaker et al. 1969), and especially in the Great Plains (Willey and Hofman 1994).

Table 84. Interproximal Grooves in Woodland and Coalescent Tradition Collections.

Variant	Site	N	E	Average
Archaic-Late Woodland	14GE6[1]	—	12	—
Late Woodland	14CY32[1]	—	1	—
	14GE3[1]	—	2	—
	14GE4[1]	—	18	—
	14GE5[1]	—	2	—
	14GE7[1]	—	7	—
Woodland	39HT2[2]	1	—	—
	39HU203[3]	1	1	1
	39LM256[3]	1	1	1
	39RO10[2]	2	—	—
Late Late Woodland	39RO4[2]	2	—	—
Coalescent				
Extended	39CA4[4]	1	2	2
	39CA4[2]	1	—	
	39C032[1]	2	11	5.5
	39HU7[4]	1	3	3
Extended/Postcontact	39SL4[3]	1	1	1
	39WW1[1]	4	8	2
	39WW7[2]	3	—	—
Postcontact	39C034[3]	1	1	1
	39DW2[2]	1	—	—
	39HU2[2]	1	—	—
	39LM34[4]	1	5	5
	39ST1[1]	1	1	1
	39WW2[5]	49	106	2.2
Disorganized	39CO9[1]	1	2	2
	39CO9[2]	2	—	—
Unknown	25CU201[1]	1	4	4

Note: N = Number of individuals with grooves;
E = Number of examples;
Average = Average Number per individual

[1] Ubelaker, Phenice, and Bass (1969:146)
[2] Willey and Hofman (1994:149)
[3] Williams (1988:105)
[4] Willey et al. (1987)
[5] Berryman, Owsley, and Henderson (1979)

Table 84 summarizes the temporal and geographical distribution of interproximal grooves that have been reported in this region. The listing includes the number of individuals with grooves, the number of grooves observed in each sample,

Table 85. Interproximal Grooves in Mixed South Dakota Archeological Collections.

Tooth Type	Teeth N	Interproximal Grooves N	%
Maxilla			
Incisors	39	2	5.1
Canines	22	0	0.0
Premolars	44	1	2.3
Molars	64	7	10.9
Mandible			
Incisors	19	0	0.0
Canines	20	0	0.0
Premolars	41	1	2.4
Molars	78	5	6.4
Total[1]	327	16	4.9
Total[2]	83	13	15.7
Total[3]	326	4	1.2

[1] Willey et al. (1987)
[2] Langdon et al. (1989)
[3] Williams (1988)

and the average number of grooves per individual. Woodland sites from both Kansas and South Dakota and Coalescent tradition sites from South Dakota are included. There are almost no reports of this trait from Nebraska. Based on personal experience, grooves are relatively uncommon in the dentitions of individuals of the Central Plains tradition Itskari phase, the Lower Loup phase, and the Historic Pawnee. Of 161 adults from Larson (39WW2), a Postcontact Coalescent tradition site in South Dakota, 49 (30.4%) showed one or more pronounced interproximal grooves (Berryman et al. 1979); 36 were male (73.5%) and 13 were female (26.5%). Three percent (N=106/ 3,479) of the teeth in the Larson sample showed grooves. The frequencies of occurrence in three South Dakota samples representing multiple archeological components appear in Table 85.

These anomalies are found in the interproximal surfaces at the cementoenamel junction. When the groves are viewed from the buccal aspect, they appear tubular-shaped, with the axis directed distolingually. Grooves on the distal surfaces of teeth tend to be more pronounced in the distobuccal area and less so in the distolingual area, whereas grooves in the mesial interproximal surfaces are more pronounced on the lingual aspect. Under magnification, they frequently exhibit polish and parallel striations or scratches in the dentin.

Increasingly detailed studies have demonstrated that:

- Grooves are relatively common in some groups.
- Multiple grooves often occur within a dentition.
- The maxillary teeth are more frequency affected than the mandibular.
- Hard-to-reach posterior teeth are more often affected than anterior ones.
- The frequency is much higher in males than in females.
- Grooves are more common in older than younger adults.
- Most of the grooves are associated with diseased teeth and alveoli (Ubelaker et al. 1969; Berryman et al. 1979; and Willey and Hofman 1994).

There has been considerable debate about the cause of such interproximal grooves. In the case of Plains Indians, the primary explanation is that they result from the use of therapeutic or palliative dental probes for cleansing or soothing diseased or inflamed dental tissues. Certain plants with mild anesthetic qualities, such as black samson *(Echinacea augustifolia)*, were used to relieve pain caused by dental problems, and thus have been implicated as a likely source material for dental probes (Willey and Hofman 1994). In rarer cases where there is no evidence of dental disease, compulsive or habitual behavior may explain the occurrence of grooves. The use of probes seems to have been more predominantly a male activity.

In conclusion, the location, orientation, morphology, and association with diseased dental and periodontal tissues indicate that most grooves were produced by the repeated insertion of toothpicklike probes in a palliative or therapeutic attempt to alleviate dental distress. Additional data reporting the frequency of this trait in various population samples are needed to determine geographical and temporal patterning. Available data are insufficient to demonstrate whether there are differences that relate to subsistence strategy (i.e., hunting and gathering versus horticulture) or cultural tradition.

Cranial Deformation

Artificially deformed crania are rare in the Central and Northern Plains. Table 86 shows the sites that have produced examples and their archeological context. This compilation is based on published and unpublished reports and on data on Plains Indian cranial measurements collected by the University of Tennessee. The craniometric data include any evidence of deformation and a brief description. Using the data forms, the number of deformed and undeformed crania present is tabulated for each site. (It should be noted that counts derived from this data base are biased as they pertain only to measured crania.)

Most examples involve flattening of the occipital and the posterior parietals. Only three examples of occipital deformation with lambdoidal flattening were reported. The deformation is sometimes asymmetrical, with the effect more pronounced on one side than the other. Both Woodland and Plains Village sites are represented, though deformation in both periods appears to have been infrequent and sporadic. Only two Middle Woodland period skulls show evidence of artificial occipital deformation, one from the Taylor Mound (14DP3) and one from Arbor Hill (39UN1) (Klepinger and Bass 1971; S. Ousley, personal communication 1994). A majority of the crania recovered from two Late Woodland Schultz focus mounds in North Central Kansas show artificial occipital deformation (Phenice 1969). Related samples from the Lower Republican Valley do not show such deformations.

Examples reported from Itskari (25HW2), Nebraska (25DO4, 225SY1, 25SY67), and Upper Republican (25FT13) phase sites suggest that cranial deformation may have been slightly more common and geographically widespread during the Central Plains tradition and may also have been more common in the east near the Missouri River. Most of the skulls from the Wallace Mound (25SY67) in east-central Nebraska exhibit slight occipital flattening, which often was more pronounced on the right side (Poynter 1915). Recovered from the Calovich Mound (14WY7), a Steed-Kisker complex site in eastern Kansas (Barnes 1977), were seven crania with asymmetrical occipital deformation and

Table 86. Archeological Sites with Artificially Deformed Crania.

Period, Tradition and Variant	Site No.	No. of Deformed Crania	No. of Normal Crania	Comments
Middle Woodland	14DP3[1]	1	4	Occipital deformation
	39UN1[2]	1	2	Slight occipital deformation
Middle/Late Woodland	14PH4[3]	1	—	Slight asymmet. occip. deformation
Late Woodland	14CY32[4]	1	—	Intentional occipital deformation
	14GE2[4]	Majority	—	Intentional occipital deformation
	14GE4[4]	Majority	—	Intentional occipital deformation
	39CL2[5]	1	—	Lambdoidal flattening
Central Plains	14WY7[6]	15	5	Assymet. & symmet. occip. deformation; 1 with lambdoidal depression
	25CU28[7]	2	8	Occipital deformation
	25DO4[2]	2	2	Anterior-posterior flattening
	25FT13[8]	1	—	
	25HW2[9]	2	3	Slight asymmet. flattening of posterior rt. parietal & occipital
	25SY1[10]	1	—	Occipital deformation
	25SY67[9]	Majority	—	Asymmet. occipital deformation
	39PO207[2]	1	2	Slight occipital deformation
Coalescent				
Initial	39BF3[11]	1	1	Slight to medium occip. deformation
Extended	39PO7[2]	1	—	Occipital deformation
Postcontact	39ST215[12]	2	5	Slight occipital flattening
	39ST235[2]	1	10	Slight lambdoidal flattening
Disorganized	25KX207[2]	1	1	Marked occipital flattening
Middle Missouri				
Initial	39HS1[2]	1	1	Occipital deformation
Southern Extended	39SL2[2]	1	8	Slight occipital deformation
Historic Kansa	14DP2[13]	8	—	Asymmet. and symmet. occipital deformation
Unknown	25CU201[8]	1	—	Assymet. occipital deformation
	39BK20[14]	1	—	Occipital flattening

[1] Klepinger and Bass (1971)
[2] Ousley, S. (1994, personal communication)
[3] Kivett (1953)
[4] Phenice (1969)
[5] Willey et al. (1987)
[6] Barnes (1977)
[7] O'Shea and Bridges (1989)
[8] Bass (1957)
[9] Bubniak and Verano (1993); Poynter (1915)
[10] Owsley and Potter (1993)
[11] Murrill (1977)
[12] Verano, J. (1994, personal communication)
[13] Bass and Nelson (1968); Stewart (1959); Willey and Bass (1969)
[14] Williams (1993)

seven with symmetrical vertical flattening. Steed-Kisker and Nebraska phase sites on the opposite side of the Missouri River in Platte County, Missouri, show a similar pattern of symmetrical and asymmetrical deformation.

Deformed crania are infrequent in Coalescent and Middle Missouri tradition sites, and when present cannot be used as an indicator of cultural affiliation (e.g., Williams 1993:29,32). Deformation is not associated with the following Historic era tribes: Arikara, Arapaho, Blackfeet, Cheyenne, Crow, Hidatsa, Mandan, Pawnee, Ponca, Omaha, and Sioux. However, one skull with pronounced occipital flattening has been reported for a Historic Ponca site (25KX207), and the craniometric data base includes an Osage skull with slight occipital deformation from Fort Osage, Kansas. Skulls from the Doniphan site (14DP2), a historic Kansa village, show symmetrical and asymmetrical occipital deformation (Bass and Nelson 1968; Stewart 1959; Willey and Bass 1969). Any examples as yet unreported should be documented using the coding system adopted by the Department of Anthropology, National Museum of Natural History, Smithsonian Institution.

Some of the examples in Table 86 have been attributed to unintentional deformation resulting from the use of a hard-backed cradle board. However, symmetrical vertical flattening at the Calovich Mound probably resulted from intentional cultural practices involving restraints that prevented an infant from turning the head while attached to a cradle board (Barnes 1977). Schultz focus crania with occipital flattening show increased vault heights without widening or bulging at the sides, postcoronal constrictions, narrower frontal breadths, and, occasionally, lateral frontal depressions. The frontal depressions might represent areas where pads were placed against the sides of the head to apply pressure to the frontal, the sides of the parietals, and the occipital (Phenice 1969). This type of intentional deformation during the Late Woodland period might reflect a Southeastern cultural influence (Phenice 1969).

10 Prehistoric Adaptation Types and Research Problems, by Jack L. Hofman, Brad Logan, and Mary Adair

Cultural and historical definition and integration of prehistoric societies based on the archeological record has consumed a substantial component of archeological effort (e.g., Willey and Phillips 1958; Lehmer 1971). The need for unit concepts for discussion and comparison of archeological assemblages and for the organization of material remains into logical analytical units which enable and reflect approaches to archeological study is widely evident in archeological literature. Decades of research in the Great Plains region and elsewhere have resulted in at least two significant problems in the use and development of archeological unit concepts.

One problem is the attribution or assignment of specific collections or assemblages to archeological taxa as a means of, or in lieu of, explanation. It is perhaps too easy to succumb to the tactic of considering the assignment of a component or assemblage to a specific archeological phase as a normative explanation of that portion of the archeological record. Unit concepts should be used as organizational tools, not as explanatory ones (Binford 1968; Clarke 1968; Flannery 1968; Struever 1968; Watson et al. 1971).

Secondly, the history and politics of archeological research has been such that state boundaries or river basins, and historical flurries of geographically localized archeological effort have tended to result in the narrow definition of complexes. The focus of most archeological unit definitions has been normative, to encompass the "typical" common or standard elements of phases and other taxa, and less concern has been given to demonstrating and studying the variation within such taxa. For example, archeological complexes within the Plains Village tradition have often been viewed or defined as occurring within major river valleys, without consideration or incorporation of affiliated satellite sites such as seasonal hunting camps, quarries, or kill-butchery sites. It is commonly assumed that these other components of a prehistoric culture's archeological record will be self evident, obvious, or of secondary importance.

Archeological taxa which initially appear distinctive and temporally or geographically discrete become less so as more is learned about additional assemblages or adjacent periods and places. The end result is that archeological unit concepts tend to progress through awkward and often erratic periods of growth and development as the archeological record becomes better documented and more completely represented. This growth has a different cadence for each region and time period. Likewise the tempo and scales of cultural change varied dramatically throughout the prehistory and history of human occupation of the Plains, and an archeological phase from 9,000 years ago may have a very different temporal and geographical scale and composition than one based on evidence from 300 years ago.

It is not unusual for locally defined complexes to "complicate" the archeological literature with a "plague of phases" (cf. L. Johnson 1987) which can do as much to hinder as to help in developing an understanding of cultural processes, variability, relationships, and comparisons through archeology. One of the efforts to overcome the specifics of locally defined unit concepts in a broad comparative framework is Fitzhugh's concept of adaptation types.

The concept of adaptation types as developed and used by Fitzhugh (1975) is a framework which integrates information about environment and technology in categorizing or summarizing lifeways of human groups at a level which is intermediate between the more general and encompassing stage and the smaller more particularistic phase (Willey and Phillips 1958). Adaptation types are in part comparable to the concept of *pattern* in the McKern system. According to McKern (1939:), "The traits used as determinants for the pattern will be such as deal with the cultural reflection of the primary adjustments of peoples to environment, as modified by tradition. For example, the Mississippi Pattern, as compared with the Woodland Pattern." The notion of adaptation types as used by Fitzhugh, ultimately has its roots in cultural ecology, the culture core concept, and the environment-technology interface (Steward 1955, 1978).

The importance of comparative studies in archeology, studies which involve larger than traditional units of archeological analysis, is undeniable. And, as noted by McKern (1939:), "archeological classification necessarily must be based upon criteria available to the archeologist." The broadened perspective which results from comparative studies should in and of itself provide the incentive for such pursuits. When addressing questions which reach beyond the culture history of a specific region, expanded comparative analysis is necessary. In turn, such broadened perspective will potentially enhance recognition of distinctive and significant aspects of local archeological remains or the definition of previously unrecognized patterns at a variety of scales. With the potential of archeology to contribute to anthropological comparative studies in mind, Fitzhugh (1975:341-342) provides these remarks concerning the purpose for the concept of adaptation type.

> To compare culture units and traditions from different historical and geographic areas, a new concept which links environmental potential and technological capabilities is required. Adaptation type performs this function suitably since it describes a nonspecific cultural or chronological unit which may be archeological or ethnographic, and its particular usage may depend on the definition ascribed to it in the context of the discussion. As such its use is similar to that of the term "complex" in archeological systematics. Further, an adaptation type may include a series of subtype variants which

may be defined to correspond with demographic and economic realities.

The term complex is used in a variety of contexts in this volume and it is used in a very flexible manner. Complex is not used by Fitzhugh or us as congruent with or equivalent to adaptation type.

The limitations of using the adaptation types framework should also be mentioned. The use of adaptation types to overcome some of the historical factors and problems of scale which occur when making comparisons among archeological assemblages from different states or regions is an important goal. The concept of adaptation as generally used in anthropology and archeology since the 1960s and 1970s has been taken to form a purposefully constructed humanly directed articulation between cultural and natural systems. Adaptations are historically seen as the directional or goal-oriented actions of people or groups to conform to or expand into a specific environment with a particular technological system.

The adaptive systems are generally discussed in normative terms as being in stable or dynamic equilibrium with the nature of systems operation being of much greater concern than system change. This adaptive-functional perspective has tended to emphasize the normative operation of cultural systems rather than variability. This has historically resulted in the definition of discrete prehistoric cultural complexes which are stacked and fitted together like bricks in a chronological and spatial wall (Clark 1968:246, Figure 53). During the process of definition of normatively formulated cultural units, variability at all levels (stylistic, functional, local, regional) tends to be neglected in the course of designating the primary or distinguishing cultural elements for each archeological "culture." Variability is generally considered as unimportant, uninteresting, and inessential noise.

An alternative approach which is increasingly evident in archeological literature is to consider change and variability more directly through a selectionist (Darwinian) evolutionary perspective (Dunnell 1980, 1982, 1988, 1992a; Leonard and Jones 1987; O'Brien and Holland 1990, 1992; Teltser 1995). From this perspective an adaptation is seen as the result of selective forces acting on behavioral variation in a human system. The variation and selection generally occurs at the individual level, with the cumulative effect reflected in the archeological record as changes in patterning. Only through a deliberate focus on variability (at multiple scales) as an important topic of analysis will it be possible to understand the processes of change, and the full operation of cultural systems. As opposed to the brick wall model of archeological complexes, the cultural brick theory (Clarke 1968), we must concern ourselves with the boundaries of the units and the mortar which holds them together. The details provided in the preceding cultural history chapters is intended to provide an awareness of the variability not just between but within the cultural complexes which have been defined for the Central Plains region.

The adaptation types and subtypes outlined in this section generally follow the concept as defined by Fitzhugh and as applied by Sabo and others (1982). For each adaptation type recognized in the Central Great Plains region, a series of information categories will be addressed. These include the date range, environmental context, cultural context, technology and subsistence activities, settlement and site distribution, ideology, trade and exchange, areas with high probability of site occurrence, and finally data gaps and critical research questions. In many cases the critical research questions involve or indicate the significance of the intermediate areas and time periods as the key to understanding the development, change, and even the operation of cultural complexes and adaptation types.

Fitzhugh (1975) based his definitions of General Northern Maritime and Riverine adaptation types on the economy and "core" technological and integrative elements of several hunter-gatherer groups in the Arctic region. In this study, the large encompassing category of hunter-gatherers is subdivided into five primary adaptation types based on known or inferred information pertaining to economy, population, environmental conditions, and cultural situations. These five adaptation types are First Arrivals, Early Specialized Hunters, Broad Spectrum Foragers, Incipient Horticulturists, and Late Aboriginal Hunter-Gatherer-Traders. The Village Horticulturist adaptation type is the final adaptation type recognized for the aboriginal prehistoric and protohistoric groups. Historic period adaptation types include Indigenous Native Americans, Resettled Native Americans, Transportation, Military, Rural Settlement, Urban Settlement, and Industrial categories, which were discussed in Chapter 8.

First Arrivals Adaptation type

Date Range.

The date range for this adaptation type is that portion of the Pleistocene before 12,000 B.P. when early hunters occupied the New World. Prior to 12,000 years ago, evidence for human occupation of the Central Great Plains, and for North America, is equivocal. No available evidence remains entirely unquestioned and completely accepted by the archeological community as a whole (e.g., Stanford 1982; Waters 1985). Two facts are generally accepted; sometime before 12,000 years ago there were no humans present in the New World, and by soon after 12,000 RCYBP there is widespread and well-accepted evidence of human activity in both North and South America (Bryan 1986; Bonnichsen and Steele 1994; Bonnichsen and Turnmire 1991; Soffer and Praslov 1993; Meltzer 1993). First arrivals were those peoples who are assumed by many researchers to have inhabited the New World before the time of the well-known Clovis or Llano cultural complex. The time frame for this archeologically poorly known interval extends from 11,500 years ago to some undetermined earlier time which marked the first entry of human groups into the New World. The presence of human settlement in southern Chile and other parts of South America by about 12,500 or 13,000 B.P. (Dillehay 1989; Bryan 1986) leaves open the questions of when and how the Central Plains region was first occupied.

Environmental Context.

The Pleistocene period was substantially cooler and wetter than the present environment in the Plains region (Jacobson et al. 1987; Porter 1983; 1988; Wendland 1978; Wright 1991; Kutzbach and Webb 1991). The chronology of climatic fluctuations has been fairly well established for the late Pleistocene (Martin and Klein 1984), and it is known to have been a period of dynamic fluctuations in climate, vegetation, and animal populations. The environments of many localities were apparently distinct from those presently known, and the changes were not simply a matter of north-south changes in biotic districts, but include numerous occurrences which are considered disharmonious when compared to modern biotic associations (Graham 1990; Graham and Lundelius 1984; Graham and Mead 1987; Graham and Grimm 1990; Lundelius 1988). For the vast majority of species composing the Rancholabrean fauna, including mammoth, mastodons, horse, camel, dire wolf, and ground sloth, there is no unequivocal evidence of human involvement or predation before Clovis times. Several sites in the Central Great Plains have been dated to the period between 12,000 and 20,000 B.P., which have been suggested by some researchers to represent early human activity (Anderson 1975; Stanford 1979; Holen 1994). Evidence from these sites is generally in the form of patterned modification or "high-impact" breakage of bones from extinct Pleistocene fauna, especially mammoth. The general lack of chipped stone tools in association with these bone assemblages is seen as problematic among some researchers.

Cultural Context.

Information pertaining to social organization, mobility, and demography is lacking for the pre-Clovis period. There is general agreement that population density was very low during this period and that any groups present would have been mobile hunter-gatherers. Assuming their derivation from Eurasia via Beringia, we may expect technological organization similar to that expressed at Paleolithic sites such as described by Soffer (1985). Soffer has argued for two primary periods of relatively intense occupation of the Ukraine, one between 24,000 and 30,000 RCYBP and the second between 12,000 and 18,000 RCYBP. However, there is evidence for much earlier occupations in Siberia, which predate the radiocarbon time scale (more than 50,000 B.P.), and which may indicate that, during relatively warm periods of the Pleistocene, technologically simple human groups utilized northern Asia and Siberia.

Technology and Subsistence.

It is likely that the first arrivals in North America would have possessed a technology generally comparable to that of the Russian Upper Paleolithic (Sofer 1985). Controlled use of fire and manufacture of bone and stone artifacts, clothing and shelter is assumed (Jelinek 1992). These people would have had access to a variety of Pleistocene fauna which would probably have provided the primary economic focus. Furthermore, these animal populations would have had little or no previous interaction with human predators and may have been particularly susceptible to hunting. A variety of studies including research in optimal foraging theory indicate that large mammals generally provide a first line resource and that smaller animals, invertebrates, and plant resources become increasingly important as economic pressures or population increase and territory sizes decrease (Winterhalder and Smith 1981; Pianka 1983). Plant foods were probably not as economically important as in many ethnographically recorded hunter-gatherer groups because of the abundance of animal foods. Also, detailed knowledge of a variety of new plant species would have required a longer term familiarity with local areas and some degree of "settling in." This would not be conducive in a highly mobile hunting economy. In colonizing a new region we can expect an economic focus on already familiar animal species rather than the less secure information on new plants in an unfamiliar terrain.

Settlement Pattern.

Information pertaining to site distributions is not available for specific areas. Few sites potentially attributable to this time period are known, and most of these are widely dispersed. Study of this period will require deliberate study and definition of land surfaces of the appropriate age. Terraces and lake margin deposits are perhaps those most likely to hold well-preserved remains from this period. These locations may not be representative of the overall settlement, but may reflect in large part the historical events relating to land surface modifications and preservation (Johnson and Logan 1990).

Trade and Exchange.

No information is available concerning interactions among groups of this time period. We assume that such supposedly small, mobile groups would have required interaction with other such groups in order to be viable. Exchange of information pertaining to specific resources and localities would have been of considerable benefit. Exchange of marriage partners was probably essential to long-term group fitness and maintenance of intergroup contacts and alliances (e.g., Gamble 1982).

Ideology.

Specific information pertaining to religious activities and ceremonies is not available.

Bioarcheology.

No human remains attributable to this period and adaptation type have been documented in the Central Great Plains region.

Areas of High Site Probability.

Only landscapes of pre-Holocene age will have the potential to contain intact sites of this adaptation type. In alluvial bottomlands, Pleistocene-age deposits tend to be deeply buried, but these situations have the potential to contain relatively well-preserved land surfaces and so archeological sites of pre-11,500 B.P. age. Upland areas, terraces, and terrace slopes of late Pleistocene age provide the best opportunity to encounter archeological remains from the First Arrivals, however, the problems of component mixing and dating make adequate evaluation of such sites less feasible. The best chances of finding unequivocal evidence of the earliest occupants of the Plains and Rocky Mountain regions is probably in cave deposits, stratified alluvium, loess, or stratified ponded sediments (Drew 1979; May and Holen 1993; Holliday 1982; Johnson and Logan 1990).

Data Gaps and Critical Research Questions.

Because so little is known about this period, any site bearing evidence of human activity prior to 12,000 years ago is of considerable significance. Site locations are not predictable at present except that late Pleistocene land forms are typically deeply buried in alluvial valleys, contained within deep loess deposits, buried beneath Holocene dune fields, or exposed in prominent terrace faces or upland ridges. As dating of these sites will be a critical consideration, those with primary research potential will occur in buried situations (below dunes or in Pleistocene dunes, in loess, in playa deposits, in buried terrace deposits) where there is the potential for faunal and floral remains. Upland sites which are deflated or heavily weathered are unlikely to produce materials which would allow verification for the age of artifacts which might be recovered from the surface or upper portion of Pleistocene-age deposits. The target of research should include systematic investigation and sampling of late Pleistocene deposits which are known to date between 25,000 and 12,000 years ago.

Early Specialized Hunters Adaptation Type

Date Range

An increasing number of radiocarbon dates pertaining to Paleoindian kill and habitation sites are available which document the activities of mammoth and bison hunting groups in the Plains region to the period between 12,000 to 8,000 RCYBP (Cassells 1983; Frison 1991a; Haynes 1992, 1993; Wedel 1986). Examples of defined cultural complexes which are included in this adaptation type are Clovis, Folsom, Plainview, Cody, and Allen/Frederick.

Environmental Context.

An increasing amount of paleoenvironmental information pertaining to this period in the study area has been developed through studies in Colorado, Kansas, and Nebraska in recent years (Dort and Jones 1970; Holliday 1986, 1988; Johnson 1987; Johnson and Logan 1990; Johnson and Park in this volume; Lundelius et al. 1983; Mandel 1995). This period encompasses the Pleistocene-Holocene transition and is a dynamic one in terms of climatic changes and biotic communities. By soon after 11,000 years ago the Rancholabrean fauna became extinct (Grayson 1991; Kurten and Anderson 1980; Mead and Meltzer 1984). Climatic and ecological reconstructions vary between investigators and depending on the study location and the type of ecological data used, but the overall pattern of change is generally agreed upon. For the Central Great Plains, the period before 12,000 years ago was cooler, more moist, and more equitable with less extreme temperature fluctuations between winter and summer than during the Holocene.

Lower summer maximums and less severe winter temperatures (with an absence or rarity of extended hard freezes), in conjunction with greater effective moisture, resulted in a rich and diverse fauna and flora probably not directly comparable to any that exist at present. Perhaps the primary distinction between the late Pleistocene and Holocene climates is the increased seasonality during the Holocene which acted to restrict the ranges of many species that are (were) sensitive to extremes of temperature and moisture. Animal taxa which survived this transition are generally those which were able to accommodate the competitive and climatic stresses. Often this was accomplished in part by reduction in body size (e.g., bison, beaver) and changes in social behavior (e.g., larger herd size for bison). Continental glaciers were retreating rapidly by 12,000 years ago but still covered a significant proportion of North America. By 6,000 years ago the ice was restricted to northern Canada (Wendland 1978), and by 4000 B.P. the glacial ice had reached its approximate modern position. There was not a simple northward and elevation movement of biotic provinces following the glaciers, but a complex reorganization of ecological communities (Lundelius et al. 1983; Graham and Lundelius 1984; Graham 1979, 1985; Guthrie 1984, 1990).

The Central Great Plains region was not glaciated, but the area was dramatically impacted by the climatic, geomorphic, and biological changes associated with the close of the Wisconsin glaciation. Co-occurrences of species in faunas from the Pleistocene/Holocene transition which today are nonsympatic (disharmonious) has led to the discussion of biotic provinces which are distinct from those presently known (Holman 1976; Graham 1979; Guthrie 1984; Martin, Rogers, and Neuner 1985) and which include species now restricted to boreal or tropical climates. As stated by Graham and Lundelius (1984:224), "the degree of diversity of late Pleistocene disharmonious biotas suggests that they existed during times when the climate was equable and seasonal extremes in temperature and effective moisture were reduced."

Also, "many late Pleistocene communities had higher species densities than their modern counterparts" (Graham 1985:139) which is related in part to the fact that "there is a positive correlation between increased species diversity and decreased climatic variability as measured by winter-summer differences in mean temperature" (Graham and Lundelius 1984:224). Specific animal taxa of particular significance include mammoth, horse, camel, giant armadillo, giant tortoise, short-faced bear and a variety of others which become extinct by

11,000 years ago or soon thereafter (Graham 1987; Martin, this volume). Palynological information for the Pleistocene/Holocene transition in the Central Plains area is most widely known from study of ponded sediments (Baker and Waln 1985; Barnosky et al. 1987; Gruger 1973; Johnson and Park, this volume; Wright 1970, 1989). The Younger Dryas interval between 11,000 and 10,000 B.P., representing the last important and distinct cold event during the Pleistocene to Holocene transition (Wright 1989), has been the focus of paleoecological research on a global scale, and correlates roughly with the Folsom period on the Great Plains. The early period of formation of the Brady paleosol in the Nebraska and Kansas region correlates with the Younger Dryas cold interval (Johnson and Park, this volume).

There is general agreement that despite fluctuations the close of the Pleistocene was generally cooler and wetter (less severe summers and more effective moisture) than at present, and there was a general warming and drying trend during the early Holocene.

Cultural Context.

The terminal Pleistocene is the first period during which there is evidence of a substantial human population in the Central Plains and Rocky Mountain region. With due consideration to the fact that "absence of evidence is not evidence of absence" (Thomas 1978), prehistoric people during this period did not inhabit permanent occupation sites, but were apparently mobile hunter-gatherers whose economy focused to varying extent on large herbivores. The social groups were probably small bands, but the structure and organizational variation of these is not known (Kelly and Todd 1988; Bamforth 1988). Flexibility in group composition can be expected, but group sizes and dynamics of group aggregation and dispersal are not known (Hofman 1994). If the basic premise is correct that these early hunters were highly mobile and not keyed into specific locations but rather to specific resources such as large herbivores (Kelly and Todd 1988), then it is unlikely that cyclical or seasonally regular aggregations would occur at the same location for more than a few consecutive years. Intergroup relationships would have been maintained or established in order to provide marriage partners and to enhance information "networks" pertaining to resource locations and conditions. These networks may have been very extensive and of the anucleate nature discussed by Yellen (1977). The Lindenmeier site in north-central Colorado has been suggested by some researchers to represent the location of Folsom period aggregations (Wilmsen 1974; Wilmsen and Roberts 1978; Price and Feinman 1993). This is an important possibility which deserves further evaluation. Also, large bison kills of Paleoindian age have often been argued to represent the efforts of communally organized hunting events (e.g., Bamforth 1988).

Technology and Subsistence.

A highly developed stone and bone technology is documented for the Paleoindian groups in the Plains region. Direct information pertaining to the perishable technology is essentially lacking. Possible structural remains of Paleoindian age attributable to the Early Specialized Hunter adaptation type are documented at the Hell Gap site in Wyoming (Irwin 1968, 1971; Irwin-Williams et al. 1973), and consist of relatively small roughly circular patterns of shallow postmolds in the Agate Basin and Midland components. A possible stone circle of Frederick age is also present at the site. Possible evidence of temporary structures is also reported from the Folsom components at the Agate Basin (Frison and Stanford 1982) and Hanson sites (Frison and Bradley 1980) in Wyoming. All evidence suggests that whatever structures were used were of a light frame and temporary nature. Another form of structure documented at the Colby mammoth site in Wyoming (Frison and Todd 1986) is interpreted to have been a security cache where meat was stored under a pile of mammoth bones (probably combined with snow or ice) in order to protect it from scavenging carnivores. The stone technology was highly versatile and consisted of bifacial blanks or preforms which could serve as tools, sources for large flakes for various scrapers and knives, and as preforms for production of projectile points (Bradley 1991, 1993; Ingbar 1992; Kelly 1988; Stanford and Day 1992). Distinctive tool forms for the adaptation type include delicate gravers, spurred endscrapers, composite scraping-graving-cutting tools, and a variety of nonstylized tools made from large thin flakes of bifacial reduction. Bone technology included projectile points, at least during Clovis and Folsom times, and the use of eyed needles. The latter were apparently an important component in the manufacture of tailored clothing which would have been integral to adaptation in many areas during the late Pleistocene.

Settlement Pattern

Variability in the "settlement" or land use patterns of Early Specialized Hunters has been documented primarily through the study of lithic raw material utilization and source area studies. There are strong differences in the lithic material frequencies of Folsom and Clovis points from Kansas for example. Such differences may reflect changes in directions or patterns of group movement. As noted above, the occupation sites exhibit only minimal evidence for the presence of habitation structures. Mobility of groups was apparently extensive, but the specific nature of movements is not well documented (Kelly and Todd 1988; Wheat 1971). Evidence from kill-butchery sites indicates that the processing and consumption of large animal such as bison by Paleoindian groups was distinctly different than during the Late Prehistoric Period. Todd (1983, 1987, 1991) has referred to one common pattern as a gourmet butchering strategy in which only selected portions of the animals were utilized. Factors such as small groups size and high mobility would have influenced decisions pertaining to butchering and intensity of resource use. High mobility may have been a factor providing increased security for early hunters (Wilmsen 1973; Kelly and Todd 1988).

Because of mobility and related factors, patterning of Early Specialized Hunter sites is probably biased and is certainly poorly understood. Animal kill sites where faunal remains have been preserved have an increased likelihood of being observed and reported, whereas many camp and bivouac sites would have been temporary in nature and located in settings which preserve minimal archeological evidence (Hofman and Ingbar 1988; Naze 1986). Dawson and Judge (1969; Judge 1973), and Hester and Grady (1977) have provided useful discussions of site variability and occurrences which hold considerable promise for developing refined models of land-use patterning by Early Specialized Hunters. In the High Plains region, the occurrence of sites on stable dunes located on the leeward side of playa lake beds has been noted repeatedly. Often, however, these sites contain materials from later components. The occurrence of kill sites in sand dunes or dissected and eroded areas of small tributary valleys is also a recurrent pattern. The presence of kills in situations which apparently lacked distinctive topographic features is also documented (Stanford 1978, 1979; Frison and Todd 1987) and suggests that the use of deep snow or constructed "corrals" may have been important options in procurement of large animals during this period. Recognized site types for this adaptation type include animal kill-processing sites, caches, campsites, hunting overlooks, lithic workshops, and possible burials. No rock art sites of this age are yet documented in the region.

Trade and Exchange.

Determining the nature and importance of trade and exchange in the Early Specialized Hunter adaptation type is a problem which has received varied attention. Opinions differ as to the extensiveness and importance of trade, with some researchers (Hayden 1982) suggesting that the common occurrence of "exotic" raw materials is a result primarily of trading between groups of Paleoindians. Others believe that this extensive pattern of raw material use resulted from mobility of the early hunting groups (Goodyear 1989; Wheat 1971; Irving 1971; Kelly and Todd 1988; Meltzer 1989). Exchanges between hunting bands can be expected to have occurred, based on what is known of the operation of modern mobile hunter gatherers (Weissner 1982, 1983). Such exchanges of materials and ideas probably went hand-in-hand with intermarriage between bands and served to provide extended networks of information and economic support.

Ideology.

A recurrent theme at several sites of the Early Specialized Hunter adaptation type is the presence of intensive use of red ochre (Roper 1991; Stafford 1990; Frison 1991; Bement 1994a). A variety of uses are indicated for this material including painting of artifacts, covering burials (Anzick site in Montana), use or intentional deposition in occupation areas (Frison and Stanford 1982; Frison and Bradley 1980). A variety of artifacts have been recovered for the processing of red ochre into powder (Wilmsen and Roberts 1978). On the Central Plains, Bement (1993, 1994) reports the occurrence of a bison skull painted with red ochre in the lowest level of the Cooper bison kill site of Folsom age.

Ritual activities have been interpreted for Jones-Miller site in eastern Colorado where there is evidence of ceremonial activities associated with a Hell Gap bison kill which show close similarities to the pre-kill ceremonies of the Cree Indians (Stanford 1978, 1979). A post hole near the center of the bonebed may represent a shaman's pole, near which were found a miniature Hell Gap point, a bird bone whistle, and remains of a dog.

Bioarcheology.

Minimal human remains have been recovered and reported which pertain to the Early Specialized Hunters adaptation type. The Gordon Creek burial, dated to about 9,600 years ago (Breternitz et al. 1971) was a flexed female associated with a few artifacts and red ochre. Potentially early human remains from the lower Kansas River basin have been radiocarbon dated and are apparently of Holocene age (L. D. Martin, personal communication; Steele et al. 1991).

Areas of High Site Probability.

Archeological sites representing the Early Specialized Hunters adaptation type are documented in a variety of open settings as well as cave sites. These sites will occur on land surfaces which are of late Pleistocene and early Holocene age, but will be buried, if preserved, in stream bottoms containing middle and late Holocene sediments or contained in thick loess deposits in upland, slope, or valley settings. Prominent terrace scarps, buttes, and other elevated settings will potentially provide evidence of short-term camps or hunting overlooks, but often lack good preservation or stratified archeological deposits unless they are contained in loess or dunes. Campsites and kill-butchery sites or often exposed in sand dune regions which were usually near ponds or lakes in the past, but which may lack nearby water sources at present. Key sites of the Early Specialized Hunters are definitely not limited to present-day water courses or stream valleys. Distinctive ponded or lake sediments of late Pleistocene and early Holocene age occur in many localities in the Central Great Plains and Rocky Mountain regions (Stanford 1979; Holliday et al. 1994; Johnson and Park, this volume). These deposits have good potential for preservation of faunal and floral remains and represent potential situations for the occurrence of Paleoindian activity. Often the paleoecological information which can be gained from such sites is of considerable importance whether or not archeological materials are found (e.g., Wyckoff and Carter 1994). The occurrence of occupation sites of Early Specialized Hunter buried in alluvial situations has been widely documented (Davis 1962; Ferring 1994; Holliday 1986; Howard 1935; Johnson 1987; Johnson and Logan 1990; Mandel 1995; Schmits 1980; Wyckoff 1964).

Data Gaps and Critical Research Questions.

The number of early sites that have provided quality information pertaining to the Early Specialized Hunters for the period between 12,000 and 8,000 years ago is few and the locations are scattered. There remain many gaps in the basic information for the various archeological complexes recognized which represent this adaptation type. Finding sites of this age is hampered not only by the age of the deposits, but also by the relatively limited human population of the time. Therefore, any site of this age is potentially highly significant, even if perishable materials are not preserved.

Detailed studies of intrasite structure are needed, regional studies of site distributions have met with limited success due to the small data base, and documentation of assemblage variability and site functional differences have only been addressed at a cursory level (Hofman 1994b). Research at the Lindenmeier site provides an exceptional example of the scale of excavation which may be need to sample Paleoindian campsites (Wilmsen and Roberts 1978). The problem of scale and the spatial extent of sites has become increasingly evident at other excavations as well including Cattle Guard (Jodry 1992; Jodry and Stanford 1992), Murray Springs (Haynes 1982), Aubrey (Ferring 1994), and Hanson (Frison and Bradley 1980). The scale of excavations has generally been inadequate in part due to low artifact density at some sites (e.g., Sellards 1952:151-152), and to the limited concern for spatial and organizational studies rather than primarily cultural historical and temporal concerns. O'Connell (1987; O'Connell et al. 1992) has shown that most open air hunter-gatherer sites, especially those that involve butchery of large animals, are very extensive and that most archeological investigations have probably been severely inadequate to gain information about site structure and activity organization.

A key problem, certainly not limited to the sites of this adaptation type, is the ability of archeologists to distinguish between repeated use of site areas and long-term habitation (Schiffer 1987; Hofman and Enloe 1992). Archeological research focused on distinguishing the nature of occupations, whether repeated short-term camps or long-term habitation, must go hand in hand with investigation of site formation processes. The problems of studying group organization and mobility patterns through the archeological record are just beginning to be developed.

The Paleoindian or Early Specialized Hunters adaptation type is represented by groups of hunter-gatherers who possessed a highly developed technology, comparable to the later Upper Paleolithic of the Old World, and who lived in productive environments where they were essentially unfettered in their movements. This provides an important scenario for the study of hunter-gatherers in general terms and with regard to the impacts of population growth, environmental change, subsistence change, and the eventual adoption of more intensive subsistence systems. Because of the extreme importance of these sites for addressing a variety of anthropological, environmental, technological, and historical questions, and due to their relatively rare occurrence, all site of the Early Specialized Hunters deserve careful consideration and evaluation of their research potential. Much of the available information pertaining to this adaptation type, with regard to occurrence, density, and nature of artifacts and sites, is in the hands and minds of nonprofessional archeologists and interested laypersons.

Recognition of many early sites will only be possible through cooperative work between field archeologists and interested local persons. Recent work involving surveys of Paleoindian projectile points (Meltzer 1987; Hofman 1987, 1993, 1994; Hofman and Wyckoff 1991; Weatherill 1995; Banks et al. 1994; Wyckoff and Bartlett 1995) has provided encouraging results for the use of information which can be gained only through cooperation between archeologists and interested laymen. Figure 62 provides an example of a form which is being used to record artifacts in private collections. Several hundred of these have been completed, many by interested individuals with brief training. It is increasingly evident that short-term visits and studies (from a few hours to a few months) of an area provide a limited view not only of regional archeology, but also of the potential of specific sites. Reliance upon avocational input can provide a substantial increase of information potential for CRM and other projects.

The transitional period between the Early Specialized Hunters and Broad-Spectrum Hunter-Gatherer adaptation types represents an interval of significant ecological, technological, and perhaps social changes which is poorly documented or understood. Many projectile point types occur which may pertain to this period, but most have received minimal study. The assemblages associated with these potentially early point types are not well documented and the regional/temporal variation in these materials is essentially unknown. Focused research is needed on the earliest Holocene period in order to better define the climate and technologies of this dynamic period. Documenting the changes which lead to what we recognize as the Broad-Spectrum adaptation type is an important regional research theme. The distinctiveness of late Pleistocene versus early Holocene hunter-gatherer groups in the Plains region has been to an extent assumed rather than demonstrated, and this is especially true concerning the supposed distinctiveness of middle Holocene (8,000 to 4,000 B.P.) archeological record as compared to the early Holocene record. Simms (1989) and others have suggested that if we document the variability within Paleoindian and Archaic assemblages and other evidence, that there are potentially many lines of continuity rather than an abrupt and dramatic change. We must address the Paleoindian to Archaic transition and the variation within Holocene hunter-gatherers as important research questions, not simply assume them to be dramatic or rapid cultural changes or events.

Broad-Spectrum Hunter-Gatherer-Forager Adaptation Type

Date Range.

This adaptation type is considered to date primarily between 8,000 and 2,000 B.P. with this adaptation type possibly lasting until the historic period in some of the High Plains and Mountain portions of the region. The variety of Archaic

GREAT PLAINS FLUTED POINT SURVEY specimen data sheet 5/1/92 JLH
Date: Recorder: Spec. Number: Type:
Collection of:
Specimen found by: Date Found:
Find Spot-State: County: River system:
Site: Legal: 1/4S: T: R:
Context: (field, pasture, road, streambed, terrace, upland, slope, excav)

Type of Specimen: point-fluted/unfluted preform-fluted/unfluted

Portion present: (complete, base, blade, tip, edge, channel flake)

Lithic Material: (include translucence, color, texture)

Ultraviolet response: LW/SW
Thermal alteration:
Abrasion/Patina:

Measurements (cm/in):
Length: Width: Basal Width: Thickness:
Fluted Thickness: Basal Depth: Weight: (gm/oz)
Flute A: length width ; Flute B: length width
Flake Scars (per/cm): face edge ; Stem Length:

Reworking: (tip/base/edge)
Flaking Pattern A:________________ B:________________
Flake Blank: (Y/N)
Distal end of flute A: (extended to tip y/n)
removed by flaking: hinged: feathered: missing:
Distal end of flute B: (extended to tip y/n)
removed by flaking: hinged: feathered: missing:
Nipple: (present/absent/remnant)________________________________
Base outline:______________ Edge outlines:______________________
Edge Grinding A:_____ Edge Grinding B:_____ Basal Grinding: _____
Photos: y/n, b&w, slides, color/ Draw specimen below or on back
Notes:

Return form to: Jack L. Hofman, Anthropology Dept., 622 Fraser Hall
University of Kansas, Lawrence, KS. 66045. 913/864-4103

Figure 62. Paleoindian projectile point recording form

complexes defined in Kansas, Nebraska, and Colorado are subsumed within this adaptation type.

Environmental Context.

Several lines of evidence indicate that the mid-Holocene period from about 8,000 until almost 4,000 years ago was the hottest and most dry since the Pleistocene. The Altithermal climatic period was first recognized by Antevs (1955) based on stratigraphic evidence primarily in the Southwest, and subsequently referred to as the Hypsithermal in the mid continent region (Deevey and Flint 1957). On the eastern prairie and deciduous forest border, several palynological and paleoclimatic studies have documented the occurrence of a mid-Holocene dry and warm period (Benedict 1979; Brakenridge 1980, 1981; Holliday 1989; Hurt 1966; Johnson 1987; King 1981; Reeves 1973; Wendland 1978; Wright 1970). This period is variously referred to as the Hypsithermal or Atlantic episode and may not have been a single event with progressively drier and warmer climate. Evidence from Colorado suggests that the Hypsithermal was a relatively dynamic period with at least two intensive dry periods (Benedict 1979). Evidence from several sites strongly suggests that there was a dramatic lowering of the water table during the mid-Holocene and that utilization of the High Plains or more arid portions of the Plains was significantly impacted. Similar evidence for middle Holocene drought is found at sites on the southern High Plains (Evans 1951; Green 1962; Meltzer 1989). Several lines of evidence indicate that seasonal variability was more extreme and species diversity was significantly less than during the late Pleistocene (Dort and Jones 1970; Graham 1987; Johnson 1987; Semken 1983).

Cultural Context.

There is a substantial increase in the number of reported Archaic archeological sites for the middle and late Holocene period, but whether this evidence resulted from population increase, a different pattern of land use and occupation types, increased proportion of exposed sites, the ability of archeologists to recognize the sites, or some combination of these factors is not well established. On a continental scale there is general agreement that Native American populations increased in North America. This was not, however, a steady increase in all areas of the Plains throughout the period. Localized foraging territories seem to have been the pattern with a relatively limited amount of long-distance trade or mobility, if the pattern of lithic raw material usage is a reliable indication.

Hunter-gatherer groups are thought to have operated as foragers (following Binford's 1980 terminology) during much of the year, maintaining a high degree of group flexibility which would enable effective use of various resource patches on a seasonal basis. Group size may have varied from occasional or regularly patterned aggregations of multiple family groups to dispersed small groups of foragers operating within a familiar area. Aggregation sites may appear in the archeological record as "base camps" if they were repeatedly utilized, even though they may have been occupied only briefly. Collecting, processing, and short-term camp sites—including lithic workshops—are the most common expression of Holocene Broad Spectrum foragers in the Central Plains. Regional population density probably varied depending upon productivity and reliability of key resources such as bison, deer, turkey, fish, grasses, fruits, and nuts. Artifacts indicative of long-distance trade and interaction are relatively rare in these assemblages, at least until late in time. No reliable information is currently available pertaining to group size from a site or regional perspective.

Technology and Subsistence.

The technological repertoire included atlatls, which were probably made in a variety of types based on finds in adjacent areas to the east and west (Harrington 1971; Baker and Kidder 1937). Other tools include a variety of hafted knives and scraper forms including Munkers Creek gouges, ground stone tools and a wide range of stemmed projectile points which probably also served commonly as cutting tools. Some specialized cutting tools, such as the Munkers Creek Knife which was apparently used for cutting grasses, also reflect some technological changes during the Holocene. Features include common hearths and roasting pits containing fire-cracked rock and sometimes extensive burned rock middens. This constellation of features probably reflects the intensive processing of tenacious plant foods including grasses, yucca, mesquite, and perhaps acorns which required parching and/or leaching. Bison appear to have been limited in occurrence, distribution, and availability on the Plains during the middle Holocene. They were apparently not abundant in the region until after 4,000 B.P. Smaller animal resources figured prominently in the subsistence of the Broad Spectrum Forager's adaptation, but relatively few sites have been studied which exhibit good faunal preservation (Graham 1987).

The technology is thought to have had a substantial component of expediently used tools, but with a variety of curated tool forms including the atlatl and component parts, hafted knives, gouges, axes, grinding stones (perhaps caches at locations of redundant usage), and probably basketry. Although clay containers were apparently unknown until the late Archaic period where they are minimally represented in the Nebo Hill complex, use of fired clay or ceramic objects in other functions occurs much earlier (Witty 1982). A predominance of unpatterned core-flake assemblages may characterized some of the Broad-Spectrum hunter-gatherers. The importance of planning depth and seasonal storage probably varied by region and year, but the pit house dwelling hunter-gatherers probably had a substantial component of collectorlike behavior during the winter.

For some areas and during some periods, the importance of plants such as yucca in production of sandals, baskets, matting, garments, twine, and so forth was extremely important. The versatile and widely useful bison and deer products were not always accessible or bountiful. A significant portion of these technological systems was focused on processing of vegetal materials for purposes other than food. The perishable technology was substantial, if our clues from dry cave deposits in the Ozarks and Rocky Mountains is any indication.

Settlement Pattern.

Evidence of structural remains is extremely limited for the Broad Spectrum foragers, although many researchers believe such evidence will be forthcoming. Late Archaic structural evidence from the McEndree Ranch site in Colorado (Cassells 1983) is extremely important but only briefly reported. Semisubterranean structures are now known to occur on the western Plains and Rocky Mountains (Larson and Francis 1996; Metcalf and Black 1991). Utilization of rockshelter sites becomes extremely important during the middle and late Holocene with evidence of occupation in most areas which have shelters or caves in the vicinity of water and other resources. It is likely that seasonal aggregations occurred and these may be reflected at sites such as burned rock middens or locations of high bison density during the fall of the year. To date there has been little effort directed toward documenting the occurrence or timing of aggregate activities by Holocene foraging groups.

Trade and Exchange.

Few artifacts recovered from sites of the Broad Spectrum Forager adaptation type provide evidence of long-distance or intercultural trading. Relatively few occurrences of bannerstones, gorgets, pipes, axes or other such curated objects made from "exotic" materials are known in the Plains region, and the context of most such finds is poorly understood. It is probable that trade was conducted between groups in a variety of perishable and durable commodities and that the need for intergroup contact and interaction was important for long-term group viability. Marriage partners would usually have been sought outside the immediate extended family. Trade and marriage relationships between groups, perhaps being focused during specific seasons, would have been extremely important to these groups but the details of these relationships have not been studied effectively through the archeological record.

Ideology

It is during the middle and late Holocene when cemeteries first appear in the archeological record of the Plains, but whether this reflects an increased concern for the deceased or simply a decreased mobility pattern with redundant use of burial sites is not known. Burials are most often flexed interments which possess utilitarian offerings, shell pieces, or most commonly, no preserved offerings at all. There does not seem to be a consistent use of red ochre, burial orientation, or other such pattern, but the number of burials for this adaptation type for specific areas is very low (Owsley and Sandness, this volume), especially when we consider the long time span this adaptation type represents in the region.

Bioarcheology.

The vast majority of burials attributable to this adaptation type come from sites where only one or two burials are documented (Owsley and Sandness, this volume), and little patterning is evident. Archaic cemeteries are not known until very late Archaic or Woodland times. Interments are generally flexed and occasionally have associations.

Areas of High Site Probability.

Deeply buried land surfaces in alluvial settings provide one of the prime areas for occurrence of Broad Spectrum Hunter-Gatherer sites. However, the majority of reported sites attributed to the Archaic or Broad Spectrum adaptation type are located in eroded or otherwise exposed upland settings. Sites of primary importance for providing information on subsistence, site structure, and relatively unmixed assemblages, however, are usually those found in alluvial settings. Even though our best information may be derived from stratified buried sites, these are extremely difficult to locate and expensive to study. Depth of burial of old land surfaces, often demarked by buried A horizon paleosols, depends upon local geomorphic history and stream characteristics. Any interest in study of middle Holocene or early late Holocene archeological sites in stream valley settings must necessarily consider the potential and importance of buried sites. Effective location, evaluation, and study of stream valley sites requires cooperative integration of archeological, geomorphological, and soils studies. Rockshelter sites appear to have been intensively utilized by the Broad Spectrum Foragers, but these sites tend to have higher visibility and are more readily recognized than those in deep alluvial settings.

Data Gaps and Critical Research Questions.

One of the prominent gaps in our information pertaining to the Broad Spectrum Foragers pertains to the dearth of information on physical anthropology, mortuary practices, and the relationship of these data to the organization and structure of the forager societies. Many of the archeological sites recorded for the region reflect the activities, primarily or in part, of Broad Spectrum Foragers. The number of available detailed studies, reliably dated components, economic subsistence studies, settlement and land use studies, and technological analyses does not reflect the richness of the archeological record or the potential it holds for interpretations which reach beyond cultural historical concerns. On a regional scale, so little is known about the Broad Spectrum Forager adaptation type that any site which has good integrity and potential for functional, economic, technological, or bioarcheological study should receive special consideration. Dramatic changes apparently occurred in the region's climate and natural resource productivity. Changes in economy throughout the region and during the long time span of the Archaic have been hinted at in numerous studies, but the details of these changes and the seasonal or yearly variation in behaviors of groups have not been investigated. Recent discoveries and documentation of substantial architectural remains, primarily pithouses, for this adaptation type open exciting new possibilities for research concerning sedentism, storage, and technological organization (e.g., Metcalf and Black 1991; Osborn 1993). More extensive site studies and detailed recovery of botanical and faunal remains for ecological and subsistence information should be forthcoming which will complement the lithic and faunal information which is currently available. The variability of hunter-gatherer adaptations included within the Broad Spectrum Forager adaptation type is tremendous. It should not be assumed that all these groups were similar or that they all engaged in truly broad-spectrum economies. Some groups, especially in some seasons or years, may have been economic specialists, but with a wide repertoire of economic and technological options at their disposal. Documenting the variability in Holocene hunter-gatherer adaptations in the Plains and Mountains, and developing an understanding of the interface between plains, foothills, and mountain adaptations will remain key issues for years to come.

Late Aboriginal Hunter-Gatherer-Traders

Date Range

Only one currently recognized culture complex of the Central Plains, the Dismal River phase, is assignable to this adaptation type. Dendrochronology and Southwestern pottery in Dismal River assemblages date the complex to ca. A.D. 1675-1725, though Gunnerson (1987) suggests on the basis of historic records that this adaptation was in place by 1640.

Environmental Context

Dismal River sites have been recorded from the Black Hills of South Dakota to throughout the western half of Nebraska and Kansas, eastern Colorado and the Oklahoma Panhandle. Though most of this region is High Plains, the most extensive sites are in the eastern, mixed-grass Prairie-Plains of the range where rainfall conditions permitted more sedentism and the practice of maize-based horticulture (Gunnerson 1960, 1968, 1987). Wedel (1986:135-136) has pointed out that the appearance of this and other late ceramic cultures correlated with the Neo-Boreal climatic episode, though the affects of this cool period on Central Plains cultures may have differed in various regions. It may have accounted for the increased size of bison herds on the High Plains that were the staple of Dismal River subsistence (Gunnerson 1972).

Cultural Context

The Dismal River people were active participants in a trade network that linked the Central and Southern Plains with Puebloan cultures of the Southwest. The coincidence of this complex with the arrival of the Spanish in the Southwest, Southern and Central Plains also affected its development. The relationship between Dismal River and Puebloans is particularly evident at the site of "El Curatelejo," the Kansas Pueblo in Scott County, Kansas, which is believed to have been occupied by refugees from Taos or Picuris. Dismal River hunter-gatherer-traders have been convincingly identified as ancestral Apacheans who later merged with Jicarilla and Lipan Apache (D. Gunnerson 1974).

Technology and Subsistence

While maize agriculture was a part of the economic adaptation of the Dismal River culture, it was only in the eastern part of its geographic range that successful farming based on rainfall could have been practiced (Wedel 1986). Irrigation ditches at the Scott County pueblo (14SC1) indicate that gardening was not entirely forsaken in the western range. Hunting, particularly of bison, and gathering of wild foods continued to be integral to the subsistence of this High Plains adaptation. Technologically, Dismal River shares a variety of characteristics with its contemporaries in the Central Plains. Among these are unnotched arrow points, ubiquitous endscrapers and end-side scrapers, shaft abraders, splinter bone awls, serrated bison metapodial fleshers, and bison scapula hoes (Gunnerson 1987).

Settlement Pattern

Sites vary in size but include, particularly in the eastern part of the range, villages as extensive as 185 ha. They are found in a variety of topographic locations, including streamside terraces, in lacustrine settings of the Nebraska Sand Hills, in blowouts, on buttes, and in rock shelters (Wedel 1986:140). Houses, supported by a unique five post pattern, occur at random in clusters and show no sign of the need for defense. Sites lack thick middens or other signs of dense population. Storage pits are lacking as well, which suggests a more nomadic lifestyle than their Great Bend and Lower Loup contemporaries. Bell-shaped roasting pits are a distinctive feature of the Dismal River expression of this adaptation type.

Trade and Exchange

As this adaptation type implies, trade was central to the economy of the Dismal River culture. Archeological evidence of contact and exchange with groups of the Southwest includes Puebloan potsherds of a type called Ocate Micaceous or painted types such as Tewa Red-on-Buff; obsidian and turquoise from New Mexico, Olivella shell beads and a few Pueblo style shaft straighteners. The exchange system with between the Plains and Rio Grande Pueblo groups has been argued to have been an integral component of the social and economic systems of both groups (Baugh 1982, 1994; Spielmann 1983, 1986, 1991). Contact with Euro-Americans is limited and suggests trade with them was limited or indirect. The strongest indication of a relationship with Puebloan groups is at the Scott County site, where all evidence but dry-laid masonry structure, irrigation ditches, and a minority of the ceramic assemblage is attributable to the Dismal River culture. The pueblo itself and irrigation are sufficient evidence of a close relationship between these cultures.

Ideology

Given the generally supported view that the Dismal River culture is ancestral Plains Apache, we might expect that the ideology of this manifestation was comparable to the historic groups with which they have been linked. Gunnerson (1987:104) has described the Dismal River house as a "Navajo forked-stick hogan with the five religiously prescribed posts set vertically and use like the center posts of a plains earth lodge." The inclusion of ceramic pipes comparable to the "cloud blowers" of the Southwest in Dismal River assemblages may also have ideological implications. However, the fact is that Dismal River artifact assemblages and settlement/house do not yet provide insight to this aspect of their culture.

Bioarcheology

Only three interments, all in roasting pits, have been recorded. These were found at sites in South Dakota, New Mexico (described as a Navaho site; Carlson 1965; Gunnerson 1987:104) and the Scott County pueblo in Kansas. Gunnerson (1987) suggests these may not have been remains of Dismal River people, who may have shared with their historic Apache relatives a general fear of the dead and disposed of their remains at locations distant from their settlements. Consequently, direct biological analyses of the Dismal River people have not been possible.

Areas of High Site Probability

The wide variation in site locales and their distribution across the gradient of rainfall-dependant maize horticulture preclude identification, with any specificity, of the areas of greatest site probability. Given the nomadic lifestyle of the Dismal River people, their settlements and campsites can be sought, perhaps with greater probability of success, in both stream valleys and distant upland settings.

Data Gaps and Critical Research Areas

Wedel (1986:150) has pointed out that, despite the variety of information available about Dismal River, only three major sites—Scott County Pueblo, Lovitt, and White Cat Village—have contributed most of what we now know about it. Given the wide dispersion and great number of sites of this complex, this is a truly dismal sample of the potential data available. The chronological placement of the complex appears to be firmly fixed, as does its geographic range. Less well known are the nature of smaller campsites scattered throughout the High Plains and how these relate to the larger settlements. Trade with Southwest Puebloans has been demonstrated but the significance of this aspect of Dismal River economy in their overall cultural system has not been evaluated. Neither do we understand the relations between this hunter-gatherer-trader culture with its Central and Southern Plains neighbors, Lower Loup and Great Bend. If the basis of exchange was bison products for maize, what prevented or discouraged trade for the latter commodity with these eastern corn-growing peoples?

Incipient Horticulturists Adaptation Type

Date Range

The time frame for this adaptation type is roughly the first millennium following Christ, 2000 to 1000 B.P. (A.D. 1 to 1000). Examples of defined archeological complexes which are included in this adaptation type are the Kansas City Hopewell, Valley, Cuesta, Keith, Grasshopper Falls, and South Platte phases.

Environmental Context

Available evidence suggests that the first millennium A.D. was more moist with generally more mesic conditions than immediately preceding or following the period (Ferring 1982; Hall 1982). Bison were apparently less common in the prairie-plains region during this period and there was apparently an expansion of forest and tall grass prairie at the expense of short grass plains. Deer remains are common in the archeological deposits of this time, as noted from both the Middle and Late Woodland faunal assemblages. Although bison are represented in the archeological record, deer and antelope predominate at sites located in both the eastern prairies and the western plains. Evidence from geomorphology, land snails, vertebrate fauna and pollen all suggest that this period was substantially cooler and wetter or had less severe summers than previously (Hall 1982; Graham 1987).

Cultural Context

The Woodland or Incipient Horticulturist adaptation type was relatively short-lived by comparison to the preceding Archaic tradition. Population size has not been studied in a systematic manner, although several researchers believe that population increased significantly during the Woodland period (Wedel 1959, 1961). Sites attributed to the Woodland period tend to be more numerous, especially in the eastern portion of the study area, than earlier period occupations. Given the potential for buried Archaic components, however, this observation may not be an adequate measure of population size. Other researchers note the complexity and quantity of artifacts and the structural debris at Woodland period sites as indirect evidence of increased population size. With increased sedentism, and a concomitant focus on more locally available food resources, population is likely to rise (Binford and Chasko 1976; Cohen 1977; Lee 1972; Hassan 1977). It is further argued within this context, that population growth can stimulate subsistence change (Boserup 1965; Cohen 1977; Styles 1981). Within the Central Plains, subsistence change during the Woodland period is marked by the introduction and increased use of cultigens, although the importance for this change remains an open question. It is quite likely that native groups had reached a point where continued expansion using traditional hunter-gatherer tactics was becoming less feasible. Settlements appear to have become highly localized with an increasing importance on plant foods and smaller game animals. Technological advances such as the widespread acceptance of ceramics and the bow and arrow were, however, almost certainly factors in this scenario.

Technology and Subsistence System

The key technological developments distinguishing this adaptation type are earthenware ceramic vessels and the bow and arrow. Use of atlatls continued and is evidenced by fairly common finds of "boatstones" and other forms of atlatl weights. The ceramic technology varies considerably from east to west across the region. On the eastern prairie border, ceramics of the Early and Middle Woodland periods reflect contact or influence from temporally equivalent groups in the Eastern Woodlands. Thick, stone-tempered ceramics with cordmarked exteriors occasionally overlain in the rim area with geometric designs have been compared to the Liverpool type and appear in limited contexts before the time of Christ. Hopewellian ceramics, distinctive with incised cross-hatched lines and punctate designs on vessel rims, are more widespread during the first five millennia after Christ. Between 1500 and 1100 B.P. (A.D. 500-800), there was a widespread occurrence of cordmarked vessels, both conical and globular in shape, across much of the Central Plains. Temper inclusions consist of bone, stone, or clay. Use of these vessels was apparently as much for storage as for cooking, as evidenced by numerous examples of mending holes, baked-on food residue in the vessel interiors, and the large conical shape.

The bow and arrow was in use in the region, based primarily on a relatively dramatic decrease in the size of some projectile points, at the beginning of the Christian Era and soon thereafter. Replacement of dart points with arrowpoints may have occurred sooner or more rapidly in the Plains and Prairie areas than in the Woodlands (Vehik 1984). The earliest arrowpoints are typically elongated with corner notches, but there are a number of intermediate sized projectile points which were possibly versatile in use and appear intermediate in form between some late Archaic dart points and typical corner-notched arrowpoints.

Subsistence for the Incipient Horticulturists was focused to a variable but increasing degree on plant foods, with the introduction or adoption of native and tropical cultigens occurring during this period. The extent to which domesticates were known to the earlier Archaic populations in the Central Plains remains unknown, despite the recovery of several species of domesticates in adjacent areas (Asch 1994; King 1985; Kay 1983). The identification of domesticated marshelder seeds in Early Woodland contexts on the eastern border of the study area suggests that some level of cultivation was in place before the beginning of the Woodland period. However, significant involvement in the propagation of domesticates with a corresponding reliance on crops for food items did not occur until the latter part of the Woodland period. The mechanisms by which native groups altered their subsistence from the traditional hunter-gatherer-forager tactics to ones of cultivation and harvesting are fairly difficult to elucidate due to significant gaps in the archeobotanical record. It appears, however, that the use of garden plots varied throughout the region, a situation perhaps due to a combination of less than ideal climate and availability of environmentally tolerant plant species. Many indigenous wild plants were also utilized by Woodland groups, with nuts being more common from sites in the eastern part of the study area.

A variety of nonplant foods were used with continuing emphasis upon small animals such as turtles, turkeys, migratory birds, freshwater mussels, and small mammals. Deer and antelope were apparently a staple supply of protein, with bison being represented in fewer numbers (smaller MNI) at many sites. The overall economic focus was decidedly riverine in nature, with sites located on terraces of both major waterways and secondary tributaries. Seasonal occupation and regional occupation patterns have been suggested for peoples in both the eastern and western areas of the Central Plains (Reynolds 1979; Grange 1980).

Settlement Pattern.

Settlement patterns for the entire Woodland period vary considerably between the Middle Woodland Hopewell complex and the later Plains Woodland complexes. The Middle Woodland has been identified by the presence of both large villages with extensive features and middens and smaller sites indicative of shorter periods of occupation and perhaps more restricted activities. It is difficult to determine, however, if the large village sites were occupied on a permanent basis since no house patterns have been identified. The extensive midden accumulations and numerous features may be more a product of a large number of people during repeated shorter occupations.

An appropriate description of the settlement pattern for the latter part of the Incipient Horticulturist period in the Central Plains may be "entrenched mobility," a term also applied to the Southern Plains Woodland period. This term implies that groups were not completely sedentary, but moved periodically (perhaps seasonally) as the need arose. Several types of sites are known, including isolated houses, small hamlets, and rockshelters. No true villages are recognized. The known site types imply that people were organized around family or related small groups and that the decision making for the group was conducted on a more egalitarian basis than later village groups. Small hamlets or middens located along stream valleys are more frequent in the eastern half of the study area, with rockshelters and sparse midden deposits more typical of the western High Plains. In both areas, seasonal or limited occupation of the sites has been suggested (Butler 1988; Reynolds 1979; Grange 1980). House patterns, while unknown for most of the Woodland complexes, are identified by postmold stains, daub scatters, and interior hearths and other features. A wattle and daub construction is therefore assumed to have been the common mode of construction while post stains outline structures of variable size. For the Grasshopper Falls phase in northeastern Kansas, one or two oval patterns of postmolds associated with daub scatters are typical.

Burial patterns for the late Plains Woodland vary from single interments in prepared graves, cremations, ossuaries, multiple individuals placed together in a prepared grave, and isolated remains within habitation features (Thies 1990). The number and uniqueness of grave goods also varies considerably. Utilitarian goods, including ceramics and lithic tools, are perhaps more commonly found in graves of the late Woodland period, whereas more exotic or specially prepared funerary items have been recovered from the Middle Woodland burials.

Trade and Exchange

While ceramic decorative styles in the Early and Middle Woodland periods are indicative of contact or influence from the Eastern Woodlands, research on the vessel paste suggests that the ceramics were manufactured locally. Reid (1983) has also demonstrated that some of the lithic raw material was traded into the Middle Woodland region from central Missouri. Other items of trade documented from Middle Woodland period sites include shells from the Gulf Coast, obsidian from the Yellowstone area, and copper from the Great Lakes region. The actual number of items made of these exotic materials is very limited, suggesting that the Middle Woodland people were not engaged in an extensive trade network or any reciprocity agreements. The extent to which Hopewell materials, especially ceramics, were traded west into the Plains to non-Hopewell groups is unknown. Evidence for trade associated with the Late Woodland complexes is even more limited. A few artifacts manufactured from Gulf Coast shell have been recovered from Keith complex sites.

Ideology

Elaborate burial mounds are attributed to the Middle Woodland Kansas City Hopewell, Schultz, and Valley complexes and have a limited distribution within the study area. Within the rest of the Central Plains, however, elaborate burial rituals are suggested by the size of the burial sites and modifications of the deceased. Examples such as the extensive use of shell beads on select individuals assigned to the Keith and Ash Hollow complexes attest to the time allocated for the preparation of the body, while the cremation identified for the Deer Creek phase documents the variable practices of interment during the Plains Woodland period.

Ceremonial sites or burial mounds only occur in the northeastern portion of the study region, but relatively elaborate mortuary rituals are suggested by the diverse and intensive modifications of the deceased (including defleshing and cremation). Some of this variability may, however, relate to mobility and group aggregation patterns as much as to specific burial ideology (Hofman 1986). Ritual activities associated with burial may have been elaborate for some of these groups or in specific instances, but the highly imaginative reconstructions sometimes offered (e.g., O'Brien 1971) are not compelled by the evidence and are unrealistic. It is probable that repeated use of burial sites intensified during this period, and it is during this adaptation type that sites used specifically for repeated burial are first well documented. These factors reflect changing settlement and land use patterns which go in hand with changing ideology and ritual practices. The changes in ideology which occurred during this adaptation type represent an important research topic, but one which will require substantially more information for most of the recognized complexes.

Bioarcheology

The number of reported burials for the Incipient Horticulturist adaptation type is limited, and well-documented cases within the study area are extremely rare (Phenice 1969; Button and Agogino 1987). Burials are most commonly flexed single interments, but multiple burials and cremations are documented.

Data Gaps and Critical Research Areas

Significant research areas which should be addressed for the Central Plains Woodland period include an elucidation of factors and influences surrounding the beginning of the period; a comprehension of the social, political, and economic dynamics involved in the relationships between Middle Woodland Hopewellian groups and surrounding Plains Woodlands populations; a documentation of cultural changes involved in the shift from forager to farmer; a more complete appreciation of the importance of domesticated crops in an area considered by many to be marginal for horticultural pursuits; and a comprehension of the spatial and temporal parameters of the various Woodland complexes. These and other problems will require substantially refined data retrieval mechanisms and corresponding persistence in analyses.

There are many Woodland assemblages curated without having originally received adequate description, let alone formal analysis. In addition, many new Woodland sites are excavated without well-defined descriptions of how the settlement-subsistence pattern will be reconstructed, how the lithic and ceramic technologies will be defined and compared, and how intersite variability will be addressed. The Woodland period offers researchers an opportunity to study significant anthropological issues such as the adoption of new technologies, changing settlement patterns, changing resource use, and the sociopolitical foundations which were surely altered as well. By comparison, the Woodland period was a relatively short-lived time in the cultural sequence of the Central Plains, but an extremely dynamic and important one from the perspective of cultural, economic, and technological developments in the region.

The adoption of domesticated plants and the increasing dependence on cultigens was a central focus in the chapter on the Woodland period. It is very clear, however, that the archeobotanical data needed to critically address the nature and status of Central Plains Woodland horticultural activities are insufficiently represented in the assemblages. More importantly, however, these data need to be identified and evaluated for their economic importance within their surrounding cultural setting. The possibility of profitable western dry farming (with the use of highly drought resistant maize varieties), the dietary percentage of plants vs. animals in association with group size and mobility, and the potential for trade as a means of acquiring the necessary crop commodities are research areas which transcend the recovery and identification of plant remains, but which can only be accomplished with the recovery and identification of plant remains as the first step.

Several distinctive ceramic traditions occur in the Central Great Plains region during the Incipient Horticulturists adaptation including materials comparable to Kansas City Hopewell, Plains Woodland, and Mogollon. The users of these diverse ceramics apparently shared a variety of social and economic similarities including relatively large regional population, decreasing territory sizes, emphasis upon plant foods and nonherd animals, use of domesticated plants, and repeated burial in selected or preferred locations. This adaptation type represents a relatively short-lived period in the prehistory of the Central Plains, but an extremely dynamic and important one from the historical perspective of cultural and technological developments in the region. The correlation of temporary camps, shelter sites, and burials with semipermanent habitation sites presents a significant problem to be confronted. This and other problems of intersite comparisons will require substantially refined information on the ages of and variability within assemblages. There are many components and collections presently assigned to the "Woodland" period simply because they do not fit within the defined or recognizable Archaic or Late Prehistoric complexes.

The development of the Incipient Horticulturist technologically and economically in a region which is largely marginal for horticultural pursuits provides an important setting for the study of important anthropological issues such as the interface between hunter-gatherers and food producers. Also important is the documentation of cultural changes necessary to cope with environmental, population, and economic change. The adoption of new technologies (ceramics and the bow and arrow), changing settlement, and changing resource use are probably all factors that relate to solving general problems which were facing the peoples of this region. The possibility of population movements into the Plains area during the

Woodland period deserves consideration and might be monitored through detailed study of skeletal samples.

Also, the changes in diet and nutrition that occur with the Incipient Horticulturist adaptation may be reflected in bone chemistry. If intensification of horticultural activities reflects increased pressure from population increase, decreased size of hunting or resource use territories, and/or environmental changes, then these pressures may also be reflected through evidence of increased competition or even conflict between groups.

Developed Village Horticulturists Adaptation Type

Date Range

The temporal range of the Developed Village Horticulturists adaptation type in the Central Plains is from about the tenth to the eighteenth century A.D. As in the case of any given cultural adaptation type, its beginning and end are not yet fully known, the former more so than the latter. Historical records indicate the abortive Spanish entrada of the midsixteenth century and the continued presence and trade of the Spanish in the Southwest had considerably less affect on the continuity of the Plains Villagers of the Central Plains than those of the French traders of the succeeding two centuries. Severe acculturative pressures on indigenous peoples of the region were increased considerably by American settlement in the nineteenth century. With respect to the first appearance of this adaptation type in the Central Plains, archeologists face two problems, one physical and the other theoretical. The former, enhancement and refinement of radiocarbon control, requires only the acquisition of more dates from more sites and improvements in radiocarbon laboratory techniques or calibration. Theoretically, we have yet to define that threshold that separates Incipient Horticulturists from other cultures who relied on cultigens sufficiently for us to recognize them archeologically as farmers. At the present time, radiocarbon dates and taxonomic recognition of Central Plains tradition complexes as representative of Village Horticulturists suggests this threshold had been crossed by A.D. 900.

Environmental Context

Village Horticultural groups of the Central Plains adapted to a variety of environments dominated by grasslands that graded eastward from the shortgrass communities of the High Plains through mixed shortgrass and tallgrass prairies to ecotones of tallgrass prairies and oak-hickory woodlands along the Missouri River trench. These vegetational communities and their associated faunas had been established in the region since the Altithermal climatic episode of the mid-Holocene.

The most dramatic change of the late Holocene that some (e.g., Baerris and Bryson 1965, 1966, 1967, Bryson et al. 1970, Lehmer 1970) have suggested was a significant factor in the readaptation of Plains Villagers was the Pacific climatic episode that prevailed from ca. A.D. 1200 to 1550. The prevalence of strong westerly air flow across the Great Plains resulted in an increase in the frequency of summer droughts. There is no consensus about how or whether this episode, recognized in correlated pollen and radiocarbon analyses (Bryson 1974; Bryson and Wendland 1967; Wendland 1978; Bryson and Padoch 1980) and supported by some faunal studies (e.g., Semken 1983; Hall 1982), caused or influenced the movement or readaptation of horticultural groups in the Great Plains. That interpretation has its proponents and detractors (e.g., Ludwickson 1978; Dallman 1983; Lintz 1986; Wedel 1986) and the disagreement suggests the contribution of the physical environment to adaptations of Central Plains horticulturists still promises to be the subject of future research.

Cultural Context

Cultures recognized as significantly more dependant on horticulture in the Great Plains are generally referred to as Plains Villagers. All share the adaptive economic strategy of producing a large part of their food as compared to the supplementary or redundancy strategy characteristic of Incipient Horticulturists. In the Central Plains this adaptation led to a more sedentary lifeway than their Plains Woodland predecessors, though different cultures of the region practiced sedentism to varying degrees (Wood 1969). Indeed, the variety of hunting-gathering-gardening cultures that are here assigned to the Village Horticulturist adaptation type are not adequately described by the term Plains Villagers since not all occupied settlements of sufficient size to warrant use of the term "village."

Those archeological cultures of the region that can be described as Village Horticulturists include the Pomona variant, Steed-Kisker phase, three phases of the Central Plains tradition—Nebraska, Upper Republican and Smoky Hill, and the Itskari (Loup River), St. Helena, Oneota (Orr, Correctionville/ Blue Earth, and White Rock), Lower Loup, and Redbird phases.

Technology and Subsistence

The subsistence economy combined hunting and gathering of wild resources with cultivation of domestic plants, including maize, beans, squash, sunflowers, and marshelder (Adair 1988). The extent to which Plains Villagers were reliant on horticulture is reflected in their technology in the form of gardening tools such as the scapula hoe and "squash knife." Bones of bison (in the west) and deer (in the east) were modified into a variety of tools such as fleshers, awls, needles, beamers, "corn shellers", etc. Lithic tools related to hunting that are diagnostic of the adaptation type in the Central Plains include notched (side or side-and-basal) and unnotched, triangular arrow points. Beveled knives make their first appearance in the region with this adaptation type.

The impact of maize-based agriculture on Central Plains Villagers in a semiarid environment has been explored in several articles by Wedel (1941, 1953, 1961, 1979a, 1983b, 1986:114-129). The most recent of these treatments explores the range of factors that influenced this aspect of Upper Republican economy, including dependency on rainfall, length of frost-free seasons, food preparation and storage capabilities.

Archeological inference of the practice of long-distance bison hunting expeditions by Village Horticulturists of the western portion of the region has both its advocates (e.g., Wood 1969, 1990) and critics (Wedel 1986:123-126). The impact of change from a broad-based hunting-gathering-gardening economy by the Upper Republican culture to greater reliance on seasonally determined hunting forays by Itskari and Lower Loup populations has been explored by Roper (1989). The diverse yet bison-poor faunal assemblage from the Hulme site, an Upper Republican settlement on the divide between the Platte and Loup rivers, indicates readjustment of hunting practices to the increased aridity of the Pacific climatic episode (Bozell 1991).

Settlement Pattern

Settlements characterized as isolated farmsteads and hamlets or villages are located primarily in tributary drainages of major streams, including the Smoky Hill, Republican, Kansas, Platte and Missouri rivers. Lowland sites are more typical, as would be expected of farmers of alluvial soils. However, upland habitation sites of both the Pomona variant and the Central Plains tradition are not at all unusual. It has been suggested that sites in these differing topographic contexts reflect seasonal variation in settlement patterns (Brown 1984).

There are proponents to both sides of the issue of whether the varying sizes of some settlements of this adaptation type, specifically the Nebraska phase, should be considered villages or accumulations of noncontemporaneous lodges in one area over a period of time. Gradwohl (1969) supports the nucleated village concept and Blakeslee and Caldwell (1979; Blakeslee 1990) support the latter interpretation. With respect to the issue as it applies to the Smoky Hill phase, the Minneapolis site in Ottawa County, Kansas has been described as a village (Wedel 1934). The cluster of lodge depressions in the vicinity of the Whiteford cemetery in Saline County and those strung along Wildcat Creek in the Manhattan, Kansas area (an arbitrary portion of which is called the Griffing site; Wedel 1959) could be interpreted in either fashion. Lacking such demarcations as fortifications or other discrete boundaries, archeologists cannot yet clearly infer whether these lodge accumulations represent contemporary occupations. Wedel (1986:100-106) interprets Upper Republican settlements as small villages or hamlets based on "loose aggregations of dwellings" which are located on valley terraces, sloping hillsides and bluff tops.

Social Organization

Inferring social organization, beyond recognizing general population size and the maximum number of occupants that a lodge might have accommodated (e.g., Wedel 1961:95, 1979b; Blakeslee 1989), has been one of the more controversial and frustrating problems of Central Plains archeology. One of the most criticized attempts to infer marital residence patterns from archeological data is that of Deetz (1965), who recognized matrilocality among the protohistoric Pawnee and Arikara in the high level of attribute association in ceramics. A more speculative interpretation of Central Plains Villager social organization was offered by Wood (1969:106-107), who suggested the dispersed hamlets of these cultures were linked through "matrilineal, matrilocal groups composed of extended, polygynous (sororal) families." This hypothesis has also had its detractors (Wedel 1970, 1986:128).

Trade and Exchange

The existence of a single trade network that linked both nomadic and sedentary groups of the Great Plains and Prairie Peninsula during the late prehistoric and historic periods has been postulated by Blakeslee (1975; 1981a). Exchange was conducted during informal visits between or among groups, among informal visiting parties, and at intergroup trade fairs. The calumet ceremony is suggested as one possible mechanism that solidified trade or warfare alliances formed during such exchanges among these groups, such as those of the Nebraska phase (Blakeslee 1981b). It has been argued, however, that the vastness of the Great Plains and its ecological and cultural diversity may have mitigated against the establishment or maintenance of any such trade network (Wedel 1986:129).

Trade between Upper Republican groups and cultures of the Eastern Woodlands is inferred from the presence of artifacts of such nonlocal materials as Gulf Coast conch shells, freshwater snail shells of the Ohio and Wabash rivers, marine olivellas and marginella from the Southeast coast at Upper Republican sites (Strong 1935; Neuman 1963; Wedel 1986:111).

The increasing importance of trade, direct or indirect, with groups of the Southwest is examined by Loosle (1992) in his analysis of Great Bend aspect data. The extent to which this protohistoric culture of the Southern Plains-Central Plains border involved the Developed Horticulturists of the latter region has yet to be determined.

Ideology

Ideological aspects of Central Plains horticulturists, as indeed of most prehistoric cultures, are most difficult to discern. Nonetheless, some archeologists have dared to interpret the superstructural realm of the cultures that are here our concern.

The presence of Mississippian and Caddoan traits or artifacts in assemblages from sites of the Steed-Kisker, Nebraska, Upper Republican and Smoky Hill cultures raises the possibility that the trade relationship between the latter and cultures of the Eastern Woodlands was subsumed within a broader ideological framework. O'Brien (1981:103; 1984) has suggested that the incised designs of Steed-Kisker pottery, including "weeping eyes, nestled arches, crosses and the sunburst motif" are evidence of a connection with the Southern Ceremonial complex. McNerney (1987) has suggested that the effigy complex and some exotic ceramic vessel forms of the Nebraska phase points to the northward diffusion of the Spiro-Southeastern Ceremonial complex from the Caddoan area. The association of a single sherd of Crockett Curvilinear Incised ware and four well-made "ceremonial" bifaces with the burials at the Whiteford cemetery, in Saline County, Kansas, has been proffered as tantalizing testimony of a comparable link between the Smoky Hill phase and the Caddoan area (Wedel 1959:519-

520; Reynolds 1990). The appearance of the hand-eye motif on an antler bow guard from Graham ossuary in Harlan County, Nebraska, an Upper Republican phase site, has also been described with reference to this feature of the Southeastern Ceremonial complex (Wedel 1986:113).

O'Brien (1986; 1988) has interpreted some artifacts, their context and the attributes of a lodge at the Witt site as evidence of the prehistoric (Smoky Hill phase) antecedents of the historic Pawnee cosmology and ideology. O'Brien and McHugh (1987; McHugh 1980) have described the remains of a unique rectangular structure at the 23CL276 (Steed-Kisker phase) as a solstice shrine that provides evidence of a Mississippian-like world view. The validity of these interpretations has yet to be verified.

Bioarcheology

Human remains, and the analyses thereof, have provided some insight into mortuary practices, pathologies, nutrition, and biological relationships of the Central Plains Developed Horticulturists. It is certain that the recent enactment of state laws protecting unmarked burials and human remains in both Kansas and Nebraska, and at the federal level of the Native American Graves Protection and Repatriation Act (Nagpra), will continue to spur further bioarcheological research as well.

Human remains from Pomona variant sites are limited to 20 individuals from four sites (Brown and Simmons 1987:XIII 36-37). Fifteen of these were excavated from the Wiley site in the Melvern Reservoir area, Osage County, Kansas. Bass and others (1964) report on the physical anthropology of these remains. Other interments or human remains were found at two sites in the Elk City Reservoir area, Montgomery County, Kansas (Marshall 1972). Remains of one individual interred at one of these sites, Infinity, is described by Turner and Bass (1972). Johnson (1968) describes the poorly preserved remains of two persons, an adolescent and an infant, recovered from a pit at the Anderson site in the Clinton Reservoir area, Douglas County, Kansas. Unfortunately, the Anderson site contains both Woodland and Pomona components and the feature could not be positively assigned to either.

Cemeteries and burial mounds of the Steed-Kisker phase have been excavated and the human remains described with respect to both their archeological context and physical attributes. The cemetery area of the type site in Platte County, Missouri contained the remains of at least 83 individuals in extended, flexed or bundle fashion (Wedel 1943). Burial mounds of the Steed-Kisker phase occur on both sides of the Missouri River trench and include Avondale, Shepard, Noland, Vandiver, and Reeves Mounds on the Missouri side (Wedel 1943; Shippee 1972; O'Brien 1977) and Calovich Mound on the Kansas side (Barnes 1977). Stewart (1943), Finnegan (1977) and Barnes (1977) provide biological analyses of human remains from these sites.

Nebraska phase mortuary sites are less well known than those of the Steed-Kisker phase, though some cemeteries from the southernmost extent of the Nebraska phase area provide evidence of the interaction of or developmental relationship between these cultures. Examples of the latter, all in northwestern Missouri, include Amazonia Mound in Andrew County, Cloverdale ossuary in Buchanan County, and Sugar Creek ossuary in Platte County (Feagins 1988). Biological analysis of the Sugar Creek site has been completed by Nickels (1971). Strong (1935:172-175) describes what he suggests was a charnel house at the Saunders site, where charred human bones were found scattered throughout the floor fill with other animal remains, ceramic, and lithic refuse.

Nebraska phase human remains have been used in comparison to those from St. Helena and Upper Republican sites to determine biological relationships between these cultures and also to infer continuity from earlier Woodland through Central Plains tradition and later historic (e.g., Arikara) populations (Jantz et al. 1978). Multivariate analyses of craniometric data from protohistoric and historic Caddoan and Siouan populations with St. Helena human remains have further demonstrated that the latter were related to the Arikara (Jantz et al. 1981).

Smoky Hill burials are known from the Whiteford cemetery, where remains of more than 140 individuals were excavated in the early twentieth century by an amateur archeologist, left in situ and sheltered by a frame structure (Wedel 1959:512-523). Long on display for tourists, this site was filled in and capped with a concrete slab following its purchase by the state in 1990. A team of researchers, including a physical anthropologist, completed data gathering at the site between January and March of that year. Except for a detailed analysis of four "ceremonial" bifaces from the cemetery (Reynolds 1990), no results of analyses have been published at this time. Phenice (1969) describes the physical attributes of human remains in the Schultz Collection at the University of Kansas Museum of Anthropology. While most of these are Plains Woodland individuals, at least one interment (from the Dittmar site in Clay County, Kansas) is now believed to be attributable to the Central Plains tradition (Smoky Hill phase). Others of that affiliation in the collection may have been intrusive burials in Woodland mounds (Ritterbush and Logan 1991). A critical review of the data from mortuary sites excavated by Schultz and described by Eyman (1966) and Phenice (1969) to determine, as far as the records permit, the cultural affiliation of the human remains.

Upper Republican burials, including ossuaries and individual interments, have been described from both Kansas and Nebraska (Strong 1935:103-114; Wedel 1959:560). One of the ossuaries examined by Strong is Graham Ossuary, located in the Harlan County Lake area, south-central Nebraska. Recent National Register evaluation of the site, extensively excavated by Strong in 1930, demonstrated that it still not only retains undisturbed deposits but that the variety of skeletal remains can provide significant information about Upper Republican lifeways. For example, the sample of individuals recovered during the 1985 test excavations point to a high mortality rate for infants (Adair et al. 1987:78-89).

Lower Loup mortuary practices may have been like those of the descendant historic Pawnee, who practiced flexed inhumation in tumuli, generally on overlooks above their villages (Wedel 1938:91-94). Human remains (crania) from two

Lower Loup sites were used by Ubelaker and Jantz (1979) to examine biological relationships among Plains Caddoan groups.

Oneota burials are better documented in the Iowa portion of the Central Plains where they occur as inhumations in individuals graves in a cemetery area near villages (M. Wedel 1959; Harvey 1979). The Leary site in Richardson County, Nebraska yielded 15 burials during the 1935 excavations (Hill and Wedel 1937). Remains of three individuals were excavated from one of several mounds at the site during salvage operations in 1960. Bass (1961) presents a brief report with little physical data beyond the elements represented, sex and age of these discoveries.

Human remains from sites of the Redbird culture are limited. Wood (1965:116) briefly describes the physical attributes of two primary, extended burials and an isolated skull from two sites of this protohistoric complex.

No bioarcheological information is available for the White Rock culture.

Areas of High Site Probability

Past research has focused, for reasons of financial support and site visibility, on sites in lowland settings. Early archeologists such as A.T. Hill and W. Duncan Strong in Nebraska focused on visible sites in stream valleys where lodge depressions or plow-disturbed habitations were easily discerned. Though Hill and others investigated sites throughout the Central Plains (particularly in Nebraska), the post-World War II era of cultural resource management has been focused on the numerous federal reservoirs throughout the region. A consequence of the research of our predecessors is that what remains largely unexplored are areas beyond these reservoirs. Some of these intervening areas have seen archeological work connected with highway, Soil Conservation Service, oil and water line surveys, and the field training projects of universities, state historical and avocational societies. However, the scope of these projects has rarely been as broad as those undertaken in stream reaches affected by federal reservoirs. Thus, areas that we know from the reservoir studies have high site probability, such as lowland terraces in tributary valleys, have yet to be explored.

Recent geoarcheological investigations in the Central Plains have also pointed out the potential of various landforms for containing sites in buried alluvial contexts heretofore largely unexplored (Johnson and Logan 1990; Mandel 1987; May 1986). While we have frequently acknowledged the affect of alluvial burial on early and mid-Holocene sites, we generally assume ceramic-age sites lie just below or at the surface. In some drainages this may not be the case. For example, recent reinvestigation of the Mugler site, a Smoky Hill habitation in the Republican River valley, Clay County, Kansas indicates some lowland settings experienced substantial alluviation that effectively buried evidence of occupation to depths of 70-100 cm (Ritterbush and Logan 1992). Such areas of site potential have not yet been adequately investigated.

Data Gaps and Critical Research Questions

The Central Plains has long been one of the most archeologically well-documented regions of the Great Plains, particularly with regard to the ceramic periods, but many problem domains have yet to be thoroughly researched. Though the basic culture historical outline of the region's horticulturist/hunter-gatherers has been in place since the 1960s, refinements of it are still required. Indeed, recent research has indicated the basic culture-chronological scheme is flawed in some respects. An ecologically based cultural sequence for the Central Plains tradition in the Glen Elder locality (now Waconda Reservoir), Mitchell County, Kansas by Krause (1970) was critically evaluated by Lippincott (1978a; 1978b). More recently, Blakeslee (1991, 1992) has reviewed the sequences of Krause and Lippincott, particularly with regard to the radiocarbon dates on which both were based, and seriously undermined the validity of either scheme.

The recognition of three geographically and ceramically distinct cultures of the Central Plains tradition (Strong 1935; Wedel 1959) that has been the standard for so long is weakened when sites generally referred to as "hybrids" are considered (e.g., Strong 1935:181-182, 287 Hill and Cooper 1936:246-248; Hill and Wedel 1936:3, 34, 34, 69;). Ceramic assemblages from these sites display greater variability than the "pure" or homogeneous assemblages from core area occupations. These sites hold more promise for answering questions about the relations, or indeed, the reality of the Nebraska, Smoky Hill and Upper Republican archeological cultures. Recent examination and analysis of ceramic assemblages from Smoky Hill sites in the lower Republican River basin has revealed what may actually be an east-west (or upstream-downstream) gradient in the pottery types that are one of the linchpins of these cultures (Hedden 1992).

The relation of archeological cultures that may have reflected distinct, contemporary populations (i.e., Steed-Kisker and Pomona) has yet to be clarified (Logan 1988). The origin and fate of all of the prehistoric Plains Villagers is still a subject of dispute (e.g., Steinacher et al. 1991). Recent radiocarbon dating of the White Rock aspect has indicated this culture, once thought protohistoric, must now be assigned, at least in part, to the Plains Village period. This requires a reassessment of the influence of western Oneota cultures on Central Plains tradition developments (Logan 1993, 1994).

The spatial and temporal nature of the Nebraska phase is still the subject of reanalysis (Billeck 1993; cf. Anderson 1961; Brown 1967; Krause 1969; Zimmerman 1977b; Hotopp 1978a, 1978b; Blakeslee and Caldwell 1979). St. Helena has only recently seen the acquisition and analysis of new data, from a single excavated lodge, after a hiatus of 50 years and this, of course, has raised a variety of still new research problems (Blakeslee 1988).

More extensive geoarcheological studies are needed in valley settings in order to gauge the geographic extent and nature of buried Central Plains tradition sites. The early recognition of Upper Republican sites buried below sterile silt deposits and the climatic implications of that process are among the more renowned accomplishments of regional archeology (Strong 1935; Wedel 1941; Kivett 1948). However, whether the process of burial was due to conditions of increased aridity or precipitation in different parts of the region are opposing interpretations yet to be substantiated. This is but one example of the variety of culture ecological problems that can still be addressed and which will require an interdisciplinary approach.

Appendix: Paleobiogeography of Post-Sangamonian Vertebrates in the Central Plains, by Larry D. Martin

The late Pleistocene is commonly regarded as the Sangamonian and Wisconsinan, although the Late Illinoian may be included. It corresponds roughly to the Rancholabrean Land Mammal age. There are probably no credible human associations in the Central Great Plains that are as old as Sangamonian and practically no sediments that can be clearly assigned to that age. The earliest widespread assemblage of Wisconsinan vertebrates is associated with the Gilman Canyon Formation. Feng, Johnson and Lu (1993) give a range of ages from 35-20,000 B.P.for the Gilman Canyon Formation, representing a late interstadial (Farmdalian) in the Wisconsinan sequence. It varies in thickness, but seems to be a mixture of eolian deposition and soil forming processes. During times of local surface stability it was extensively burrowed by rodents and especially by the fossil ground Squirrel *Spermophilus kimballensis* Kent. Several local faunas from southwestern Kansas are time equivalents of Gilman Canyon deposition. The best known is the Jones Local Fauna that has recently been restudied by Davis (1975; 1987). Because Gilman Canyon Formation sites represent buried surfaces with reasonable preservation of bones and charcoal; are usually deeply buried and have good stratigraphic control, they should be searched by archaeologists for human evidence.

The Wisconsinan full glacial sequence is encompassed by the deposition of the Peoria Loess Formation ranging from 20,000-15, 000 B.P. The Peoria Loess is a massive sequence of windblown dust reflecting locally severe aridity and cold temperatures. Local concentrations of snails and plant macrofossils document scattered stands of trees (Wells and Stewart 1987a,1987b), but pollen sites from the same areas lack evidence for extensive forests. The best interpretation is a conifer parkland in the uplands while the floodplains may have been forested with spruce permitting the westward extension of *Bootherium, Cervalces* and *Mammut,*

Holen's description of the La Sena site (Holen 1994) suggests a real possibility of human activity in Nebraska and Kansas during the full glacial. If people were living in the region, it seems unlikely that any elephant carcass would go unscavenged and a systematic examination of loess sites with large mammal remains would be a good way of investigating the possibility of a human presence.

The interval from 15,000 to 10,000 B.P. covers the transition from the end of the Pleistocene to the inception of the Holocene. The entire interval is encompassed by solid evidence of human occupation in South America (Rogers et al. 1992) and the latter part by the well-known Clovis, Folsom, and Plano cultures. This was a time of environmental change with the break up of the Wisconsinan forests and parklands and the establishment of modern prairies and deciduous forest along with modern vertebrate and invertebrate biogeographic distributions. Extirpation of both large and small mammals occurred throughout the region (Martin et al. 1985). Most of the small mammals found refuge at higher elevations or latitudes, but the large mammals with their more defined breeding patterns and large home ranges proved less able to adjust and many became extinct.

The critical period of extinction is now closely confined between 12,000 and 10,000 B.P. Bison are rare as fossils up to about 11,000 B.P. after which they become abundant and are often found as mass death assemblages associated with evidence of human hunting. This is especially evident during the interval from 10,000 B.P. to 5,000 B.P. It may be that as the competitive pressure from other grazers diminished, bison became more abundant and the total biomass of large game animals was not reduced much by the decrease in large mammal diversity. Certainly hunters would have had little choice but to rely on bison after 10,000 B.P. There is some evidence that arid conditions were widespread in the Early Holocene (Altithermal?) and prairie conditions may have spread eastward carrying the bison herds with them. The Early Holocene record of bison near Bonner Springs, Douglas County, Kansas seems more extensive than the Late Holocene record (Rogers and Martin 1983), and may suggest a movement of the prairie-deciduous forest ecotone to the east.

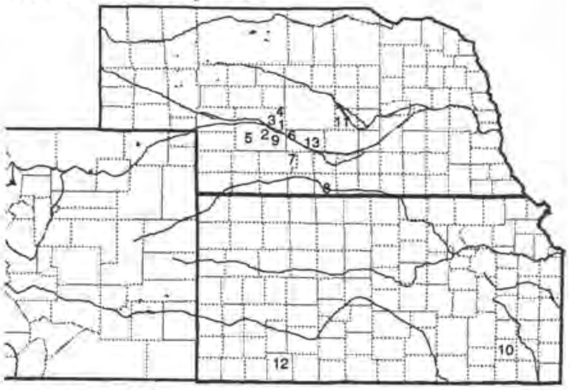
Very few Early Archaic living floors have been excavated in Kansas and Nebraska. It is clear that this will bias our record against small mammals and other aspects of collecting and gathering as opposed to big game hunting. The development of agriculture must have reduced dependency on large game and made such hunting a more seasonal activity. Certainly, the younger sites show a dominance of deer and a greater variety of small prey.

The geographical distributions of Late Pleistocene-Holocene organisms has only recently been appreciated. The first comprehensive efforts to map Pleistocene mammal distributions against vegetational distributions were those of Martin and Neuner (1978) who proposed a system of Pleistocene faunal provinces (Martin et al. 1985). Martin and Hoffman (1987) later suggested that those faunal provinces were the Pleistocene equivalents of modern biomes, Holocene distributions have been less extensively studied but good distributional data for Nebraska and Kansas have been recently published (David 1987; Semken and Falk 1987). The following maps, lists of sites, and lists of species rely on their efforts as well as other published reports. Only sites that can be reliably dated through absolute dates or stratigraphy are included although some latitude has been allowed for interesting sites that have dating information, but probably not for the whole assemblage. The intervals chosen are intended to group sites that may share a similar climatic history.

Scientific and Common Names of Mammals

Insectiivora	
Sorex cinereus	masked shrew
Sorex nanus	dwarf shrew
Sorex palustris	water shrew
Sorex arcticus	arctic shrew
Blarina brevicauda	short-tailed shrew
Blarina kirtlandi	Kirtland's short-tailed shrew
Scalopus aquaticus	eastern mole
Lagomorpha	
Ochotona princeps	pika
Sylvilagus floridanus	eastern cottontail
Lepus americanus	snowshoe hare
Lepus townsendii	white-tailed jackrabbit
Lepus californicus	black-tailed jackrabbit
Rodentia	
Marmota monax	woodchuck
Spermophilas Kimballensis	ground squirrel
Spermophilus richardsonii	richardson's ground squirrel
Spermophilus tridecemlineatus	thirteen-lined ground squirrel
Spermophilus franklinii	Franklin's ground squirrel
Cynomys ludovicianus	black-tailed prairie dog
Cynomys niobrarius	Niobrara prairie dog
Sciurus niger	fox squirrel
Tamiasciurus hudsonicus	red squirrel
Thomomys talpoides	northern pocket gopher
Geomys bursarius	plains pocket gopher
Perognathus sp.	pocket mouse
Chaetodipus hispidus	hispid pocket mouse
Dipodomys ordii	Ord's kangaroo rat
Castor canadensis	beaver
Castoroides kansansis	giant beaver
Oryzomys palustris	marsh rice rat
Reithrodontomys megalotis	western harvest mouse
Peromyscus maniculatus	deer mouse
Peromyscus leucopus	white-footed mouse
Onychomys leucogaster	northern grasshopper mouse
Sigmodon hispidus	hispid cotton rat
Neotoma floridana	eastern woodrat
Clethrionomys gapperi	southern red-backed vole
Phenacomys intermedius	heather vole
Microtus pennsylvanicus	meadow vole
Microtus montanus	montane vole
Microtus xanthognathus	yellow-cheeked vole
Microtus ochrogaster	prairie vole
Microtus pinetorum	pine vole
Lagurus curtatus	sagebrush vole
Ondatra zibethicus	muskrat
Synaptomys cooperi	southern bog lemming
Mictomys borealis	northern bog lemming
Dicrostonyx torquatus	collared lemming
Zapus hudsonius	meadow jumping mouse
Zapus princeps	western jumping mouse
Erethizon dorsatum	porcupine
Edentata	
Glossotherium harlani	Harlan's ground sloth
Megalonyx	ground sloth
Carnivora	
Canis latrans	coyote
Canis lupus	gray wolf
Canis familiaris	domestic dog
Canis dirus	dire wolf
Vulpes vulpes	red fox
Vulpes velox	swift fox
Urocyon cinereoargenteus	gray fox
Ursus americanus	black bear
Arctodus simus	giant short-faced bear
Procyon lotor	raccoon
Martes americana	marten
Martes nobilis	noble marten
Mustela erminea	ermine
Mustela frenata	long-tailed weasel
Mustela nigripes	black-footed ferret
Mustela vison	mink
Gulo gulo	wolverine
Taxidea taxus	badger
Mephitis mephitis	striped skunk
Lutra canadensis	river otter
Puma concolor	mountain lion
Lynx	bobcat
Panthera atrox	American lion
Proboscidea	
Mammut americanum	American mastodon
Mammuthus colombi	Columbian mammoth
Artiodactyla	
Platygonus compressus	flat-headed peccary
Mylohyus nasutus	long-nosed peccary
Cervus elaphus	elk
Odocoileus virginianus	white-tailed deer
Cervalces scotti	stagmoose
Rangifer tarandus	caribou
Antilocapra americana	pronghorn
Bison bison	bison
Ovibos moschatus	barren ground muskox
Bootherium cavifrons	woodland muskox
Ovis canadensis	bighorn sheep
Camelops	American camel
Hemiauchenia	macrocephala large-headed llama
Perissodactyla	
Equus sp.	horse
Equus niobrarensis	Niobrara horse
Tapirus terrestris	extinct tapir

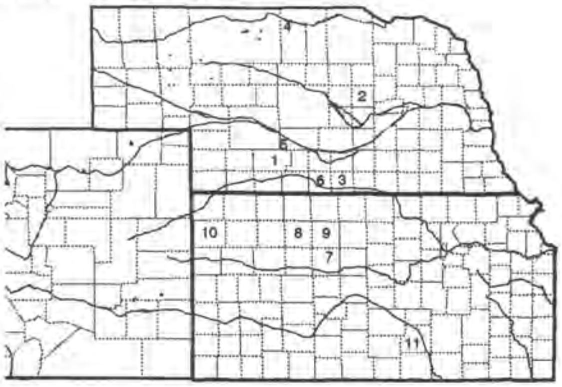
Sites 35,000 to 20,000 yr B.P.



1. Twelve miles SE of Maxwell, Lincoln Co., NE, "Citellus Zone" (Schultz 1934)
2. Ten miles SW of Maxwell, Lincoln Co., NE, "Citellus Zone" (Schultz 1934)
3. Three miles south of Bignell, Lincoln Co., NE, "Citellus Zone" (Schultz 1934)
4. Two miles south of Bignell, Lincoln Co., NE, "Citellus Zone" (Schultz 1934)
5. Sixteen miles south of Bignell, Lincoln Co., NE, "Citellus Zone" (Schultz 1934)
6. Dales Farm, Dawson Co., NE, "Citellus Zone" (Neuner 1975; Goodwin 1990),
7. Eustis, Frontier Co., NE, "Citellus Zone" (Neuner 1975)
8. UNSM Coll. Loc. Hn 101, Harlan Co., NE, "Citellus Zone" (Neuner 1975)
9. Gilman Canyon, Box Elder Canyon, and Cottonwood Canyon, Lincoln Co., NE (Neuner 1975)
10. Wilson Co., KS, Alluvial deposits dated at 30,000 YBP (Miller 1978; Goodwin 1990)
11. Litchfield Local Fauna, Sherman Co., NE This was reported by Voorhies and Corner (1985) and incudes *Phenacomys* and *Clethrionomys*. The only dates associated with it are Holocene and must certainly be in error. Based on its faunal composition it could be an equivalent of the Gilman Canyon faunules. It is one of the most diverse late Pleistocene faunas and would be very important if it could be securely dated. Rogers and Martin (1985) reported a small number of pollen grains from the Litchfield site most of which were from grass. As some of the fauna requires forest cover, he suggested a pine parkland.
12. Jones Local Fauna, Meade Co., KS. Discovered by Claude Hibbard (1970), this is a southwestern Kansas equivalent of the Gilman Canyon Fauna and has been dated at 26,700±1500 YBP and 29,000±1300 YBP (Davis 1987). The fauna includes Sorex cf. arcticus and probably *Microtus montanus* (Davis 1987) so that it has a more boreal aspect than the modern fauna. Large mammals include mammoth, peccary, bison, camel and horse. No human association is known.
13. Devils Gap, Dawson Co., NE. The type locality of *Bison antiquus barbour*; Schultz and Frankforter (1946), 2.4 miles west of Gothenburg.

Vertebrates	Sites 1	2	3	4	5	6	7	8	9	10	11	12	13
Edentata													
Glossotherium sp.										X			
Insectivora													
Sorex cinereus											X	X	
Sorex arcticus												X	
Blarina carolinensis											X		
Blarina kirtlandi											X		
Cryptotis parva											X		
Scalopus aquaticus											X		
Myotus sp .											X		
Lagomorpha													
Sylvilagus sp.											X	X	
Lepus americanus											X		
Lepus sp.											X		
Rodentia													
Marmota sp.											X		
Spermophilus kimballensis		X				X	X	X	X		X	X	
Spermophilus tridecemlineatus											X	X	
Spermophilus franklini											X	X	
Cynomys ludovicianus						X				X		X	
Cynomys niobrarius											X		
Tamias striatus											?		
Thomomys talpoides		X		X	X						X		
Thomomys sp.												X	
Geomys bursarius											X		
Geomys sp.												X	
Chaetodipus hispidus					X						X		
Perognathus sp.											X	X	
Reithrodontomys sp.											X		
Peromyscus sp.											X		
Onychomy leucogaster											X	X	
Neotoma sp.											X		
Clethrionomys gapperi											X		
Phenacomys intermedius											X		
Ondatra zibethicus											X		
Microtus xanthognathus											X		
Microtus pennsylvanicus											X	X	
Microtus montanus											X	X	
Microtus ochrogaster											X	X	
Microtus pinetorum											X		
Synaptomys cooperi											X		
Zapus sp.											X		
Carnivora													
Canis latrans											?		
Canis lupus											X		
Mustela frenata													
Mustela ermina											X		
Mustela nigripes		X											
Taxidea taxus													
Martes americana												X	
Mephitis mephitis													
Lutra canadensis													
Proboscidea													
Mammut americanum										X			
Mammuthus columbi			X	X	X					X	X	X	
Platygonus compressus												X	
Odocoileus sp.											X		
Ovibos													
Bootherium cavifrons										X			
Bison cf. *antiquus*										X	X		X
Antilocapra americana											?		
Camelops	X												
Perissodactyla													
Equus sp.												X	

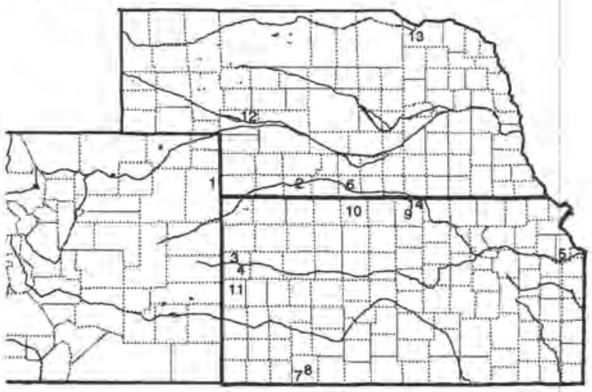
Sites 20,000 to 15,000 yr B.P.



1. La Sena Local Fauna, Frontier Co., NE, Peoria Loess, dated at about 18,000 YBP.
2. Wolbach Local Fauna, Greely Co., NE, base of the Peoria Loess (Schultz, et al. 1994)
3. Franklin Co., NE, peccary mass death, Peoria Loess (Schultz 1934)
4. Smith Falls Local Fauna (Voorhies and Corner 1985). A series of eleven separate sites on the highest terrace of the Niobrara River: Cherry, Brown, and Keya Paha Counties, NE. These faunas may not be strictly contemporaneous and the presence of the collared lemming, *Dicrostonyx*, makes it the most boreal NE fauna with tundra during at least part of the time.
5. Jensen Mammoth Site, Dawson Co., NE, mammoth skeleton in the Peoria Loess.
6. Harlan Co., Reservoir (North Side), Harlan Co., NE. This is a number of occurrences either *in situ* in Peoria Loess or apparently just eroded out of it (Burres 1992).
7. Duck Creek Local Fauna, Ellis Co., KS. The Duck Creek Local Fauna was considered "Illinoian" in age (Zakrzewski and Maxfield 1971; Kolb et al. 1975; McMullen 1975 1978; Holman 1984) until Stewart (1987) provided a full glacial date of 17,000±350 YBP. The presence of *Clethrionomys* and *Mictomys* demonstrates its boreal nature.
8. Coon Creek Local Fauna, Graham Co., KS. The Coon Creek Local Fauna was discovered by J. D. Stewart, who described it as a thin veneer of late Pleistocene deposits lying on top of Pliocene sediments. The fauna (Wells and Stewart 1987) included a boreal assemblage similar to that from the Trapshoot local fauna including *Phenacomys* and a few macrofossils of *Pinus flexilis* (limber pine). A full glacial radiocarbon date of 17,930±550 B.C. was obtained from this site.
9. Trapshoot Local Faunal. This site was discovered by J. D. Stewart, who was also responsible for its excavation and used it as the subject of an M.S. thesis (Stewart 1978). Most of the Fauna was recovered from a large crotavena within loess considered to be Peorian. This relationship suggests an age somewhere in the range of deposition for the Peoria Loess or from 20,000 to 14,000 B.P. Fragments of baby foxes indicate that the crotavena is a fossil fox den, and as such the site is an unlikely one for human associations. The presence of such boreal animals as *Phenacomys* indicate a glacial influence.
10. Goodland Peccary Quarry, Sherman Co., KS. Mass death of nine peccaries in the Peoria Loess (Hay 1924).
11. Wichita Sandpit, Sedgwick Co., KS. Peat balls from this site dated at 19,340±200/210 YBP (Fredlund and Jaumann 1987). This probably dates the oldest level at this site (Rogers and Martin 1985).

	Sites										
Vertebrates	1	2	3	4	5	6	7	8	9	10	11
Edentata											
Glossotherium harlani											X
Megalonyx				X							X
Insectivora											
Sorex nanus									X		
Sorex cinereus					X						
Sorex arcticus					X		X	X			
Cryptotis parva				X							
Parascalops breweri				X							
Lagomorpha											
Ochotona				X							
Lepus californicus									X		
Lepus townsendii									X		
Sylvilagus sp.	X								X		
Lepus americanus		X		X							
Rodentia											
Erethizon dorsatum				X							
Spermophilus kimballensis	X			X	X	X		X	X		
Spermophilus tridecemlineatus				X				X	X		
Spermophilus franklini				X							
Cynomys niobrarius				X				X			
Tamiasciurus hudsonicus				X							
Thomomys talpoides	X	X		X	X	X	X	X	X		
Geomys bursarius				X	X						
Reithrodontomys sp.									X		
Chaetodipus hispidus					X		X				
Peromyscus maniculatus									X		
Peromyscus sp.				X							
Onychomy leucogaster				X					X		
Neotoma sp.				X							
Clethrionomys gapperi	X				X		X	X	X		
Phenacomys intermedius				X				X	X		
Dicrostonyx torquatus				X							
Ondatra zibethecus				X							
Lagurus curtatus	X										
Microtus xanthognathus				X				X			
Microtus pennsylvanicus							X	X	X		
Microtus ochrogaster									X		
Microtus montanus	X	X		X	X			X	X		
Mictomys borealis							X	X			
Synaptomys cooperi				X							
Zapus princeps								X	X		
Carnivora											
Canis lupus				X							
Vulpes vulpes									X		
Mustela nigripes		X		X							
Martes americana				X							
Gulo gulo				X		X					
Proboscidea											
Mammuthus columbi	X			X	X	X	X				X
Mammut americanum											X
Platygonus compressus			X	X						X	
Odocoileus sp.				X							
Bison cf. *antiquus*				X					X		?
Camelops	X			X							X
Hemiauchenia				X							
Perissodactyla											
Equus sp.				X							X
Antilocaprid				X							

Sites, 15,000 to 10,000 yr B.P.

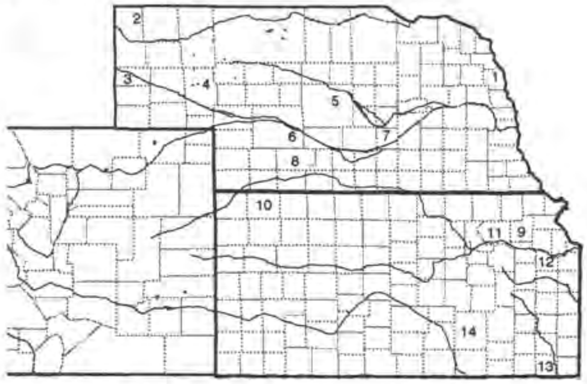


1. Selby-Dutton Sites, Yuma Co., CO. Dated at 13,600±485 on bone collagen (Stanford and Graham 1985). This site is supposed to be stratigraphically in the Peoria Loess although the date is a little young for that stratigraphic position. Human activity has been postulated for this site.
2. Red Willow Gravel Pits, Willow Co. NE. (Corner 1977).
3. Twelve Mile Creek Site, Wallace Co. KS. Bison kill dated at 10,435±260 and 10,245±335 (Rogers and Martin 1984).
4. Adjacent terrace deposits to the Twelve Mile Creek Site (Hay 1924).
5. Kansas River Sandbars, Douglas, Johnson, and Wyandotte Co., KS. (Johnson 1987; Rogers and Martin 1982, 1983).
6. North Cove Local Fauna, Harlan Co., NE. The North Cove site was discovered by J. D. Stewart, who later joined W. Johnson in directing excavations at this site. It contains both abundant floral and faunal remains, making it the most important late Pleistocene site in the Central Plains. Two lithic flakes were recovered in association with boreal indicators, including: *Phenacomys, Microtus xanthognathus, Clethrionomys, and Mictomys.* The spruce forest character of this association is confirmed by the presence of *Picea glauca* in adjacent strata (Stewart 1989). The human origin of the flakes has been questioned, but the presence of small concentrations of burned bones and charcoal coupled with the flakes should maintain a cautious interest in the possibility of an archeological component. Among the burned bones are portions of bison (Stewart 1989). The proposed cultural remains are from a Woodfordian horizon that has produced radiocarbon dates ranging from 12,750±100 to 11,015±135 B.C. Radiometric dates from the fossilferous sequence range from 14,700±100 to 9145±865 B.C. Proboscidian, horse, and camel remains occur in similar sediments near the site but do not appear in the published lists from the excavations. Similar Pleistocene remains and sediments occur as isolated occurrences on the north side of Harlan Co. Reservoir and there is potential for additional discoveries. The most interesting aspect of this assemblage is the undoubted local occurrence of spruce forest accompanied by a typical forest assemblage. Its existence in the middle of the plains may not require an extension of the Pleistocene forests of Iowa to south-central NE, but instead documents a conifer gallery forest along the ancient drainages.
7. Classen Local Fauna, Meade Co., KS. The Classen Local Fauna produced a date of 16,100±250YBP (Stewart 1987).
8. Robert Local Fauna, Meade, Co., KS. This local fauna has a date of 11,100±390 YBP (Schultz 1967). It still contains extralocal animals of boreal aspect, including: Sorex palustris, Thomomys talpoides, and Spermophilus kimballensis.
9. Jewell Co., KS. This locality was discovered by J.D. Stewart. It produced bones of Lepus americanus (Snowshoe hare) and snails (Stewart 1984). A date on spruce charcoal places it near the end of the full-glacial 14,450±140 B.C. There is no archeological association.
10. Phillips Co., KS. J.D. Stewart (1984) discovered an additional record of Snowshoe hare in the Peoria Loess.
11. Koehn-Schneider Mammoth Site, Greely Co., KS. Alluvial fill dated on bone at 11,050±170 YBP.
12. Crappie Hole Site, Keith Co., NE. The age on this site (Voorhies and Corner 1984) is uncertain and may be older than 15,000 YBP.
13. Wolverine Slide Site, Knox Co., NE. This locality is very similar to the Crappie Hole Site (Corner and Voorhies 1987) and is also of uncertain age.
14. Lovewell Reservoir Hemiauchenia Site, Jewell Co., KS (Logan, Martin, and Neas 1991) from deposits dated at 13,410±300 YBP.

	Sites													
Vertebrates	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Marsupialia														
Glossotherium harlani	X													
Megalonyx					X									
Insectivora														
Sorex cinereus								X						
Sorex palustris								X						
Sorex arcticus						X								
Blarina brevicauda								X						
Lagomorpha														
Sylvilagus sp.	X							X						
Lepus americanus						X			X	X				
Rodentia														
Spermophilus kimballensis	X					X	X	X				X	X	
Spermophilus tridecemlineatus						X	X	X						
Cynomys ludovicianus	X						X	X						
Cynomys niobrarius						X								
Eutamias minimus						X								
Tamiasciurus hudsonicus						X								
Castoroides kansasensis					X									
Thomomys talpoides						X		X					X	
Geomys bursarius	X													
Geomys sp.								X						
Reithrodontomys sp.								X						
Peromyscus maniculatus								X						
Peromyscus leucopus								X						
Onychomy leucogaster	X													
Clethrionomys gapperi						X							X	
Phenacomys intermedius						X								
Ondatra zibethicus		X												
Microtus xanthognathus						X							X	
Microtus pennsylvanicus	X					X		X						
Microtus montanus						X								
Microtus ochrogaster	X					X	X							
Microtus sp.	X													
Mictomys borealis						X								
Synaptomys cooperi								X						
Zapus hudsonius								X						
Zapus princeps						X								
Carnivora														
Canis latrans		X												
Canis lupus		X												
Canis dirus					X									X
Canis sp.				X										
Vulpes vulpes		X												
Vulpes velox							X							
Ursus americanus												X		
Arctodus simus		X			X									
Mustela nigripes		X												
Taxidea taxus	X	X					X							
Gulo gulo												X	X	
Mephitis mephitis							X							
Lutra canadensis							X							
Panthera atrox		X												

	Sites 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Proboscidea														
Mammuthus columbi		X		X	X		X				X	X	X	
Mammut americanum				X										
Platygonus compressus		X												
Mylohyus					X									
Rangifer		X												
Cervalces					X									
Odocoileus sp.		X										X		
Ovis catclawensis		X												
Ovibos		X												
Bootherium cavifrons		X			X		X							
Bison cf. *antiquus*	X	X	X	X	X		X					X	X	
Antilocapra americana		X												
Camelops	X	X		X			X					X		
Hemiauchenia		X			X									X
Perissodactyla														
Tapirus terrestrius					X									
Equus sp.	X			X	X		X					X	X	
Equus conversidens		X												
Equus cf. *niobrarius*		X												

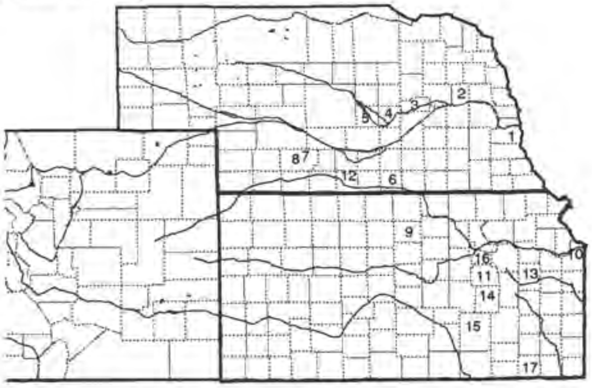
Sites, 10,000 to 5000 yr B.P.



1. Logan Creek, Burt Co., NE. This is a complex of cultural zones dating from 8125±250 to 6633±300 (Kivet 1962; Snyder and Bozell 1983).
2. Hudson-Meng Site, Sioux Co., NE. This is and Early Archaic Bison kill dated at 9820±160 and 8990±190 (Agenbroad 1978).
3. Scottsbluff Bison Quarry, Scottsbluff Co., NE. The type site for Scottsbluff points (Barbour and Schultz 1932)
4. Clary Ranch Site, Garden Co., NE. Mass kill of Bison cf. occidentalis should date around 8,000 YBP based on associated Frederick points (Myers et al. 1981).
5. Milburn Bison Quarry, Custer Co., NE. This is a peat deposit where bison bogged down around 8,000 YBP. Some artifacts were recovered from the peat (Hillerud 1970).
6. Cumro Bison Site, Lincoln Co., NE. A single bison skeleton associated with a distinctive Paleoindian point (Barbour and Schultz 1936).
7. Meserve Bison Quarry, Hall Co., NE. A bison kill site with the original Meserve points (Barbour and Schultz 1936).
8. Lime Creek, Red Smoke, and Allen Sites. A series of deeply buried Terrace deposits containing occupational floors, the oldest dating at 9524±45 YBP (Schultz, Lueninghoener, and Frankforter 1951).
9. Sutter Site, Jackson Co., KS. This site produced a small number of bison bones and dates of 7970±245 and 7668±237 YBP (Katz 1971;1972).
10. Burntwood Bison kill, Rawlins Co., KS. A probable Early Holocene bison kill (Hill, Hofman, and Martin 1993)
11. Coffey Site, Pottawatomie Co., KS. This site ranges in age from 5850±135 to 4840±95 (Schmits 1978).
12. Kansas River Sandbars at Bonner Springs, Douglas Co., KS This material is not in situ but radiocarbon dates, Early Archaic artifacts and the evolutionary state of many of the bison specimens demonstrate an Early Holocene component.
13. Stigenwalt Site, Labette Co., KS. Early Archaic site dating around 7,000 YBP.
14. Snyder Site, Butler Co., KS. Archaic site dated around 5,000 YBP (Bradley 1973).

Vertebrates	Sites 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Insectivora														
Blarina brevicauda						X								
Cryptotis parva	X													
Scalopus aquaticus									X		X			
Lagomorpha														
Sylvilagus floridanus											X		X	
Sylvilagus sp.						X			X	X				
Lepus townsendii													X	
Lepus sp.	X					X								
Rodentia														
Spermophilus franklinii									X		X			
Spermophilus sp.	X													
Cynomys ludovicianus	X					X								
Sciurus niger													X	
Sciurus sp.	X										X			
Castor canadensis	X												X	X
Geomys bursarius	X										X		X	X
Perognathus sp.								X					X	
Ondatra zibethicus					X					X				X
Neotoma floridana											X			
Microtus pinetorum/ochrogaster													X	X
Microtus sp.								X						
Synaptomys cooperi								X						
Carnivora														
Canis latrans								X					X	X
Canis lupus										X		X		
Canis sp.	X										X	X		
Vulpes vulpes										X				
Ursus americanus										X				
Procyon lotor	X							X		X	X	X	X	
Mustela vison													X	
Taxidea taxus	X							X				X	X	
Mephitis mephitis											X			
Lutra canadensis	X												X	
Puma concolor											X		X	
Artiodactyla														
Cervus elaphus	X									X		X		
Odocoileus virginianus									X	X	X	?	X	X
Odocoileus sp.	X							X	X					
Bison cf. *antiquus*		X	X	X	X	X	X	X		X	X	X		
Bison bison	X								X		X	X	X	X
Antilocapra americana	X					X		X						X

Sites, 5000 to 500 yr B.P.



1. Walker-Gilmore, Cass Co., NE. Woodland site developed on a low terrace and dated between 1030±150 and 665±55 YBP (Haas 1983; Falk and Angus 1983; Thompson and Bettis 1980).
2. Gray-Wolfe Site, Colfax Co., NE. Protohistoric (Bozell et. al. 1982).
3. Nance Co., NE. Late Prehistoric sites (Ludwickson 1978; Mick 1983).
4. Schmidt Site, Howard Co., NE. Late Prehistoric (Morey 1982; Satorius-Fox 1982).
5. Bill Packer Site, Sherman Co., NE. Late Prehistoric (Bozell and Rogers 1985; Mckenzie and Holen 1983).
6. Shipman Site, Webster Co., NE. Late Prehistoric (Mick 1983).
7. Owens Site, Frontier Co., NE. Late Prehistoric (Mick 1982;1983).
8. Medicine Creek Terraces, Frontier Co., NE. Late Prehistoric (Mick 1983).
9. Solomon River, Mitchell Co., KS. Late Prehistoric (Lippincott 1978).
10. Trowbridge, Wyandotte Co., KS. Dated from 1820±105 to 1550±105 YBP (E. M. Johnson 1975).
11. Council Grove Lake Area. Witty (1982).
12. Harlan Co., NE Prehistoric Sites. (Brown 1982).
13. Osage Co., KS (K. L. Brown and A. H. Simmons eds. 1987; Kansas Prehistoric Archaelogical Preservation Plan).
14. Chase Co., KS (K. L. Brown and A. H. Simmons eds. 1987; Kansas Prehistoric Archaelogical Preservation Plan).
15. Butler Co., KS (K. L. Brown and A. H. Simmons eds. 1987; Kansas Prehistoric Archaelogical Preservation Plan).
16. Geary Co., KS (K. L. Brown and A. H. Simmons eds. 1987; Kansas Prehistoric Archaelogical Preservation Plan).
17. Montgomery Co., KS (K. L. Brown and A. H. Simmons eds. 1987; Kansas Prehistoric Archaelogical Preservation Plan).

	Sites																
Vertebrates	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Insectivora																	
Blarina brevicauda				X											X		X
Scalopus aquaticus	X			X					X				X	X	X		
Lagomorpha																	
Sylvilagus floridanus	X		X	X	X	X		X	X	X	X	X	X	X			
Lepus californicus													X	X			
Lepus townsendii								X	X								
Lepus sp.			X	X	X						X	X					
Rodentia																	
Ereibizon dorsatum								X									
Marmota monax								X									
Spermopbilus tridecemlineatus				X	X		X	X				X					
Spermopbilus franklinii		X		X	X				X								
Spermopbilus sp.					X									X			
Cynomys ludovicianus		X		X	X				X	X		X	X				
Sciurus niger		X							X	X			X				
Castor canadensis	X	X	X	X		X	X	X	X	X	X	X	X			X	
Geomys bursarius	X		X	X	X	X	X	X	X	X		X	X		X		
Dipodomys ordii								X									
Chaetodipus bispidus				X	X		X		X								
Perognatbus sp.				X					X	X							
Oryzomys palustris			X	X		X				X							
Reitbrodontomys sp.		X		X													
Peromyscus maniculatus				X													
Peromyscus leucopus								X									
Peromyscus sp.												X			X		
Onchomy leucogaster				X	X			X					X				
Sigmodon bispidus																X	
Ondatra zibithecus		X	X	X	X			X									
Neotoma floridana								X		X							
Neotoma sp.						X		X							X		
Microtus pennsylvanicus				X													
Microtus ochrogaster									X			X			X		
Microtus sp.	X				X			X	X				X				
Synptomys cooperi				X													
Zapus budsonius				X													
Carnivora																	
Canis latrans			X	X	X			X				X	X		X		
Canis lupus				X				X	X	X		?	X				
Canis familiaris	X			X				X	X	X			X				
Canis sp.	X	X		X	X	X		X	X								
Vulpes vulpes		X							X								
Vulpes velox				X				X	X			X					
Urocyon cinereoargenteus								X		X							
Procyon lotor			X			X	X	X	X	X		X	X		X		
Mustela frenata				X	X		X										
Mustela vison	X			X				X					X		X		
Taxidea taxus		X	X	X	X			X	X		X						
Gulo gulo								X									
Mephitis mephitis		X	X	X	X				X	X							
Lutra canadensis				X					X								
Lynx rufus			X		X			X	X				X				
Puma concolor								X									
Cervus elaphus		X	X			X			X	X		X	X	X			
Odocoileus virginianus									X		X				X		X
Odocoileus sp.	X	X	X	X	X	X	X	X		X		X	X		X		
Bison bison	X	X	X	X	X	X	X	X	X	X		X	X	X	X		
Antilocapra americana		X	X	X	X	X	X	X	X	X	X	X			X		

References

Abbott, C. C.

1876 The Stone Age in New Jersey. *Smithsonian Report for 1875*: 246-380.

Abel, A. H. (editor)

1939 *Tabeau's Narrative of Louisel'a Expedition to the Upper Missouri.* University of Oklahoma Press, Norman.

Aber, J. S.

1981 Two-Ice-Lobe Model for Glaciation of Kansas. *Kansas Academy of Science, Transactions* 84:162-163.

1991 The Glaciation of Northeastern Kansas. *Boreas* 20:297-314.

Adair, M. J.

1977 *Subsistence Exploitation at the Young Site: A Predictive Model for Kansas City Hopewell.* Unpublished Master's thesis, Department of Anthropology, University of Kansas, Lawrence.

1980 Analysis of Plant Remains from the Traff Site (23JA159). In *Archaeological Investigations in the Proposed Blue Springs Lake Area, Jackson County, Missouri,* Appendix B. Project Report Series No. 45. Museum of Anthropology, Lawrence.

1984 Some Observations on Woodland Ethnobotany. Paper presented at Flint Hills Archaeological Conference, Topeka, Kansas.

1987 Macrofloral Analysis of Flotation Samples from a Crematorium at the Richland Site (14SH101). In *Archaeological Investigations in the Clinton Lake Project Area, Northeastern Kansas.* Kaw Valley Engineering and Development, Inc. Junction City, Kansas. Submitted to U.S. Army Corps of Engineers, Kansas City District.

1988 *Prehistoric Agriculture in the Central Plains.* Publications in Anthropology, No. 16. University of Kansas, Lawrence.

1990 *Iva annua* as a Prehistoric Cultigen in the Central Plains: A Regional Synthesis. Paper presented at the 48th Plains Conference, Oklahoma City, Oklahoma.

1991 Macrobotanical Remains from the Avoca Site (14JN332): The Role of Agriculture during the Early Ceramic Period. In *The Avoca Site (14JN332), Excavation of a Grasshopper Falls Phase Structure, Jackson County, Kansas,* by T G. Baugh, Chapter 5. Contract Archeology Series Publications No. 8. Kansas State Historical Society, Topeka.

1992 Archaeobotanical Remains from the Patterson and Little Pawnee Creek Sites. In *Nebraska Phase Archaeology in the South Bend Locality,* edited by J. R. Bozell and J. Ludwickson, Appendix A:1-19. Nebraska State Historical Society, Lincoln.

1993a Ethnobotanical Remains from the Quarry Creek Site. In *Quarry Creek: Excavation, Analysis and Prospect of a Kansas City Hopewell Site, Fort Leavenworth, Kansas,* edited by B. Logan, pp. 170-175. Project Report Series No. 80. University of Kansas, Museum of Anthropology, Lawrence.

1993b Premaize Gardening in the Central Plains. Paper presented at the 58th Annual Meeting of the Society for American Archaeology, St. Louis.

1994 Corn and Culture History in the Central Plains. In *Corn and Culture in the Prehistoric New World*, edited by S. Johannason and C. Hastorf, pp. 315 - 334. Westview Press, Boulder.

n.d. Tobacco on the Plains: Historical Use, Ethnographic Accounts and Archaeological Evidence. In *Food for the Gods: The Use of Tobacco by Native Americans*, edited by J. C. Winter. Yale University Press, New Haven.

Adair, M. J. (editor)

1989 Archaeological Investigations at the North Cove Site Harlan County Lake, Harlan County, Nebraska. An Interdisciplinary Approach. Kaw Valley Engineering and Development, Junction City, Kansas. Submitted to U.S. Army Corps of Engineers, Kansas City District.

Adair, M. J. and K. L. Brown (editors)

1987 *Prehistoric and Historic Cultural Resources of Selected Sites at Harlan County Lake, Harlan County, Nebraska. Test Excavations and Determination of Significance for 28 Sites.* 1987 Final Report. Museum of Anthropology, University of Kansas, Lawrence. Submitted to the U.S. Army Corps of Engineers, Kansas City District.

Adair, M. J., K. L. Brown, M. E. Brown, D.C. Fitzgerald and K. J. Cornwell

1987 Site Descriptions and Recovered Artifacts. In *Prehistoric and Historic Cultural Resources of Selected Sites at Harlan County Lake, Harlan County, Nebraska,* edited by Mary J. Adair and Kenneth L. Brown, pp. 76-297. Kaw Valley Engineering, Junction City, Kansas. Submitted to U.S. Army Corps of Engineers, Kansas City District.

Adair, M. J. and M. E. Brown

1978 The Two Deer Site (14BU55): A Plains Woodland-Plains Village Transition. In *Prehistory and History of the El Dorado Lake Area* (Phase II). Museum of Anthropology, Project Report Series, No. 47, Lawrence.

Adair, M. J. and R. Estep

1991 The Archaeobotanical Record from Kansas River Basin Sites. Paper presented at the 49th Plains Conference, Lawrence.

Adair, M. J. and J. D. Feagins

1986 *An Analysis of Prehistoric Plant Remains from an Archaeological Test at the Sibley Site, Jackson County, Missouri.* Cultural Resource Investigation No. 34. The Kansas City Museum, Kansas City.

Adams, K. R.

1994 A Regional Synthesis of Zea Mays in the Prehistoric American Southwest. In *Corn and Culture in the Prehistoric New World*, edited by S. Johannason and C. Hastorf. Westview Press, Boulder.

Adovasio, J.

1993 The Ones that Will Not Go Away, A Biased View of Pre-Clovis Populations in the New World. In *From Kostenki to Clovis: Upper Paleolithic-Paleo-Indian Adaptations,* edited by O. Soffer and N. D. Praslov, pp. 199-218. Plenum Press, New York.

Adovasio, J., A. T. Boldurian, and R. C. Carlisle

1987 Who Are Those Guys?: Some Biased Thoughts on the Initial Peopling of the New World. In *Americans Before Columbus: Ice-Age Origins,* edited by R. C. Carlisle, pp. 45-62. Ethnology Monographs 12. Department of Anthropology, University of Pittsburgh.

Adovasio, J. and R. Carlisle

1988 The Meadowcroft Rockshelter. *Science* 239:713-714.

Adovasio, J., R. Carlisle, K. Cushman, J. Donahue, J. Guilday

1985 Paleoenvironmental Reconstruction at Meadowcroft Rockshelter, Washington County, Pennsylvania. In *Environments and Extinctions,* edited by J. Mead and D. Meltzer, pp. 73-110. Center for the Study of Early Man, Provo.

Adovasio, J., J. Donahue, R. Carlisle, K. Cushman, R. Stuckenrath, and P. Weigman

1984 Meadowcroft Rockshelter and the Pleistocene/Holocene Transition in Southwestern Pennsylvania. In *Contributions in Quaternary Vertebrate Paleontology: a Volume in Memorial to John E. Guilday,* edited by H. Genoways and M. Dawson, pp. 347-369.

Adovasio, J., J. Donahue, K. Cushman, R. Carlisle, R. Stuckenrath, J. D. Gunn, and W. C. Johnson

1983 Evidence from Meadowcroft Rockshelter. In *Early Man in the New World,* edited by R. Shutler, pp. 163-189. Sage Publications, Beverly Hills.

Adovasio, J. M., J. Donahue, and R. Stuckenrath
1990 The Meadowcroft Rockshelter Radiocarbon Chronology, 1975-1990. *American Antiquity* 55 (2): 348-354.
Adovasio, J. M., J. D. Gunn, J. Donahue, and R. Stuckenrath
1978 Meadowcroft Rockshelter, 1977: An Overview. *American Antiquity* 43:632-651.
Agenbroad, L. D.
1978a *The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains.* University Press of America, Washington, D.C.
1978b Cody Knives and the Cody Complex in Plains Prehistory: A Reassessment. *Plains Anthropologist* 23(80):159-161.
Agogino, G. A.
1969 The Midland Complex: Is It Valid? *American Anthropologist* 71:1117-11180
1972 Excavations at a Paleo-Indian Site (Brewster) in Moss Agate Arroyo, Eastern Wyoming. *National Geographic Society Research Reports* 1955-1960:1-6.
Agogino, G. A. and W. Frankforter
1960 A Paleo-Indian Bison Kill in Northwestern Iowa. *American Antiquity* 25:414-415.
Agogino, G. A. and E. Galloway
1965 The Sister's Hill Site: A Hell Gap Site in North-Central Wyoming. *Plains Anthropologist* 10:190-195.
Agogino, G. A. and A. Parrish
1971 The Fowler-Parrish Site: A Folsom Campsite in Eastern Colorado. *Plains Anthropologist* 16:111-114.
Agogino, G. A., D. K. Patterson, and D. E. Patterson
1976 Blackwater Draw Locality No. 1, South Bank: Report for the Summer of 1974. *Plains Anthropologist* 21:213-223.
Agogino, G. A. and I. Rovner
1964 Paleo-Indian Traditions: A Current Evaluation. *Archaeology* 17(4):237-243.
Agogino, G. A., I. Rovner, and C. Irwin-Williams
1964 Early Man in the New World. *Science* 143(3612):1350-1352.
Ahlbrandt, T. S. and S. G. Fryberger
1980 *Eolian Deposits in the Nebraska Sand Hills.* U.S. Geological Survey Professional Paper 1120 A.
Ahlbrandt, T. S., S. G. Fryberger, J. H. Hanley, and J. P. Bradbury
1980 *Geologic and Paleoecologic Studies of the Nebraska Sand Hills.* United States Geological Survey Professional Paper 1120 A-C.
Ahlbrandt, T. S., J. B. Swinehart, and D. G. Maroney
1983 The Dynamic Holocene Dune Fields of the Great Plains and Rocky Mountain Basins, U.S.A. In *Eolian Sediments and Processes,* edited by M. E. Brookfield and T. S. Ahlbrandt, pp. 379-406. Elsevier, Amsterdam.
Ahler, S. A., A. M. Cancara, D. B. Madsen, and R. W. Kornbrath
1977 Archeological Reconnaissance and Test Excavation at the Travis 2 Site, 39WW15, Oahe Reservoir, South Dakota. Ms. on file, U.S. Army Corps of Engineers, Omaha.
Ahler, S. A., D. K. Davies, C. R. Falk, D. B. Madsen
1974 Holocene Stratigraphy and Archeology in the Middle Missouri River Trench, South Dakota. *Science* 184-905-908.
Ahler, S. A. and M. Root
1993 Folsom Mobility Strategies Viewed From Within and Near the Knife River Flint Source Area, North Dakota. Paper presented at the 58th Annual Meeting of the Society for American Archaeology, St. Louis.
Alden, W. C. and M. M. Leighton
1917 The Iowan Drift, a Review of the Evidence of the Iowan Stage of Glaciation. *Iowa Geological Survey Annual Report* 26:49-212.
Aldenerfer, M. S.
1980 Melvern Lake, Kansas, Preliminary Cultural Resources Management Plan. Ms. on file, Kansas Fish and Game Commission, Topeka.
Alex, L. M.
1980 *Exploring Iowa's Past: A Guide to Prehistoric Archaeology.* University of Iowa Press, Iowa City.
Alexander, H. L.
1963 The Levi Site: A Paleo-Indian Campsite in Central Texas. *American Antiquity* 28:510-528.
Alfano, M. C.
1980 Nutrition in Dental Caries. In *The Biological Basis of Dental Caries,* edited by L. Menaker, pp. 343-364. Harper and Row, Hagerstown, Maryland.
Allerton, D.
1980 Comparison of Shells to Wood in Radiocarbon Dating. In *Archaeological Investigations in the Red Willow Reservoir*, by R. T. Grange, pp. 176-178. Nebraska State Historical Society Publications in Anthropology 9. Lincoln.
Allison, M. J., D. Mendoza, and A. Pezzia
1974 A Radiographic Approach to Childhood Illness in Precolumbian Inhabitants of Southern Peru. *American Journal of Physical Anthropology* 40:409-416.
Alsoszatai-Petheo, J.
1986 An Alternative Paradigm for the Study of Early Man in the New World. In *New Evidence for the Pleistocene Peopling of the Americas,* edited by A. L. Bryan, pp. 15-23. Center for the Study of Early Man, Orono, Maine.
Amick, D. S.
1991 Folsom Land Use Patterns in the Southern Tularosa Basin. *Current Research in the Pleistocene* 8:3-5.
1994 *Folsom Diet Breadth and Land Use in the American Southwest.* Unpublished Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.
1995 Patterns of Technological Variation Among Folsom and Midland Projectile Points in the American Southwest. *Plains Anthropologist* 40(151):23-38.
1996 Regional Patterns of Folsom Mobility and Land Use in the American Southwest. *World Archaeology* 27(3):411-426.
An, Z., G. J. Kukla, S. C. Porter, and J. Xiao
1991 Magnetic Susceptibility Evidence of Monsoon Variation on the Loess Plateau of Central China During the Last 130,000 Years. *Quaternary Research* 36: 29-36.
An, Z., T. Liu, Y. Lu, S. C. Porter, G. J. Kukla, X. Wu, and Y. Hua
1990 The Long-Term Paleomonsoon Variation Recorded by the Loess-Paleosol Sequence in Central China. *Quaternary International* 7/8:91-95.
An, Z., W. Porter, Y. Zhou, D. J. Lu, M. J. Donahue, M. J. Heads, and H. Zheng
1993 Episodes of Strengthened Summer Monsoon Climate of Younger Dryas Age on the Loess Plateau of Central China. *Quaternary Research* 39: 45-54.
Anderson, A. D.
1961 The Glenwood Sequence. *Journal of the Iowa Archeological Society* 10(3):1-101.
1975 The Cooperton Mammoth: An Early Man Bone Quarry. *Great Plains Journal* 14(2):130-173.
Anderson, A. D. and B. Anderson
1960 Pottery Types of the Glenwood Foci. *Journal of the Iowa Archeological Society* 9(4):12-39.
Anderson, A. D. and L. J. Zimmerman
1976 Settlement-Subsistence Variability in the Glenwood Locality, Southwestern Iowa. *Plains Anthropologist* 21(72):141-154.
Anderson, D. C.
1966 The Gordon Creek Burial. *Southwestern Lore* 32(1):1-9.

Anderson, D. C. and H. A. Semken, Jr. (editors)
1980 *The Cherokee Excavations, Holocene Ecology and Human Adaptations in Northwestern Iowa*. Academic Press, New York.

Anderson, D. C., R. Shutler, Jr., and W. M. Wendland
1980 The Cherokee Sewer Site and Cultures of the Atlantic Climatic Episode. In *The Cherokee Excavations, Holocene Ecology and Human Adaptations in Northwestern Iowa*, edited by D. C. Anderson and H. A. Semken, Jr., pp. 257-275. Academic Press, New York.

Anderson, J. L.
1989a Chronological Framework. In *Temporal Assessment of Diagnostic Materials from the Pinon Canyon Maneuver Site*, edited by C. R. Lintz and J. L. Anderson, pp. 8-41. Memoirs of the Colorado Archaeological Society 4.
1989b Regional Chronology. In *Temporal Assessment of Diagnostic Materials from the Pinon Canyon Maneuver Site*, edited by C. R. Lintz and J. L. Anderson, pp. 432-450. Memoirs of the Colorado Archaeological Society 4.

Andrews, D. L.
1994 Molecular Approaches to the Isolation and Analysis of Ancient Nucleic Acids. In *Method and Theory for Investigating the Peopling of the Americas*, edited by R. Bonnichsen and D. G. Steele, pp. 165-175. Center for the Study of the First Americans, Oregon State University, Corvallis.

Anfinson, S.
1979 *A Handbook of Minnesota Ceramics*. Occasional Publications in Minnesota Anthropology, No. 5, Minneapolis.
1982 *The Prehistoric Archaeology of the Prairie Lake Region*. Journal of the North Dakota Archaeological Association, Vol. 1.

Angus, C. and C. R. Falk
1978 Cultural Resources Reconnaissance for Three Missouri River Bank Stabilization Projects in South Dakota and Nebraska: Sunshine Bottom, Goat Island, Ionia Bend. Ms. on file, Nebraska State Historical Society, Lincoln

Anonymous
n.d. Blue Reservoir [Archeological Appraisal]. Ms. on file, SI-RBS, Lincoln
1947 Preliminary Appraisal of the Archaeological and Paleontological Resources of the Kanopolis Reservoir, Ellsworth County, Kansas. Ms. on file, National Parks Service, Midwest Archaeological Center, Lincoln.
1983 Results of Cultural Resource Inventory of Cherry Creek Reservoir. Ms. on file, U.S. Army Corps of Engineers, Denver.

Antevs, E.
1955 Geologic-Climatic Dating in the West. *American Antiquity* 20:317-335.

Arbogast, A. F.
1995 *Paleoenvironments and Desertification on the Great Bend Sand Prairie in Kansas*. Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

Arbogast. A. F. and W. C. Johnson
1994 Evolution of a Small Basin in the Central Great Plains and Climatic Associations. *Quaternary Research* 41:298-305.

Artz, J. A.
1983 *The Soils and Geomorphology of the East Branch Walnut Valley: Contexts of Human Adaptation in the Kansas Flint Hills*. Unpublished Master's thesis, Department of Anthropology, University of Kansas, Lawrence.

Artz, J. A. and K. C. Reid
1983 Geoarchaeological Investigations in Cotton Creek Valley. In *Hunters of the Forest Edge: Culture, Time, and Process in the Little Caney Basin (1980, 1981, and 1982 Field Seasons)*, by K. C. Reid and J. A. Artz, pp. 97-186. Oklahoma Archaeological Survey Studies in Oklahoma's Past 13. Norman.

Artz, J. A., J. Manion, J. Marshall, and C. Wright
1975 *Archaeological Investigations at 14MM26, Hillsdale Reservoir, Eastern Kansas*. Museum of Anthropology, University of Kansas, Lawrence. Submitted to U.S. Army Corps of Engineers, Kansas City.

Asch, D. L.
1994 Aboriginal Specialty-Plant Cultivation in Eastern North America: Illinois Prehistory and a Post-Contact Perspective. In *Agricultural Origins and Development in the Midcontinent*, edited by W. Green, pp. 25-86. Office of the State Archaeologist, University of Iowa, Report 19. Iowa City.

Asch, D. L. and N. B. Asch
1978 The Economic Potential of Iva annua and its Prehistoric Importance in the Lower Illinois Valley. In *The Nature and Status of Ethnobotany*, edited by R. Ford, pp. 300-341. Anthropological Papers 67. Museum of Anthropology, University of Michigan, Ann Arbor.
1985 Prehistoric Plant Cultivation in West-Central Illinois. In *Prehistoric Food Production in North America*, edited by R. Ford, pp. 149-203. Anthropological Papers 75. Museum of Anthropology, University of Michigan, Ann Arbor.

Asch, D. L. and W. Green
1992 Crops of Ancient Iowa: Native Plant Use and Farming Systems. Office of the State Archaeologist, University of Iowa. Submitted to the Leopold Center for Sustainable Agriculture.

Ashworth, K. A.
1979a Supplement No. 1 to Archaeological Test Excavation at Lyon Creek Watershed Structure No. 6, Dickinson County, Kansas. Ms. on file, Kansas State Historical Society, Topeka.
1979b Phase II Archaeological Field Reconnaissance in the Upper and Lower Salt Creek Watershed Lincoln and Mitchell Counties. Ms. on file, Kansas State Historical Society, Topeka.
1980a Phase I Project Review of Wolf River Watershed Doniphan and Brown Counties. Ms. on file, Kansas State Historical Society, Topeka.
1980b An Archaeological Survey of the Wolf Rover Watershed. Ms. on file, Kansas State Historical Society, Topeka.
1981a Phase II Archaeological Survey Investigation of Diamond Creek Watershed, Morris and Chase Counties, Kansas. Ms. on file, Kansas State Historical Society, Topeka.
1981b A Phase II Archaeological Survey of Middle Creek Watershed Chase, Morris, and Marion Counties, Kansas. Ms. on file, Kansas State Historical Society, Topeka.
1982a Phase III Archeological Investigations within the Diamond Creek Watershed. Ms. on file, Kansas State Historical Society, Topeka.
1982b Phase III Testing of Three Prehistoric Sites within Brown and Doniphan Counties, Kansas. Ms. on file, Kansas State Historical Society, Topeka.
1982c Phase II Archaeological Investigations within the Middle Creek Watershed. Ms. on file, Kansas State Historical Society, Topeka.

Bader, O. N.
1978 *Sungir* (in Russian). Nauka, Moscow.

Baerreis, D. A. and R. A. Bryson
1965 Climatic Episodes and the Dating of the Mississippian Cultures. *Wisconsin Archaeologist* 46:203-220.
1966 Dating the Panhandle Aspect Cultures. *Bulletin of the Oklahoma Anthropological Society* 14:105-116.
1967 Mississippian Cultural Developments in the Light of Historical Climatology. Paper presented at the 32nd Annual Meeting, Society for American Archaeology, Ann Arbor.

Baird, L., K. Fimple, K. Morgan, A. Pritchford, and A. B. Amerson (compilers)
1982 Draft Report, Historical and Architectural Field Survey of a Portion of Fort Scott Lake Project, Bourbon County, Kansas. Ms. on file, Bourbon County Historical Preservation Association, Fort Scott.

Baker, B. J. and G. J. Armelagos
1988 The Origins and Antiquity of Syphilis: Paleopathological Diagnosis and Interpretation. *Current Anthropology* 29(5):703-737.

Baker, G. R.
n.d. Weekly Reports, Trinidad State Junior College, Trinidad Reservoir Salvage Archaeology Project, Las Animas County, Colorado. (2nd-8th weekly reports). Ms. on file, SI-RBS, Lincoln.

Baker, R. G. and K. A. Waln
1985 Quaternary Pollen Records from the Great Plains and Central United States. In *Pollen Records of Late Quaternary North American Sediments*, edited by V. M. Bryant and R. G. Holloway, pp. 191-203. American Association of Palynologists Foundation, Dallas, Texas.

Baker, W. and A. V. Kidder
1937 A Spear Thrower from Oklahoma. *American Antiquity* 3(1):51-52.

Baker, W. E., T. M. N. Campbell, and G. L. Evans
1957 The Nall Site: Evidence of Early Man in the Oklahoma Panhandle. *Bulletin of the Oklahoma Anthropological Society* 5:1-20.

Bamforth, D.
1985 The Technological Organization of Paleoindian Small-Group Bison Hunting on the Llano Estacado. *Plains Anthropologist* 30:243-258.
1988 *Ecology and Human Organization on the Great Plains*. Plenun Press, New York.
1991a Population Dispersion and Paleoindian Technology at the Allen Site. In *Raw Material Economies Among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. R. Holen, pp. 357-374. University of Kansas Publications in Anthropology 19. Lawrence.
1991b Flintknapping Skill, Communal Hunting, and Paleoindian Projectile Point Typology. *Plains Anthropologist* 36(137):309-322.

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

Banks, W. E., J. L. Hofman, and R. Patterson
1994 Paleoindian and Paleoecological Evidence from Farra Canyon, Oklahoma. *Current Research in the Pleistocene* 11:1-3.

Barbour, E. H.
1906 *Preliminary Report on the Primitive Man of Nebraska*. Nebraska Geological Survey Volume II, Part 5. Lincoln.
1907 Evidence of Man in the Loess of Nebraska. *Science* 25(629): 110-112.

Barbour, E. H. and C. B. Schultz
1932a The Mounted Skeleton of Bison Occidentalis, and Associated Dart-Points. *Bulletin of the Nebraska State Museum* 1(32):263-270.
1932b The Scottsbluff Bison Quarry and its Artifacts. *Bulletin of the Nebraska State Museum* 1(34):283-286. Lincoln.
1936 Paleontologic and Ecologic Consideration of Early Man in Nebraska, With Notice of a New Bone Bed in the early Pleistocene of Morrill County, Nebraska. *Bulletin of the University of Nebraska State Museum* 1 (45):431-450, Figures 200-208.

Barbour, E. and H. Ward
1906a Discovery of an Early Type Man in Nebraska. *Science* 24: 628-629.
1906b Preliminary Report on the Primitive Man of Nebraska. *Nebraska Geological Survey* 2: 219-237.

Bard E., B. Hamerlin, and R. G. Fairbanks
1990 U-Th Ages Obtained by Mass Spectrometry in Corals from Barbados: Sea Level During the Past 130,000 Years. *Nature* 346:456-458.

Bard, E., M. Arnold, P. Maurice, J. Dupart, J. Moyes, and J.C. Duplessy
1987 Retreat Velocity of the North Atlantic Polar Front During the Last Deglaciation Determined by ^{14}C Accelerator Mass Spectrometry. *Nature* 328:791-794.

Barnes, A.
1985 Modern Faunal Inventory of West-Central Colorado. In *Sisyphus Shelter*, by J. Gooding and W. L. Shields, pp. 209-232. Bureau of Land Management, Colorado, Cultural Resources Series 18. Denver.

Barnes, E. J.
1977 *The Calovich Burials (14WY7): Skeletal Analysis of a Plains Mississippian Population*. Unpublished Master's thesis, Wichita State University, Wichita.
1994 *Developmental Defects of the Axial Skeleton in Paleopathology*. University Press of Colorado, Niwot, Colorado.

Barnosky, C. W., E. C. Grim, and H. E. Wright, Jr.
1987 Towards a Postglacial History of the Northern Great Plains: a Review of the Paleoecological Problems. *Annals of Carnegie Museum* 56:259-273.

Barr, T. P.
1968 Appraisal of the Archeological Resources in the Cedar Point Reservoir, Chase County, Kansas. Ms. on file, U.S. Army Corps of Engineers, Kansas City.
1977 *An Archeological Inventory of the Fort Leavenworth Military Reservation*. Kansas State Historical Society, Topeka.

Barry, R. G.
1983 Climatic Environments of the Great Plains, Past and Present. In *Man and the Changing Environments in the Great Plains*, edited by W. W. Caldwell et al., pp. 45-55. Transactions of the Nebraska Academy of Sciences 11.

Bartlein, P. J., T. Webb, III, and E.C. Fleri
1984 Holocene Climatic Change in the Northern Midwest: Pollen-Derived Estimates. *Quaternary Research* 22:361-374.

Barton, B. S.
1797 *New Views of the Origin of the Tribes and Nations of America*. John Byron, Philadelphia.

Bass, W. M.
1957 Indian Skeletal Remains from Site 25FT13, Frontier County, Nebraska. Ms. on file, Department of Anthropology, National Museum of Natural History.
1961 1960 Excavations at the Leary Site, 25RH1, Richardson County, Nebraska. *Plains Anthropologist* 6(13):201-202.
1964 The Variation in Physical Types of the Prehistoric Plains Indians. *Plains Anthropologist* 9(24):65-145.
1973 Lansing Man: A Half Century Later. *American Journal of Physical Anthropology* 38(1):99-104.
1976 An Early Indian Cranium from the Medicine Crow Site, (39BF2), Buffalo County, South Dakota. *American Journal of Physical Anthropology* 45(3):695-700.
1981 Skeletal Biology of the United States Great Plains: A History and Personal Narrative. *Plains Anthropologist Memoir* 17:3-18.
1987 *Human Osteology. A Laboratory and Field Manual*, 3rd ed. Missouri Archaeological Society, Columbia.
1994 The Physical Anthropology of the Sully Site, 39SL4. Ms. on file, Department of Anthropology, University of Tennessee, Knoxville.

Bass, W. M., D. R. Evans, and R. L. Jantz
1971 *The Leavenworth Site Cemetery: Archaeology and Physical Anthropology*. Publications in Anthropology, No. 2. University of Kansas, Lawrence.

Bass, W. M., J. D. Featherstone, and P. Lin
1964 Skeletal Material from the Wiley Site (14OS312). In *Archaeological Investigations in Melvern Reservoir, Osage County, Kansas, 1962*, by P. S. Moore, W. H. Birkby and C. S. Smith, pp. 81-89. Museum of Anthropology, University of Kansas. Submitted to the Inter-Agency Archeological Service, National Park Service, U.S. Department of the Interior.

Bass, W. M. and J. H. Head
n.d. Skeletal Material from a Hopewell Mound (Middle Woodland Period), the Morris Site, 14MO314. Ms. on file, Department of Sociology and Anthropology, University of Kansas, Lawrence.

Bass, W. M. and R. L. Jantz

1965 Two Human Skeletons from 39LM227, A Mound Near the Striker Site, Lyman County, South Dakota. *Plains Anthropologist* 19(66):303-305.

Bass, W. M. and D. F. Nelson

1968 The Identification of an Adult Kansa Indian Male from the Doniphan Site, 14DP2, Doniphan County, Kansas. *Kansas Anthropological Society Newsletter* 13(8):4-11.

Bass, W. M. and Phenice, T. W.

1975 Prehistoric Human Skeletal Material from Three Sites in North and South Dakota. In *The Sonota Complex and Associated Sites on the Northern Great Plains,* edited by R. W. Neuman, pp. 106-140. Nebraska State Historical Society Publications in Anthropology, No. 6. Nebraska State Historical Society, Lincoln.

Bass, W. M. and M. D. Rucker

1976 *Preliminary Investigation of Artifact Association in an Arikara Cemetery (Larson Site), Walworth County, South Dakota.* National Geographic Society Research Reports 1968.

Bastian, T.

1979 Archaeological Investigations in the El Dorado Lake Area, Kansas. Ms. on file, U.S. Army Corps of Engineers, Kansas City.

Batie, S.

1970 We Dig Herby. *Nebraskaland* December:52-53.

Baugh, T. G.

1982 *Edwards I (34BK2): Southern Plains Adaptations in the Protohistoric Period.* Studies in Oklahoma's Past 8. Oklahoma Archeological Survey, Norman.

1984 Southern Plains Societies and Eastern Frontier Exchange During the Protohistoric Period. In *Collected Papers in Honor of Harry L. Hadlock,* edited by N. Fox, pp. 157-167. Papers of the Archaeological Society of New Mexico 9. Albuquerque.

1991 *The Avoca Site (14JN332): Excavation of a Grasshopper Falls Phase Structure, Jackson County, Kansas.* Archeology Publication 8. Kansas State Historical Society, Topeka.

Bauxar, J. J.

1947 Preliminary Appraisal of the Archeological and Paleontological Resources of Box Butte Reservoir, Dawes County, Nebraska. RBS-MBP-A. Ms. on file, Midwest Archeological Center, Lincoln.

Bauxar, J. J. and T. E. White

1986 Red Willow Creek Reservoir Frontier and Hayes Counties, Nebraska. SI-RBS. Ms. on file, National Parks Service, Midwest Archeological Center, Lincoln.

Bayne, C. K. and H. G. O'Connor

1968 Quaternary System. In *The Stratigraphic Succession in Kansas,* edited by D. E. Zeller, pp. 59-67. Kansas Geological Survey Bulletin 189.

Beardsley, R. K., P. Holder, A. Krieger, B. Meggers, J. Rinaldo, and P. Kutsche

1956 Functional and Evolutionary Implications of Community Patterning. In Seminars in Archaeology, 1955. *Society for American Archaeology Memoir* 11:129-157.

Beauregard, H. T. (editor)

1912 Journal of Jean Baptiste Trudeau among the Arikara Indians in 1795. *Missouri Historical Society Collection* 4:9-48.

Beck, M. E.

1995 *"Mississippian" Ceramics in the Central Plains Tradition: Petrographic Analysis and Interpretive Models.* Unpublished Master's thesis, Department of Anthropology, University of Kansas.

Behrensmeyer, A. K. and A. Hill (editors)

1980 *Fossils in the Making.* University of Chicago Press, Chicago.

Behrensmeyer, A. K. and S. M. Kidwell

1985 Taphonomy's Contributions to Paleobiology. *Paleobiology* 11(1):105-119.

Bell, E. H. and G. H. Gilmore

1936 The Nehawka and Table Rock Foci of the Nebraska Aspect. In *Chapters in Nebraska Archaeology,* vol. 1, edited by E. H. Bell, pp. 301-355. University of Nebraska, Lincoln.

Bell, P.

1976 *Spatial and Temporal Variability within the Trowbridge Site, a Kansas City Hopewell Village.* Unpublished Master's thesis, Department of Anthropology, University of Kansas, Lawrence.

Bell, R. E.

1958 *Guide to the Identification of Certain American Indian Projectile Points.* Special Bulletin 1 of the Oklahoma Anthropological Society. Oklahoma City.

1977 Early Man Points from Tulsa County. *Oklahoma Anthropological Society Newsletter* 25(1):9.

Bell, R. E. and D. Baerreis

1951 A Survey of Oklahoma Archaeology. *Bulletin of the Texas Archaeological and Paleontological Society* 22:7-100.

Bellande, D. T. and D. J. White

n.d. A Preliminary Analysis of the Osteological Remains Excavated from the Larson Site (25PT1 and 25PT31). Ms. on file, University of Nebraska, Lincoln.

Bement, L. C.

1994a The Cooper Site: A Stratified Paleoindian Bison Kill in Northwest Oklahoma. *Current Research in the Pleistocene* 11:7-9.

1994b The Cooper Site: A Stratified Folsom Bison Kill in Oklahoma. Paper presented at the 52nd Annual Plains Anthropological Conference, Lubbock.

1995 The Retooling Index, Seasonality, and the Folsom-Age Cooper Bison Kill. *Current Research in the Pleistocene* 12:61-62.

Bender, M. M., D. A. Baerreis, and R. L. Steventon

1981 Further Light on Carbon Isotopes and Hopewell Agriculture. *American Antiquity* 46:348-353.

Benedict, J. B.

1973 Chronology of Cirque Glaciation, Colorado Front Range. *Quaternary Research* 5:584-599.

1975 The Albion Boardinghouse Site: Archaic Occupation of a High Mountain valley. *Southwestern Lore* 41(3):1-12.

1978 The Mount Albion Complex: Review and Summary. In *The Mount Albion Complex, A Study of Prehistoric Man and the Altithermal,* by J. B. Benedict and B. L. Olson, pp. 118-138. Research Report 1, Center for Mountain Archaeology, Ward, Colorado.

1979 Getting Away From It All: A Study of Man, Mountains, and the Two-Drought Altithermal. *Southwestern Lore* 45(3):1-12.

1981 *The Fourth of July Valley.* Research Report No. 2. Center for Mountain Archaeology, Ward.

1992 Along the Great Divide: Paleoindian Archaeology of the High Colorado Front Range. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 343-359. University Press of Colorado, Niwot.

Benedict, J. B. and B. L. Olson

1973 Origin of the McKean Complex: Evidence from the Timberline. *Plains Anthropologist* 18(62):323-327.

1978 *The Mount Albion Complex—A Study of Prehistoric Man and the Altithermal.* Research Report of the Center for Mountain Archaeology 1.

Benn, D. W.

1981 Archaeology of the M.A.D. Sites in Denison, Iowa. Ms on file, Bureau of Historic Preservation, State Historical Society of Iowa, Des Moines.

1983 Diffusion and Acculturation in Woodland Cultures on the Western Prairie Peninsula. In *Prairie Archaeology,* edited by G. Gibbon. Publication in Anthropology 3. University of Minnesota, Minneapolis.

Benn, D. W. (editor)

1990 *Woodland Cultures on the Western Prairies: The Rainbow Site Investigations.* Office of the State Archaeologist Report 18. University of Iowa, Iowa City.

Bernabo, J. C. and T. Webb, Jr.

1977 Changing Patterns in the Holocene Pollen Record of Northeastern North America: A Mapped Summary. *Quaternary Research* 8:64-96.

Berry, J. J.

1978 *Arikara Middlemen: The Effects of Trade on an Upper Missouri Society.* Unpublished Ph.D. dissertation, Department of Anthropology, Indiana University, Bloomington.

Berryman, H. E., D. W. Owsley, and A. M. Henderson

1979 Non-Carious Interproximal Grooves in Arikara Dentition. *American Journal of Physical Anthropology* 50(2):209-212.

Bettinger, R. L.

1991 *Hunter-Gatherers. Archaeological and Evolutionary Theory.* Plenum Press, New York.

Bettis, E. A.,III, and D. W. Benn

1984 An Archaeological and Geomorphological Survey in the Central Des Moines Valley, Iowa. *Plains Anthropologist* 29:211-226.

Billeck, W. T.

1993 *Time and Space in the Glenwood Locality: The Nebraska Phase in Western Iowa.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Missouri.

Binford, L. R.

1962 Archaeology as Anthropology. *American Antiquity* 28: 217-225.

1967 Smudge Pits and Hide Smoking: The Use of Analogy in Archaeological Reasoning. *American Antiquity* 32:1-12.

1968 Archeological Perspectives. In *New Perspectives in Archaeology*, edited by S. R. Binford and L. R. Binford, pp. 5-32. Aldine, Chicago.

1978 *Nunamiut Ethnoarcheology.* Academic Press, New York.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35(3):255-273.

1980 Willow Smoke and Dog's Tails: Hunter Gatherer Settlement Systems and Archaeological Site Formation Processes. *American Antiquity* 45(1):4-20.

1981 *Bones: Ancient Men and Modern Myths.* Academic Press, New York.

1983 Long Term Land Use Patterns: Some Implications for Archaeology. In *Lulu Linear Punctated: Essays in Honor of George Irving Quimby*, edited by R. C. Dunnell and D. Grayson, pp. 27-53. Anthropological Papers 72, Museum of Anthropology, University of Michigan, Ann Arbor.

1987 Were There Elephant Hunters at Torralba? In *The Evolution of Human Hunting*, edited by M. H. Nitecki and D. V. Nitecki, pp. 47-105. Plenum Press, New York.

1989 *Debating Archaeology.* Academic Press, New York.

1991 When the Going Gets Tough, The Tough Get Going: Nunamiut Local Groups, Camping Patterns and Economic Organization. In *Ethnoarchaeological Approaches to Mobile Campsites*, edited by C. S. Gamble and W. A. Boismier, pp. 25-137. International Monographs in Prehistory, Ethnoarchaeological Series 1. Ann Arbor.

Binford, L. R. and W. J. Chasko, Jr.

1976 Nunamiut Demographic History: A Provocative Case. In *Demographic Anthropology, Quantitative Approaches*, edited by E. B. W. Zubrow, pp. 63-144. School of American Research, University of New Mexico Press, Albuquerque.

Birkeland, P. W.

1984 *Soils and Geomorphology.* Oxford University Press.

Birmingham, W. W. and T. R. Hester

1976 *Late Pleistocene Archaeological Remains from the Johnston-Heller Site, Texas Coastal Plain.* Special Report 3. Center for Archaeological Research, the University of Texas at San Antonio.

Black, F. L.

1966 Measles Endemicity in Insular Populations: Critical Community Size and Its Evolutionary Implication. *Journal of Theoretical Biology* 11:207-211.

1975 Infectious Diseases in Primitive Societies. *Science* 187: 515-518.

Black, K.

1991 Archaic Continuity in the Colorado Rockies: The Mountain Tradition. *Plains Anthropologist* 36(133):1-29.

Blackman, E. E.

1903 Report of Department of Archaeology. *Annual Report of the Nebraska State Board of Agriculture for 1902*:294-326.

1905 Report of Department of Archaeology for 1903 and 1904. *Annual Report of the Nebraska State Board of Agriculture for 1904*:207-229.

1906 Report of Department of Archaeology for 1905. *Annual Report of the Nebraska State Board of Agriculture for 1905*:390-400.

1907 Prehistoric Man in Nebraska. *Records of the Past* 6(3):76-79.

1924 Historical Society Radio, with an Account of Exploration of Aboriginal Remains in the Loup Valley. *Nebraska History Magazine* 7(1):1-8.

Blaeuer, M. W. and J. C. Rose

1982 Bioarcheology of the Powell Canal Site. In *Powell Canal*, by J. H. House, pp. 72-84. Arkansas Archeological Survey, Fayetteville.

Blaine, J.

1968 A Preliminary Report of an Early Man Site in West Texas. *Transactions of the Third Regional Archaeological Symposium for Southeastern New Mexico and Western Texas*, pp. 1-11. South Plains Archaeological Society, Lubbock.

1991 The Folsom-Midland Controversy. *Proceedings of the 27th Annual Meeting of the Southwest Federation of Archaeological Societies.* Midland.

Blaine, J. C. and F. Wendorf

1972 A Bone Needle from a Midland Site. *Plains Anthropologist* 17:50-51.

Blakeslee, D. J.

1975 *The Plains Interband Trade System.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Wisconsin, Milwaukee.

1978 Assessing the Central Plains Tradition in Eastern Nebraska. In *The Central Plains Tradition: Internal Development and External Relationships*, edited by D. J. Blakeslee, pp. 134-143. Office of the Iowa State Archaeologist, Report 11.

1979 Hillsdale Lake Archaeology: New Information for Northeastern Kansas. Paper presented at the 37th Plains Conference, Kansas City.

1981a The Origin and Spread of the Calumet. *American Antiquity* 46(1):759-768.

1981b Toward a Cultural Understanding of Human Microevolution on the Great Plains. In *Progress in Skeletal Biology of Plains Populations*, edited by R. L. Jantz and D. H. Ubelaker, pp. 93-106. Plains Anthropologist 26(94), pt. 2, Memoir 17.

1987 John Ronzee Peyton and the Myth of the Mound Builders. *American Antiquity* 52(4):784-792.

1989 On Estimating Household Populations in Archaeological Sites, with an Example from the Nebraska Phase. In *Plains Indian Historical Demography and Health: Perspectives, Interpretations, and Critiques*, edited by G. R. Campbell, pp. 3-16. Plains Anthropologist 34(124), pt. 2, Memoir 23.

1990 A Model for the Nebraska Phase. *Central Plains Archaeology* 2(1):29-56.

1991 Glen Elder Revisited: Settlement Patterns and Cultural Sequence on the Solomon River. Paper presented at the 49th Annual Plains Anthropological Conference, Lawrence.

1992 Radiocarbon Dating and the Solomon River Debate. Paper presented at the 50th Plains Anthropological Conference, Lincoln.

1993 Modeling the Abandonment of the Central Plains: Radiocarbon Dates and the Origin of the Initial Coalescent. In *Prehistory and Human Ecology of the Western Prairies and Northern Plains*, edited by J. A. Tiffany, pp. 199-214. Plains Anthropologist, 38(145), Memoir 27.

1994a Reassessment of Some Radiocarbon Dates from the Central Plains. *Plains Anthropologist* 39(148):203-210.

1994b A Radiocarbon Chronology for the Central Plains Tradition? Paper presented at the 52nd Plains Anthropological Conference, Lubbock, Texas.

1994c The Archaeological Context of Human Skeletons in the Northern and Central Plains. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence*, edited by D. W. Owsley and R. L. Jantz, pp. 9-32. Smithsonian Institution Press, Washington, D.C.

Blakeslee, D. J. (editor)

1988 *St. Helena Archaeology: New Data, Fresh Interpretations.* J & L Reprints in Anthropology 39. Lincoln.

Blakeslee, D. J. and W. W. Caldwell

1979 *The Nebraska Phase*. J & L Reprints in Anthropology 18. Lincoln.

Blakeslee, D. J., J. Hotopp, K. Lippincott, J. Ludwickson, and T. Witty

1982 Some Responses to Krause. *Plains Anthropologist* 27(95):83-90.

Blakeslee, D. J. and A. H. Rohn

1982 *Man and Environment in Northeastern Kansas: The Hillsdale Lake Project.* Archeology Laboratory, Wichita State University. Submitted to the U.S. Army Corps of Engineers, Tulsa District.

Blakeslee, D. J. and J. O'Shea

1983 *The Gorge of the Missouri: An Archaeological Survey of Lewis and Clark Lake, Nebraska and South Dakota.* Archeology Laboratory, Wichita State University. Submitted to the U.S. Army Corps of Engineers, Omaha District.

Blasingham, E. J.

1963 Appraisal of the Archeological Resources of the Norton Reservoir. Ms. on file, SI-RBS, Lincoln.

Bliss, W. L.

n.d. Bonny Reservoir, Yuma County, Colorado. Ms. on file, SI-RBS, Lincoln.

1948 Preliminary Appraisal of the Archeological and Paleontological Resources of the Proposed Reservoirs in the Smoky Hill Sub-Basin. Ms. on file, SI-RBS-MBP, U.S. Army Corps of Engineers, Omaha.

1950 Early and Late Lithic Horizons on the Plains. In *Proceedings of the Sixth Plains Archeological Conference (1948)*, edited by J. D. Jennings, pp. 108-116. University of Utah Publications in Anthropology 11.

Boellstorff, A.

1978 Chronology of Some Late Cenozoic Deposits from the Central United States and the Ice Ages. *Nebraska Academy of Sciences Transactions* 6:35-49.

Boldurian, A. T.

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

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

Boldurian, A. T. and S. M. Hubinsky

1994 Preforms in Folsom Lithic Technology: A View from Blackwater Draw, New Mexico. *Plains Anthropologist* 39(150):445-464

Bonnichsen, R.

1991 Clovis origins. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp. 309-329. Center for the Study of the First Americans, Oregon State University, Corvallis.

Bonnichsen, R., M. Beaty, M. D. Turner, J. C. Turner, and D. Douglas

1992 Paleoindian Lithic Procurement at the South Fork of Everson Creek, Southwestern Montana: A Preliminary Statement. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 285-321. Colorado University Press, Niwot.

Bonnichsen, R., M. Beaty, M. D. Turner, J. C. Turner, and M. Stoneking

1994 What Can Be Learned from Hair? A Hair Record from the Mammoth Meadows Locus, Southwestern Montana. In *Prehistoric Mongoloid Dispersions*, edited by T. Akazawa and E. Szathmary, Oxford University Press.

Bonnichsen, R. and J. Keyser

1982 Three Small Points: A Cody Complex Problem. *Plains Anthropologist* 27:137-144.

Bonnichsen, R., D. G. Rice, D. Brauner, and G. Curtis

1994 Human Adaptation at the Southern Margin of the Laurentide and Cordilleran Ice Sheets. *Current Research in the Pleistocene* 11:116-118.

Bonnichsen, R. and M. H. Sorg (editors)

1989 *Bone Modification.* Center for the Study of the First Americans, Oregon State University, Corvallis.

Bonnichsen, R., D. J. Stanford, and J. L. Fastook

1987 Environmental Change and Developmental History of Human Adaptation Patterns; The Paleoindian Case. In *North America and Adjacent Oceans During the Last Deglaciation: The Geology of North America, vol. K-3*, edited by W. F. Ruddiman and H. E. Wright, Jr., pp. 403-424. Geological Society of America, Boulder.

Bonnichsen, R. and D. G. Steele (editors)

1994 *Method and Theory for Investigating the Peopling of the Americas.* Center for the Study of the First Americans, Department of Anthropology, Oregon State University. Corvallis.

Bonnichsen, R. and K. L. Turnmire (editors)

1991 *Clovis Origins and Adaptations.* Center for the Study of the First Americans, Department of Anthropology, Oregon State University. Corvallis.

Borchert, J. R.

1950 Climate of the Central North American Grasslands. *Annals of the Association of American Geographers* 40:1-39.

1971 The Dust Bowl in the 1970s. *Annals of the Association of American Geographers* 61:1-22.

Boserup, E.

1965 *The Conditions of Agricultural Growth, The Economics of Agrarian Change under Population Pressure.* Aldine Publishing Company. Chicago.

Bowman, M. W.

1985 *A Disparity in the Rate of Later Channel Cutting Between Two Reaches of the Kansas River.* Master's thesis, University of Kansas, Lawrence.

Bowman, P. W.

1960 *Coil-Oil Canyon (14LO1): Report on the Preliminary Investigations.* Bulletin of the Kansas Anthropological Association.

Boyd, R. and P. J. Richerson

1985 *Culture and the Evolutionary Process.* University of Chicago Press.

Bozarth, S. R.

1996 *Pollen and Opal Phytolith Evidence of Prehistoric Agriculture and Wild Plant Utilization in the Lower Verde River Valley, Arizona.* Unpublished Ph.D. dissertation, University Of Kansas, Lawrence

Bozell, J. R.

1991 Fauna from the Hulme Site and Comments on Central Plains Tradition Subsistence Variability. *Plains Anthropologist* 36(136):229-254.

1994 Big Game Hunters, The Ice Age and the First Immigrants. In *Cellars of Time, Nebraska History Magazine* 75(1):85-93.

1995 Culture, Environment, and Bison Populations on the Late Prehistoric and Early Historic Central Plains. *Plains Anthropologist* 40(152):145-164.

Bozell, J. R. and M. K. Rogers

1985 Vertebrate Remains Recovered from the Great Oasis Component at the Bill Packer Site (25SM9), Sherman County, Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.

Bozell, J. R., L. M. Snyder, and C. R. Falk

1982 *Descriptive Analysis of Unmodified Vertebrate Remains Recovered from the Schuyler Site (25CX1), Colfax County, Nebraska.* Technical Report.82-06. Division of Archaeological Research, University of Nebraska.

Bozell, J. R. and J. Winfrey

1994 A Review of Middle Woodland Archaeology in Nebraska. *Plains Anthropologist* 39(148):125-144.

Bradbury, J. P.

1980 *Late Quaternary Vegetation History of the Central Great Plains and its Relationship to Eolian Processes in the Nebraska Sand Hills.* U.S. Geological Survey, Professional Paper 1120-C.

Bradley, B. A.

1982 Flaked Stone Technology and Typology. In *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains,* edited G. C. Frison and D. J. Stanford, pp. 181-208. Academic Press, New York.

1991 Lithic Technology. In *Prehistoric Hunters of the High Plains,* by G. C. Frison, pp. 369-396. Academic Press, San Diego.

1993 Paleo-Indian Flaked Stone Technology in the North American High Plains. In *From Kostenki to Clovis,* edited by O. Soffer and N. D. Praslov, pp. 251-262. Plenum Press, New York.

Bradley, B. A. and G. C. Frison

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

Bradley, B. A. and D. J. Stanford

1987 The Claypool Study. In *The Horner Site, The Type Site of the Cody Cultural Complex,* edited by G. C. Frison and L. C. Todd, pp. 405-434. Academic Press, Orlando.

Bradley, L. E.

1968 Archeological Investigations in the Melvern Reservoir, Osage County, Kansas 1967. Ms. on file, U.S. Army Corps of Engineers, Kansas City.

1969 Archaeological Investigations in the Fort Scott Reservoir, Bourbon County, Kansas 1967: A Preliminary Report. Ms. on file, National Parks Service, Midwest Archeological Center, Lincoln.

1973 *Subsistence Strategy at a Late Archaic Site in South-Central Kansas.* Unpublished Master's thesis, University of Kansas, Lawrence.

Bradley, L. E. and D. Harder

1969 Archaeological Excavations in the Fort Scott Reservoir Area, Southeastern Kansas. Ms. on file, National Parks Service Midwest Archeological Center, Lincoln.

1974 Archeological Investigations in the Fort Scott Reservoir Area, Southeastern Kansas. University of Kansas for the National Park Service. Ms. on file, Museum of Anthropology, University of Kansas, Lawrence.

Bradley, R. S.

1985 *Quaternary Paleoclimatology: Methods of Paleoclimatic Reconstruction.* Boston, Allen & Unwin.

Bradtmiller, B.

1984 Congenital Anomalies of the Lower Spine in Two Arikara Skeletal Series. *Plains Anthropologist* 29(106):327-333.

Brakenridge, G. R.

1980 Widespread Episodes of Stream Erosion During the Holocene and Their Climatic Cause. *Nature* 283:655-656.

1981 Late Quaternary Flood Sedimentation along the Pomme de Terre River, Southern Missouri. *Quaternary Research* 15:62-76.

Braun, D. P.

1981 Pots as Tools. In *Archaeological Hammers and Theories,* edited by J. A. Moore and A. S. Keene, pp. 107-134. Academic Press, New York.

Breternitz, D. A. (editor)

1971 Archaeological Investigations at the Wilbur Thomas Shelter, Carr, Colorado. *Southwestern Lore* 36(4):66-79.

Breternitz, D. A., T. G. Birkedal, D. W. Martin, and D. D. Scott

1970 Archeological Appraisal of Proposed West Bijou, East Bijou, and Big Muddy Reservoirs, Arapahoe and Adams Counties, Colorado. Ms. on file, Adams County Planning Department, Commerce City.

Breternitz, D. A., A. C. Swedlund, and D. C. Anderson

1971 An Early Burial from Gordon Creek, Colorado. *American Antiquity* 36(2):170-182.

Brice, J. C.

1964 *Channel Patterns and Terraces of the Loup Rivers in Nebraska.* U.S. Geological Survey Professional Paper 422:D.

1966 Erosion and Deposition in the Loess-Mantled Great Plains, Medicine Creek Drainage Basin, Nebraska. *U.S .Geological Survey Professional Paper* 352-H:255-339.

Brockington, P. E., Jr.

1977 *Culture Drift and Kansas City Hopewell Stone Tool Variability: A Multisite Analysis.* Ph.D. dissertation, University of Kansas. University Microfilms, Ann Arbor.

Brockington, P. E. Jr., A. E. Johnson, M. Adair, E. Anderson, and J. A. Artz (compilers)

1982 Archaeological Investigation at El Dorado Lake, Butler County, Kansas (Phase III). Ms. on file, National Parks Service, Midwest Archaeological Center, Lincoln.

Broecker, W. S., M. Andre, W. Wolfli, H. Oeschger, G. Bonani, J. Kennett, and D. Peteet

1988 The Chronology of the Last Deglaciation: Implications for the Cause of the Younger Dryas Event. *Paleoceanography* 3:1-19.

Broecker, W. S., J. P. Kennett, B. P. Flower, J. T. Teller, S. Trumbore, G. Bonani, and W. Wolfli

1989 Routing of Melt Water from the Laurentide Ice Sheet during the Younger Dryas Cold Episode. *Nature* 341:318-321.

Brogan, W. T.

1980 Archaeological Investigations at Elk City Lake, Kansas. Ms. on file, Midwest Archeological Center, Lincoln.

1981 *The Cuesta Phase: A Settlement Pattern Study.* Kansas State Historical Society Series 9, Topeka.

1982 *The Roth Site: An Early Pomona Focus Manifestation in Eastern Kansas.* Kansas State Historical Society, Contract Archeology Publication No. 1.

Brower, J. V.

1898 *Quivira.* Memoir Explorations in the Basin of the Mississippi, vol. 1, St. Paul.

1899 *Harahey.* Memoir Explorations in the Basin of the Mississippi, vol. 1, St. Paul.

Brown, J. A. and R. K. Vierra

1983 What Happened in the Middle Archaic? Introduction to an Ecological Approach to Koster Site Archaeology. In *Archaic Hunters and Gatherers in the American Midwest,* edited by J. L. Phillips and J. A. Brown, pp. 165-195. Academic Press, New York.

Brown, K. L.

1975 Summary Table of Identified Faunal Remains from the Aker Site (23PL43). Ms. on file, Museum of Anthropology, University of Kansas, Lawrence.

1984 *Pamona: A Plains Village Variant in Eastern Kansas and Western Missouri.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Kansas.

Brown, K. L., D. Evans, and M. Rucker

1974 An Appraisal of the Archeological Resources of the Big Sugar Creek Watershed, Anderson and Linn Counties, Kansas. Ms. on file, National Parks Service, Midwest Archaeological Center, Lincoln.

Brown, K. L. and B. Logan

1987 The Distribution of Paleoindian Sites in Kansas. In *Quaternary Environments of Kansas*, edited by W. C. Johnson, pp. 189-195. Kansas Geological Survey Guide Book Series, Lawrence.

Brown, K. L. and A. H. Simmons

1987 *Kansas Prehistoric Archaeological Preservation Plan*. Office of Archaeological Research, Museum of Anthropology, and Center for Public Affairs, Lawrence.

Brown, K. L. and R. J. Ziegler (assemblers)

1985 *Prehistoric Cultural Resources within the Right-of-Way of the Proposed Little Blue River Channel.* Museum of Anthropology, University of Kansas, Lawrence. Submitted to the U.S. Army Corps of Engineers, Kansas City District.

Brown, L. A.

1966 Temporal and Spatial Order in the Central Plains. *Plains Anthropologist* 11(34):294-301.

1967 *Pony Creek Archaeology.* River Basin Survey Publications in Salvage Archeology 5.

1968 The Gavins Point Site (39YK203). *Plains Anthropologist* 13(40):118-127.

Brown, M. E.

1982 *Cultural Behavior as Reflected in the Vertebrate Faunal Assemblages of Three Smoky Hill Sites.* Unpublished Master's thesis, University of Kansas.

Brumley, J. B.

1975 *The Cactus Flower Site in Southeastern Alberta: 1972-1974 Excavations.* National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper 46. Ottawa.

1978 McKean Complex Subsistence and Hunting Strategies in the Southern Alberta Plains. In *Bison Procurement and Utilization: A Symposium,* edited by L. B. Davis and M. Wilson, pp. 175-193. Plains Anthropologist Memoir 14.

Brush, G. S.

1967 Pollen Analysis of Late Glacial and Postglacial Sediments in Iowa. In *Quaternary Paleoecology,* edited by E. J. Cushing and H. E. Wright, pp. 99-115. Yale University Press, New Haven.

Bryan, A. L.

1986 Paleoamerican Prehistory as Seen from South America. In *New Evidence for the Pleistocene Peopling of the Americas,* edited by A. Bryan, pp. 1-14.

1991 The Fluted-Point Tradition in the Americas—One of Several Adaptations to Late Pleistocene American Environments. In *Clovis Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 15-33. Center for the Study of the First Americans, Department of Anthropology, Oregon State University, Corvallis.

Bryan, A. L. (editor)

1978 *Early Man in America from a Circum-Pacific Perspective.* Occasional Papers No. 1. Department of Anthropology, University of Alberta, Edmonton.

1986 *New Evidence for the Pleistocene Peopling of the Americas.* Center for the Study of Early Man, University of Maine, Orono.

Bryan, K.

1937 Geology of the Folsom Deposits in New Mexico and Colorado. In *Early Man,* edited by G. G. MacCurdy, pp. 139-152. J. B. Lippincott, Philadelphia.

Bryan, K. and L. Ray

1940 *Geologic Antiquity of the Lindenmeier Site in Colorado.* Smithsonian Miscellaneous Collections 99(2).

Bryson, R. A.

1966 Air Masses, Streamlines, and the Boreal Forest. *Geographical Bulletin* 8 (3):228-269.

1974 A Perspective on Climatic Change. *Science* 184:753-760.

Bryson, R. A. and D. A. Baerreis

1968 Introduction and Project Summary. In *Climatic Change and the Mill Creek Culture of Iowa,* edited by D. R. Henning, pp. 1-34. Journal of the Iowa Archaeological Society 15.

Bryson, R. A., D. A. Baerreis, and W. M. Wendland

1970 The Character of Late-Glacial and Post-Glacial Climatic Changes. In *Pleistocene and Recent Environments of the Central Great Plains,* edited by W. Dort, Jr. and J. K. Jones, Jr., pp. 53-74. University of Kansas Press, Lawrence.

Bryson, R. A. and C. Padoch

1980 On the Climates of History. *Journal of Interdisciplinary History* 10(4):583-597.

Bryson, R. A. and W. Wendland

1967 Tentative and Climatic Patterns for Some Late Glacial and Post-Glacial Episodes in Central North America. In *Life, Land and Water,* edited by W. J. Mayer-Oakes. University of Manitoba Press.

Bubniak, E. R. and J. W. Verano

1993 Report on Documentation of Additional Skeletal Remains Associated with the Loup River Phase and Central Plains Tradition Claimed by the Pawnee Tribe. Ms. on file, National Museum of Natural History Repatriation Office, Smithsonian Institution, Washington, D.C.

Buchner, A. P. and L. F. Pettipas

1990 The Early Occupations of the Glacial Lake Agassiz Basin in Manitoba; 11,500-7,700 B.P. In *Archaeological Geology of North America,* edited by N. P. Laska and J. Donahue, pp. 51-59. Geological Society of America Centennial Volume 4. Boulder.

Burgess, S.

1994 Warfare in North Eastern Nebraska. Paper presented at the Paleopathology Association Annual Meeting, Denver.

Burgh, R. F.

1947 Preliminary Report on Archeological and Paleontological Remains in Reservoir Areas of the Colorado-Big Thompson Project, Northern Colorado. SI-RBS. Ms. on file, Bureau of Reclamation, Upper Colorado Region, Salt Lake City.

n.d. Final Appraisal of the Archeological and Paleontological Resources of Granby Reservoir, Grand County, Colorado. Ms. on file, SI-RBS, Lincoln.

Burnet, M. and D. O. White

1972 *Natural History of Infectious Disease* (4th edition). Cambridge University Press, London.

Butler, B. R.

1963 An Early Man Site at Big Camas Prairie, Southcentral Idaho. *Tebiwa* 6:22-33.

Butler, B. R. and R. J. Fitzwater

1965 A Further Note on the Clovis Site at Big Camas Prairie, Southcentral Idaho. *Tebiwa* 8:38-40.

Butler, R. J.

1969 *The Helicoidal Pattern of Dental Attrition in a Protohistoric Arikara Skeletal Population from the Northern Plains.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Kansas, Lawrence.

1972 Age-related Variability in Occlusal Wear Planes. *American Journal of Physical Anthropology* 36(3):381-390.

Butler, W. B.

1986 *Taxonomy in Northeastern Colorado Prehistory.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Missouri, Columbia.

1988 The Woodland Period in Northeastern Colorado. *Plains Anthropologist* 33(122):449-465.

Button, V. T. and G. A. Agogino
1987 Human Skeletal material Exposed by Reservoir-Induced erosion at Lake Altus, Southwestern Oklahoma. *Bulletin of the Oklahoma Anthropological Society* 36:15-38. Norman.

Butzer, K.
1980 *Archaeology as Human Ecology*. Cambridge University Press.
1982 *Archaeology as Human Ecology*. Cambridge University Press.

Caffey, J.
1967 *Pediatric X-Ray Diagnosis*. 5th ed. Yearbook Publishers, Chicago, Illinois.

Calabrese, F. A.
1965 Summary of the Archeological Salvage in the Upper Verdigris Watershed Project. *Kansas Anthropological Association Newsletter* 119:10.
1966a Archeological Survey in the Upper Verdigris Watershed. *Plains Anthropologist* 11(32).
1966b Archeological Survey of the Walnut Creek Watershed, Brown County, Kansas. Ms. on file, SI-RBS, Lincoln.
1966c Appraisal of the Archaeological Resources of the Upper Black Vermillion Watershed, Marshall, Nemaha, and Pottawatomie Counties, Kansas, December, 1966. Ms. on file, Kansas State Historical Society, Topeka.
1967a *Archeological Survey of the Upper Black Vermillion Watershed, Marshall, Nemaha, and Pottawatomie Counties, Kansas*. Kansas Anthropological Association Newsletter 12(7).
1967b The Archeology of the Upper Verdigris Watershed. Ms. on file, KSHS-AS 3, SI-RBS, Lincoln.
1967c A Keith Focus Woodland Component at the Curry Site, 14GR301. *Kansas Anthropological Association Newsletter* 12(8).
1969a *Doniphan Phase Origins*. National Park Service, Midwest Region, Lincoln.
1969b Mowry Bluff and Nuzum Artifacts: Ground Stone. In *Two House Sites in the Central Plains: An Experiment in Archaeology*, edited by W. R. Wood, pp. 34-39, 77-78. Plains Anthropologist 14(44), pt 2, Memoir 6.
1974 *Archaeological Investigation in the Smithville Reservoir Area, Missouri, 1969*. Department of Anthropology, University of Missouri, Columbia. Submitted to the National Park Service, Midwest Region.

Caldwell, W. W., C. B. Schultz, and T. M. Stout
1983 *Man and the Changing Environments in the Great Plains: A Symposium*. Transactions of the Nebraska Academy of Sciences and Affiliated Societies, XI, Special Issue, Lincoln.

Campbell, R. G.
1976 *The Panhandle Aspect of the Chaquaqua Plateau*. Texas Tech University Graduate Studies 11, Lubbuck.

Carlisle, R. C. (editor)
1988 *Americans Before Columbus: Ice-Age Origins*. Ethnology Monographs Number 12. Department of Anthropology, University of Pittsburgh.

Carlisle, R. C. and J. M. Adovasio (editors)
1982 *Meadowcroft: Collected Papers on the Archaeology of Meadowcroft Rockshelter and the Cross Creek Drainage*. Department of Anthropology, University of Pittsburgh.

Carlson, G. F.
1967 1966 Excavations at the Sumter Site (14OB27) in the Glen Elder Reservoir, North Central Kansas. *Plains Anthropologist* 12 (36).
1971 *Local Sequence for Upper Republican Sites in the Glen Elder Reservoir Locality , Kansas*. Unpublished Master's thesis. Department of Anthropology, University of Nebraska, Lincoln.
1976 Archaeological Salvage Investigations at Santee, Nebraska. Ms. on file, Nebraska State Historical Society.
1979 *Archeological Investigations at Fort Atkinson (25WN9), Washington County, Nebraska, 1956-1971*. Nebraska State Historical Society Publications in Anthropology 8.
1994 The Foragers, Diversified Lifestyle. *Cellars of Time, Nebraska History Magazine* 75(1):95-106.

Carlson, G. F. and R. E. Jensen
1973 *Archeological Salvage and Survey in Nebraska*. Nebraska State Historical Society, Publications in Anthropology 5. Lincoln.

Carlson, G. F. and T. L. Steinacher
1978 A Preliminary Culture-Historical Sequence for the Plains Archaic Period in Nebraska. Paper presented at the TERQUA, Institute for Tertiary and Quaternary Studies Meeting, Lincoln.

Carlson, R. L.
1965 *Eighteenth Century Navajo Fortresses of the Governador District*. University of Colorado Studies Series in Anthropology 10. Boulder.

Carrillo, R. F.
1969a 14MM7: An Archaeological Site in the Hillsdale Reservoir Area, Eastern Kansas. *Kansas Anthropological Association Newsletter* 19(3/4):1-34
1969b An Archaeological Survey of the Hillsdale Reservoir Area in Southwest, Kansas, 1969. Ms. on file, Kansas State Historical Society, Topeka.

Cashion, M. A.
1987 *A Diachronic Assessment of Stress Indicators in Three Plains American Indian Populations*. Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

Caspall, F. C.
1970 *The Spatial and Temporal Variations in Loess Deposition in Northeastern Kansas*. Unpublished Ph.D. dissertation, University of Kansas.
1972 A Note on the Origin of the Brady Paleosol in Northeastern Kansas. *Proceedings of the Association of American Geographers* 4:19-24.

Cassells, E. S.
1983 *The Archaeology of Colorado*. Johnson Books, Boulder.

Chamberlin, T. C.
1902 The Geological Relations of the Human Relics of Lansing. *Kansas Journal of Geology* 10(7):745-779.
1919 Investigation Versus Propagandism. *Journal of Geology* 27: 305-338.

Chambers, K. and R. R. Purdue
1994 Genetics of Past Populations: The Analysis of mtDNA from Archaeological Bison. Paper presented at the 59th annual meeting of the Society for American Archaeology, Anaheim.

Chambers, M. E.
1977 Clinton Lake, Kansas 1977: Background Archeological and Historical Site Data. Ms. on file, Museum of Anthropology, University of Kansas, Lawrence.

Chambers, M. E., S. K. Tomkins, R. L. Humphrey, C. R. Brooks, and B. W. Poirier (compilers)
1977 *The Cultural Resources of Clinton Lake Kansas: An Inventory of Archeology, History and Architecture*. Iroquois Research Institute, Fairfax, Virginia. Submitted to U.S. Army Corps of Engineers, Kansas City District.

Champe, J. L.
1936 The Sweetwater Culture Complex. In *Chapters in Nebraska Archaeology*, vol. 1, edited by Earl H. Bell, pp. 249-300. University of Nebraska, Lincoln.
1946 *Ash Hollow Cave, A Study of Stratigraphic Sequence in the Central Great Plains*. University of Nebraska Studies, New Series 1. Lincoln.
1950 Archaeological Investigations in the Harlan County Reservoir. Ms. on file, SI-RBS, Lincoln.

Chapman, C. H.
1975 *The Archaeology of Missouri, 1*. University of Missouri Press, Columbia.

1980 *The Archaeology of Missouri, II.* University of Missouri, Columbia.

Chapman, J. and G. Crites

1987 Evidence for Early Maize *(Zea mays)* from the Icehouse Bottom Site, Tennessee. *American Antiquity* 52:352-354.

Chardon, F. A.

1932 *Chardon's Journal at Fort Clark, 1834-1839.* South Dakota State Department of History, Pierre.

Chism, J. V.

1966 Appraisal of the Archeological Resources of the Clinton Reservoir, Douglas, Osage, and Shawnee Counties, Kansas. Ms. on file, SI-RBS, Lincoln.

Chomko, S. A.

1978 Phillips Spring, 23HI216: A Multicomponent Site in the Western Missouri Ozarks. *Plains Anthropologist* 23(81):235-255.

Chomko, S. A. and G. W. Crawford

1978 Plant Husbandry in Eastern North America: New Evidence for its Development. *American Antiquity* 43:405-408.

Christenson, A. L. (editor)

1989 *Tracing Archaeology's Past: The Historiography of Archaeology.* Southern Illinois University Press, Carbondale.

Clark, G.A. and C. R. Stafford

1982 Quantification in American Archaeology: A Historical Perspective. *World Archaeology* 14(1):94-119.

Clarke, D. L.

1968 *Analytical Archaeology.* Methuen, London.

Claypoole, E. W.

1893 Preglacial Man Not Improbable. *American Geologists* 11:191-194.

Clayton, L.

1975 Bison Trails and Their Geologic Significance. *Geology* 3(9):498-500

Clayton, L. and S. R. Moran

1982 Chronology of Late Wisconsin Glaciation in Middle North America. *Quaternary Science Reviews* 1:55-82.

Cleaves, J. A.

1994 Documentation of Human Skeletal Remains from Buffalo Pasture (39ST216), South Dakota, in the Collections of the National Museum of Natural History, Smithsonian Institution. Ms. on file in Repatriation Office, National Museum of Natural History, Washington, D.C.

CLIMAP Project Members

1976 The Surface of the Ice-Age Earth. *Science* 191:1131-1137.

Coffin, R. G.

1937 *Northern Colorado's First Settlers.* Colorado State College, Fort Collins.

Cohen, M. N.

1977 *The Food Crises in Prehistory.* Yale University Press.

COHMAP Members

1988 Climatic Changes of the Last 18,000 Years: Observations and Model Simulations. *Science* 241:1043-1052.

Collins, M. B.

1990 The Archeological Sequence at Kincaid, Uvalde County, Texas. In *Transactions of the 25th Regional Archeological Symposium for Southeastern New Mexico and Western Texas,* pp. 25-34. Southwest Federation of Archaeological Societies, Midland.

Collins, M. B., T. R. Hester, and P. J. Headrick

1992 Engraved Cobbles from the Gault Site, Central Texas. *Current Research in the Pleistocene* 9:3-4.

Collins, M. B., T. R. Hester, D. Olmstead, and P. J. Headrick

1991 Engraved Cobbles from Early Archaeological Contexts in Central Texas. *Current Research in the Pleistocene* 8: 13-15.

Condra, G. E. and E. C. Reed

1950 *Correlation of the Pleistocene Deposits of Nebraska.* Nebraska Geological Survey, Bulletin, Vol. 15-A.

Condra, G. E., E. C. Reed, and E. D. Gordon

1947 *Correlation of the Pleistocene Deposits of Nebraska.* Nebraska Geological Survey, Bulletin 15.

Conkey, Margaret W.

1980 The Identification of Prehistoric Hunter-Gatherer Aggregation Sites: The Case of Altamira. *Current Anthropology* 21(5):609-630.

1987 Interpretive Problems in Hunter-Gatherer Regional Studies, Some thoughts on the European Upper Paleolithic. In *The Pleistocene Old World, Regional Perspectives,* edited by O. Soffer, pp. 63-77. Plenum Press, New York.

Connor, M. A.

1993 *1991 Test Excavations at 48LA277: A Plains Woodland Site on Crow Creek, Wyoming.* Midwest Archaeological Center, National Park Service, Lincoln.

Cook, D. C.

1979 Subsistence Base and Health in Prehistoric Illinois Valley: Evidence from the Human Skeleton. *Medical Anthropology* 4:109-124.

Cook, D. L.

1977 An Inquiry into the Fremont 1 (25SY1) "Cannibal House." Paper presented to the 35th Plains Conference (1977), Lincoln.

Cook, H. J.

1927 New Geological and Paleontological Evidence Bearing on the Antiquity of Mankind in America. *Natural History* 7(3): 240-247.

Cooper, P. L.

1936 Archaeology of Certain Sites in Cedar County, Nebraska. In *Chapters in Nebraska Archaeology,* vol. 1, edited by E. H. Bell, pp. 11-145. University of Nebraska, Lincoln.

1939 The Archeological Exploration of 1938 by the Nebraska State Historical Society. *Nebraska History* 20(2).

Corbyn, R. C.

1975 *Leary Site (25RN1): National Register of Historic Places Nomination Form.* National Park Service, United States Department of the Interior.

Corner, R. G.

1977 A Late Pleistocene-Holocene Vertebrate Fauna from Red Willow County, Nebraska. *Transactions of the Nebraska Academy of Science* 4:77-93.

Corner, R. G. and M. R. Voorhies

1987 Wolverine: *Gulo Gulo*, in Late Rancholabrean Deposits in Nebraska, First Records from the Great Plains. *CRP* 4:103-104.

Cornwell, K. J.

1987 Geomorphology and Soils. In *Prehistoric and Historic Cultural Resources of Selected Sites at Harlan County Lake, Harlan County, Nebraska*, edited by M. J. Adair and K. L. Brown, pp. 29-46. U.S. Army Corps of Engineers, Kansas City District.

Cotter, J. L.

1937 The Occurrence of Flints and Extinct Animals in Pluvial Deposits near Clovis, New Mexico, Part IV: Report on Excavation at the Gravel Pit, 1936. *Proceedings of the Philadelphia Academy of Natural Sciences* 89:2-16.

1938 The Occurrence of Flints and Extinct Animals in Pluvial Deposits near Clovis, New Mexico, Part VI: Report on the Field Season of 1937. *Proceedings of the Philadelphia Academy of Natural Sciences* 90:113-117.

1978 A Report of Fieldwork of the Colorado Museum of Natural History at the Lindenmeier Folsom Campsite, 1935. In *Lindenmeier 1934-1974: Concluding Report of Investigations,* by E. N. Wilmsen and F. H. H. Roberts, Jr., pp. 181-184. Smithsonian Institution Contributions to Anthropology 24. Washington, D. C.

Crabtree, D. E.

1966 A Stoneworker's Approach to Analyzing and Replicating the Lindenmeier Folson. *Tebiwa* 9:3-39.

Crane, H. R.

1956 University of Michigan Radiocarbon Dates III. *Science* 124:1117-1123.

Crawford, M. H.

1992 When Two Worlds Collide. *Human Biology* 64(3):271-279.

Crook, W. W. and R. K. Harris

1957 Hearths and Artifacts of Early Man near Lewisville, Texas, and Associated Faunal Material. *Bulletin of the Texas Archaeological Society* 28:7-97.

1958 A Pleistocene Campsite Near Lewisville, Texas. *American Antiquity* 23(3):233-246.

Crowley, T. J. and G. R. North

1991 *Paleoclimatology*. Oxford University Press, New York.

Cumming, R. B., Jr.

1953 Appraisal of the Archeological and Paleontological Resources of the Lower Platte Basin, Nebraska. SI-RBS-MBP-A. on file, SI-RBS, Lincoln

1958 Archaeological Investigations at the Tuttle Creek Dam, Kansas: Skeletal Remains of the Sweat Bee Mound Site (14PO14). River Basin Survey Papers, No. 10, Smithsonian Institution. *Bureau of American Ethnology Bulletin* 169:45-56, 65-78.

Cummings, T. S.

1953 A Preliminary Report on the Blue Stone Focus, White Rock Aspect. Abstract, Proceedings of the Nebraska Academy of Sciences, May 1.

Cutler, H. and L. Blake

1973 *Plants from Archaeological Sites East of the Rockies*. Missouri Botanical Gardens, St. Louis.

1983 Identified Botanical Remains. In *Walker-Gilmore: A Stratified Woodland Occupation in Eastern Nebraska*, Appendix F. Notebook No. 6, Division of Archeological Research, Department of Anthropology, University of Nebraska, Lincoln.

Cyron, G. M., W. C. Hutton, and J. D. G. Troup

1976 Spondylolytic Fractures. *Journal of Bone and Joint Surgery* 58-B(4):462-466.

Dallman, J. E.

1983 *A Choice of Diet: Response to Climatic Change*. University of Iowa, Office of the State Archaeologist, Report 16.

Daniels, R. B., R. L. Handy, and G. H. Simonson

1960 Dark-Colored Bands in the Thick Loess of Western Iowa. *Journal of Geology* 68:450-458.

Dansgaard, W., W. C. White, and S. J. Johnsen

1989 The Abrupt Termination of the Younger Dryas Climate Event. *Nature* 339:532-533.

Davis, D. D. and P. R. Rowe

1960 Further Notes on the Glenwood Culture: The Stille Site. *Journal of the Iowa Archeological Society* 9(3):13-17.

Davis, E. M.

1950 Investigations by the University of Nebraska State Museum in the Medicine Creek Reservoir Area in 1950. Ms. on file, SI-RBS, Lincoln.

1951 Archeological Investigations in 1951 in the Medicine Creek Reservoir Area by the University of Nebraska State Museum. Ms. on file, SI-RBS, Lincoln.

1952 Report of Investigations by the University of Nebraska State Museum in the Medicine Creek Reservoir Area in 1951. Ms. on file, SI-RBS, Lincoln.

1953a Recent Data from Two Paleo-indian Sites on Medicine Creek, Nebraska. *American Antiquity* 18(4).

1953b Report of Investigations by the University of Nebraska State Museum in the Medicine Creek Reservoir Area in 1952. Ms. on file, SI-RBS, Lincoln.

1962 Archeology of the Lime Creek Site in Southwestern Nebraska. UNSM-SP 3. Ms. on file, SI-RBS, Lincoln.

Davis, E. M. and C. B. Schultz

1952 The Archeological and Paleontological Salvage Program at the Medicine Creek Reservoir, Frontier County, Nebraska. *Science* 115:288-290.

Davis, L. B.

1976 The Dodge Site (24RB1225): A McKean Phase Lithic "Cache" in the Tongue River Valley. *Archaeology in Montana* 17(1 and 2):35-51.

1988 Paleoindian Tradition Fluted Points in Montana. *Current Research in the Pleistocene* 5:25-27.

Davis, L. B. and S. T. Greiser

1992 Indian Creek Paleoindians: Early Occupation of the Elkhorn Mountains' Southeast Flank, West-Central Montana. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford and J. S. Day, pp. 225-283. University Press of Colorado, Niwot.

Davis, L. B. and B. O. K. Reeves (editors)

1990 *Hunters of the Recent Past*. Unwin Hyman, London.

Davis, L. B. and M. Wilson (editors)

1978 *Bison Procurement and Utilization: A Symposium*. Plains Anthropologist Memoir 14.

Davis, L. C.

1975 *Late Pleistocene Geology and Paleoecology of the Spring Valley Basin, Meade County, Kansas*. Unpublished Ph.D. Dissertation, University of Iowa.

1987b Late Pleistocene/Holocene Environmental Changes in the Central Plains of the United States: The Mammalian Record. In *Late Quaternary Mammalian Biogeography and Environments of the Great Plains and Prairies*, edited by R. W. Graham, H. A. Semken and M. A. Graham, pp. 88-143. Illinois State Museum Scientific Papers 22.

Davis, W. A.

1985 The Montgomery Folsom Site. *Current Research in the Pleistocene* 2:11-12.

Dawson, J. and W. J. Judge

1969 Paleo-Indian Sites and Topography in the Middle Rio Grande Valley of New Mexico. *Plains Anthropologist* 14: (44 pt.1):149-163.

Dawson, J. and D. J. Stanford

1975 The Linger Site: A Re-Investigation. *Southwestern Lore* 41(4):11-16.

Deetz, J.

1965 *The Dynamics of Stylistic Changes in Arikara Ceramics*. Illinois Study in Anthropology No. 4. University of Illinois Press, Urbana, Illinois.

Deevey, E. S. and R. F. and Flint

1957 Postglacial Hypsithermal Interval. *Science* 125:182-184.

Deines, P.

1980 The Isotopic Composition of Reduced Organic Carbon. In *Handbook of Environmental Isotope Geochemistry-v.1, The Terrestrial Environment*, pp. 329-406. Elsevier, Amsterdam.

Deitrick, L. M.

1980 *The Occurrence and Interpretation of Trauma at the Larson Site, 39WW2, Walworth County, South Dakota*. Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

Delcourt, P. A. and H. R. Delcourt

1983 Late-Quaternary Vegetational Dynamics and Community Stability Reconsidered. *Quaternary Research* 19:265-271.

Denig, E. T.

1961 *Five Indian Tribes of the Upper Missouri*, edited by J. C. Ewers. University of Oklahoma Press, Norman, Oklahoma.

Dibble, D. S. and D. Lorrain

1968 *Bonfire Shelter: A Stratified Bison Kill Site, Val Verde County, Texas*. Texas Memorial Museum, Miscellaneous Papers 1. Austin.

Dick, H. W.

n.d. Preliminary Report, Trinidad Reservoir, Las Animas County, Colorado. Ms. on file, National Park Service, Midwest Region, Omaha.

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

Dillehay, T. D.
1986 The Cultural Relationships of Monte Verde: A Late Pleistocene Settlement Site in the Subantarctic Forest of South-Central Chile. In *New Evidence for the Pleistocene Peopling of the Americas,* edited A. L. Bryan, pp. 319-337. Center for the Study of Early Man, Orono.
1988 How New is the New World? *Antiquity* 62:94-97.
1989 *Monte Verde, A Late Pleistocene Settlement in Chile. Volume 1: Paleoenvironment and Site Context.* Smithsonian Institution Press, Washington, D.C.

Dillehay, T. D. and M. Collins
1988 Early Cultural Evidence from Monte Verde in Chile. *Nature* 332:150-152.

Dincauze, D.
1984 An Archaeo-Logical Evaluation of the Case for pre-Clovis Occupations. In *Advances in World Archaeology,* edited by F. Wendorf and A. Close, Volume 3:275-323. Academic Press, New York.

Dixon, J.
1985 The Origins of the First Americans. *Archaeology* 38(2):22-27.
1994 *Quest for the First Americans.* University of New Mexico Press, Albuquerque.

Donahue, J. A.
1995 Progress on the Investigation of the Jim Pitts Stratified Paleoindian Site: Geoarchaeology, Continuing Excavation, and Artifact Assemblage Processing. Paper presented at the 53rd annual Plains Anthropological Conference, Laramie, Wyoming.
1996 New Evidence for the Chronological Placement of the Goshen Complex in the Northwestern Plains. Paper presented at the 54th Annual Plains Anthropological Conference, Iowa City, Iowa.

Donahue, J. A. and N. Hannenberger
1993 A Preliminary Report on Excavations at the Jim Pitts Site, A Stratified Paleoindian Occupation Located in the Southwestern Black Hills of Custer County, South Dakota. Paper Presented at the 51st Annual Meeting of the Plains Anthropological Conference, Saskatoon.

Donahue, J. A., D. E. Weston, and A. F. Arbogast
1988 Survey and Testing at Milford Lake. In *Archaeological Inventory and Evaluation at Milford, Melvern and Pomona Lakes, Eastern Kansas,* edited by L. J. Schmits, pp. 86-154. Environmental Systems Analysis, Inc., Cultural Resources Division, Kansas City, Kansas. Submitted to U.S. Army Corps of Engineers, Kansas City District.

Dort, W. R., Jr. and J. K. Jones, Jr., (editors)
1970 *Pleistocene and Recent Environments of the Central Great Plains*. University of Kansas Press, Lawrence.

Dragoo, D. W.
1973 Wells Creek Crater: An Early Man Site in Stewart County, Tennessee. *Archaeology of Eastern North America* 1:1-56.

Drass, R.
1995 Prehistoric Cultivation of Marshelder on the Southern Plains. Paper presented at the 53rd Plains Conference, Laramie, Wyoming.

Dreeszen, V. H.
1970 The Stratigraphic Framework of Pleistocene Glacial and Periglacial Deposits in the Central Plains. In *Pleistocene and Recent Environments of the Central Great Plains*, edited by W. Dort, Jr. and J. K. Jones, Jr. University of Kansas Press, Lawrence.

Drew, D. L.
1979 Early Man in North America and Where to Look for Him: Geomorphic Contexts. *Plains Anthropologist* 24(86):269-281.

Duke, P. and M. C. Wilson (editors)
1995 *Beyond Subsistence: Plains Archaeology and Postprocessual Critique.* The University of Alabama Press, Tuscaloosa.

Dunbar, J. S.
1991 Resource Orientation of Clovis and Swannee Age Paleoindian Sites in Florida. In *Clovis: Origins and Adaptations,* edited by R. Bonnichsen and K. Turnmire, pp. 185-213. Center for the Study of the First Americans, Corvallis.

Dunlevy, M. L.
1936 A Comparison of the Cultural Manifestations of the Burkett (Nance County) and the Gray-Wolfe (Colfax County) Sites. In *Chapters in Nebraska Archaeology,* vol. 1, edited by Earl H. Bell, pp. 147-247. University of Nebraska, Lincoln.

Dunnell, R. C.
1980 Evolutionary Theory and Archaeology. In *Advances in Archaeological Method and Theory,* Vol. 3, edited by M. B. Schiffer, pp. 35-99. Academic Press, New York.
1982 Science, Social Science, and Common Sense: the Agonizing Dilemma of Modern Archaeology. *Journal of Anthropological Research* 38:1-25.
1986 Five Decades of American Archaeology. In *American Archaeology Past and Future,* edited by D. J. Meltzer, D. D. Fowler. J. A. Sabloff, pp. 23-49. Society for American Archaeology and Smithsonian Institute Press, Washington.
1988 The Concept of Progress in Cultural Evolution. In *Evolutionary Progress,* edited by M. H. Nitecki, pp. 169-194. University of Chicago Press.
1992a Archaeology and Evolutionary Science. In *Quandaries and Quests, Visions of Archaeology's Future,* edited by L. A. Wandsnider, pp. 209-224. Occasional Paper 20, Center for Archaeological Investigations, Southern Illinois University at Carbondale.
1992b The Notion Site. In *Space, Time, and Archaeological Landscapes,* edited by J. Rossignol and L. Wandsnider. Plenum Press, New York.
1995 What Is It That Actually Evolves? In *Evolutionary Archaeology, Methodological Issues,* edited by P. A. Teltser, pp. 33-50. University of Arizona Press, Tucson.

Dunnell, R. C. and Dancy
1983 The Siteless Survey: A Regional Scale Data Collection Strategy. In *Advances in Archaeological Method and Theory vol. 6,* edited by M. B. Schiffer, pp. 267-287. Academic Press, New York.

Duplessy, J. C., G. Delibrias, J. L. Turon, C. Pujol, and J. Duprat
1981 Deglacial Warming of the Northeastern Atlantic Ocean: Correlation with the Paleoclimatic Evolution of the European Continent. *Palaeogeography, Palaeoclimatology, Palaeoecology* 35:121-144.

Durkee, T.
1971 A Pollen Profile from Woden Bog, Hancock County, Iowa. *Ecology* 52:835-844.

Ebell, S. B.
1988 The Dunn Site. *Plains Anthropologist* 33:505-530.

Ebert, J. I.
1991 *Distributional Archaeology.* University of New Mexico Press, Albuquerque.

Eddy, F. W., P. D. Friedman, R. E. Oberlin, T. R. Farmer, D. L. Dahms, J. J. Reining, and B. Leichtman
1982 The Cultural Resource Inventory of the John Martin Dam and Reservoir, Bent County, Colorado. Science Applications, Golden, Colorado. Submitted to the U.S. Army Corps of Engineers, Albuquerque District, New Mexico.

Eighmy, J. L.
1983 Changes in the Plains Archaeological Community: 1960-1982. *Plains Anthropologist* 28(102):329-334.
1984 *Colorado Plains Prehistoric Context.* Office of Archaeology and Historic Preservation, Colorado Historical Society, Denver.

Eiseley, L. C.
1935 *Review of the Paleontological Evidence Bearing Upon the Age of the Scottsbluff Bison Quarry.* Master's thesis, University of Pennsylvania, Philadelphia.

1939 Evidence of a Pre-Ceramic Horizon in Smith County, Kansas. *Science* 89:221.

Eiseley, L. C. and C. W. Asling

1944 An Extreme Case of Sacphocephaly from a Mound Burial Near Troy, Kansas. *Transactions of the Kansas Academy of Sciences* 47(2):241-255.

Elias, S.

1990 The Timing and Intensity of Environmental Changes During the Paleoindian Period in Western North America: Evidence from the Fossil Record. In *Megafauna and Man, Discovery of America's Heartland,* edited by L. D. Agenbroad, J. I. Mead, and L. W. Nelson, pp. 11-14. Mammoth Hot Springs, SD.

Elias, S. (editor)

1994 *Quaternary Insects and Their Environments.* Smithsonian Institution Press, Washington D.C.

Ellis, G. L., C. Lintz, W. N. Trierweiler, and J. M. Jackson

1994 *Significance Standards for Prehistoric Cultural Resources: A Case Study from Fort Hood, Texas.* U. S. Army Corps of Engineers Construction Engineering Research Laboratories, Technical Report CRC 94/04.

Elock, D. G. and P. J. O'Brien

1979 Cultural Resources Survey of Fall River Lake, Kansas. Ms. on file, U.S. Army Corps of Engineers, Southwestern Division, Dallas.

Emery, S. and D. J. Stanford

1983 A Preliminary Report on Archaeological Investigations at the Cattle Guard Site, Alamosa County, Colorado. *Southwestern Lore* 48(1):10-20.

Engstrom, D. R., G. S. Hansen, and H. E. Wright, Jr.

1990 A Possible Younger Dryas Record in Southeastern Alaska. *Science* 250:1383-1385.

Enloe, J. G. and F. David

1992 Food Sharing in the Paleolithic: Carcass Refitting at Pincevent. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology,* edited by J. L. Hofman and J. G. Enloe, pp. 297-315. British Archaeological Reports International Series 578. Tempus Reparatum, Oxford.

Eoff, J. D. and A. E. Johnson

1968a An Archeological Survey of the Fall River Watershed, Greenwood, Butler, and Chase Counties, South-Central Kansas. Ms. on file, National Parks Service, Midwest Archeological Center, Lincoln.

1968b An Archeological Survey of the Frog Creek Watershed, Osage and Coffey Counties, East-Central Kansas. Ms. on file, Midwest Archeological Center, Lincoln.

1968c An Archeological Survey of the Little Delaware-Mission Creek Watershed, Brown, Atchison, and Jackson Counties, Northeast Kansas. Ms. on file, National Parks Service, Midwest Archeological Center, Lincoln.

1968d An Archeological Survey of the El Dorado Reservoir Area, South-Central Kansas. Ms. on file, National Parks Service, Midwest Archeological Center, Lincoln.

Epp, H. T.

1988 Way of the Migrant Herds: Dual Dispersion Strategy Among Bison. *Plains Anthropologist* 33(121):309-320.

Ericson, J., R. Taylor and R. Berger (editors)

1982 *Peopling of the New World.* Ballena Press, San Diego.

Evans, G. L.

1951 Prehistoric Wells in Eastern New Mexico. *American Antiquity* 17(1):1-8.

Ewers, J. C.

1954 The Indian Trade of the Upper Missouri before Lewis and Clark: An Interpretation. *Missouri Historical Society Bulletin* 10:429-446.

Eyman, C. E.

1966 *The Schultz Focus.* Unpublished Master's thesis, Department of Archaeology, University of Calgary.

Fagan, B. F.

1987 *The Great Journey, The Peopling of Ancient America.* Thames and Hudson, New York.

Fairbanks, R. G.

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

Fairbridge, R. W.

1983 The Pleistocene-Holocene Boundary. *Quaternary Science Reviews* 1:215-244.

Falk, C. R.

1969a Faunal Remains. In *Two House Sites in the Central Plains,* edited by W. R. Wood, pp. 39-51. Plains Anthropologist 14(44) pt.2, Memoir 6.

1969b A Contrastive Statement on Upper Republican and Nebraska: Faunal Evidence. In *Two House Sites in the Central Plains: An Experiment in Archaeology,* edited by W. R. Wood, pp. 102. Plains Anthropologist 14(44), pt. 2, Memoir 6.

1977 Analyses of Unmodified Vertebrate Fauna from Sites in the Middle Missouri Subarea: A Review. *Plains Anthropologist Memoir* 13 (Part 2) 22:151-161.

Falk, C. R. and C. A. Angus

1983 A Descriptive Summary of Vertebrate Remains Recovered from the Archaeological Investigation of the Walker Gilmore Site (25CC28). In *Walker Gilmore: A Stratified Woodland Period Occupation in Eastern Nebraska,* Appendix D, pp: 244-253. Department of Anthropology, University of Nebraska, Laboratory Notebook No. 6, Lincoln.

Falk, C. R. and H. A. Semken, Jr.

1990 Vertebrate Peleoecology and Procurement at the Rainbow Site. In *Woodland Cultures on the Western Prairies: The Rainbow Site Investigations,* edited by D. W. Benn, pp. 145-164. Office of the State Archaeologist, University of Iowa.

Farnsworth, K. B. and D. L. Asch

1986 Early Woodland Chronology, Artifact Styles, and Settlement Distribution in the Lower Illinois River Valley Region. In *Early Woodland Archaeology,* edited by K. B. Farnsworth and T. E. Emerson, pp. 326-457. Center for American Archaeology, Kampsville Seminars in Archaeology, No. 2, Kampsville, Illinois.

Farnsworth, K. B. and T. E. Emerson (editors)

1986 *Early Woodland Archaeology.* Center for American Archaeology Press, Kampsville, Illinois.

Farr, M. R., K. Park, and W. C. Johnson

1993 *Rock Magnetic Properties of the Sangamon Soil Form Southwestern Nebraska: Lack of Evidence for Ultrafine Ferrimagnetic Grains.* Geological Society of America, Abstracts and Programs 26 (7), A-237.

Fawcett, W. B.

1980 *Projectile Point Variability in Late Prehistoric Sites on the Northwestern Plains.* Unpublished Master's thesis, Department of Anthropology, University of Wyoming. Laramie.

1985 But What if We Want to Build a Pound? Bison Hunting in the Middle Plains Archaic Period. In *McKean/Middle Plains Archaic: Current Research,* edited by M. Kornfeld and L. C. Todd, pp. 169-176. Occasional Papers on Wyoming Archaeology 4. Laramie.

1986 Variation in Chipped-Stone Tool Assemblages from Bison Kills and Associated Processing and Camp Sites. *Wyoming Archaeologist* 29(1-2):9-28.

1987 *Communal Hunts, Human Aggregations, Social Variation, and Climatic Change: Bison Utilization by Prehistoric Inhabitants of the Great Plains.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Massachusetts, Amherst.

Feagins, J. D.

1988 Nebraska Phase Burials in Northwest Missouri: A Study of Three Localities. *The Missouri Archaeologist* 49:41-56.

Fenenga, F.

1951a Appraisal of the Archeological and Paleontological Resources of the Lovewell Reservoir, Jewell County, Kansas. SI-RBS-MBP-B on file, SI-RBS, Lincoln.

1951b Appraisal of the Archeological and Paleontological Resources of the Narrows Reservoir, Morgan County, Colorado. SI-RBS-MBP-B on file, SI-RBS, Lincoln.

1953 Appraisal of the Archeological and Paleontological Resources of the Gavins Point Reservoir, Nebraska and South Dakota. SI-RBS-MBP-B on file, SI-RBS, Lincoln.

Fenenga, F. and P. L. Cooper

1951 Appraisal of the Archeological and Paleontological Resources of the Lovewell Reservoir, Jewell County, Kansas. SI-RBS-MBP-B on file, SI-RBS, Washington.

Feng, Z.

1991 *Temporal and Spatial Variations in the Loess Depositional Environment of Central Kansas During the Past 400,000 Years.* Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

Feng, Z., W. C. Johnson and Y-C. Lu.

1993. Chronostratigraphy of the Loess Sequences in Central Great Plains. *Quaternary Science Review* 12(3):178-185.

Feng, Z., W. C. Johnson, Y-C. Lu, and P. A. Ward, III

1993 Climatic Signals from Loess-Soil Sequences in the Central Great Plains. *Palaeogeography, Palaeoclimatology, Palaeoecology* 93:71-83.

Feng Z., W. C. Johnson, and D. R. Sprowl

1991 Loess Depositional History and the Climatic Implication During the Last 400,000 Years in Central Kansas (abstract). Nebraska Academy of Sciences, Institute of Tertiary-Quaternary Studies, TER-QUA Symposium Series, p. 6.

Feng, Z., W. C. Johnson, D. R. Sprowl, and Y. C. Lu

1993 Loess Accumulation and Soil Formation in Central Kansas, U.S.A., during the Past 40,000 Years. *Earth Surface Processes and Landforms* 18(3).

Fenneman, N. M.

1931 *Physiography of the Western United States.* McGraw-Hill, New York.

Ferguson, L.

1992 *Uncommon Ground; Archaeology and Early African America, 1650-1800.* Smithsonian Institution Press, Washington.

Ferring, C. R.

1982 *The Late Holocene Prehistory of Delaware Canyon, Oklahoma.* Institute of Applied Sciences, Contributions to Archaeology 1. North Texas State University. Denton.

1989 The Aubrey Clovis Site: A Paleoindian Locality in the Upper Trinity River Basin, Texas. *Current Research in the Pleistocene* 6:9-11.

1990 *Late Quaternary Geology and Geoarchaeology of the Upper Trinity River Drainage Basin, Texas, Fieldtrip #11 Guidebook.* Geological Society of America 1990 Annual Meeting. Dallas Geological Society.

1992 Alluvial Pedology and Geoarchaeological Research. In *Soils in Archaeology*, edited by V. T. Holliday, pp. 1-39. Smithsonian Institution Press, Washington, D. C.

1994 The Role of Geoarchaeology in Paleoindian Research. In *Method and Theory for Investigating the Peopling of the Americas,* edited by R. Bonnichsen and D. G. Steele, pp. 57-72. Center for the Study of the First Americans, Oregon State University, Corvallis.

Figgins, J. D.

1927 The Antiquity of Man in America. *Natural History* 27(3):229-239.

1931 An Additional Discovery of the Association of a "Folsom" Artifact and Fossil Mammal Remains. *Proceedings of the Colorado Museum of Natural History* 10(2). Denver.

1933 A Further Contribution to the Antiquity of Man in America. *Proceedings of the Colorado Museum of Natural History* 12 (2).

1934 Folsom and Yuma Artifacts. *Proceedings of the Colorado Museum of Natural History* 13(2). Denver.

1935 Folsom and Yuma Artifacts, Part II. *Proceedings of the Colorado Museum of Natural History* 14(2). Denver.

Finnegan, M.

1977 Osteological Analysis of Skeletal Remains from the Chester Reeves Mound (23CL108), A Steed-Kisker Mississippian Population. In *Cultural Resources Survey of Smithville Lake, Missouri,* vol. 1, by P. J. O'Brien, pp. 111-163. Department of Sociology, Anthropology and Social Work, Kansas State University, Manhattan. Submitted to U.S. Army Corps of Engineers, Kansas City District.

1981 Archaic Skeletal Remains from the Central Plains: Demography and Burial Practices. In *Progress in Skeletal Biology of Plains Populations,* edited by R. L. Jantz and D. H. Ubelaker, pp. 85-92. Plains Anthropologist Memoir 17.

1989 Osteological Report on Human Skeletal Remains Recovered from Lovewell Lake, Jewel County, Kansas (14JW313). Ms. on file, Department of Anthropology, Kansas State University, Manhattan.

1990 A Descriptive Report on the Fieldwork at Site 14SA1, Saline County, Kansas. Vol. 1. Ms. on file, Kansas State Historical Society, Topeka.

Fischel, H. E.

1939 Folsom and Yuma Culture Finds. *American Antiquity* 4(3):232-264.

Fisher, J. W., Jr.

1992 Observations on the Late Pleistocene Bone Assemblage from the Lamb Spring Site, Colorado. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 51-81. University Press of Colorado, Niwot.

Fitzhugh, W. W.

1975 A Comparative Approach to Northern Maritime Adaptations. In *Prehistoric Maritime Adaptations in the Circumpolar Zone,* edited by W. W. Fitzhugh, pp. 339-386. The Hague, Mouton.

Fladmark, K. R.

1979 Routes: Alternate Migration Corridors for Early Man in North America. *American Antiquity* 44:55-69.

1983 Times and Places: Environmental Correlates of Mid-to-Late Wisconsinan Human Population Expansion in North America. In *Early Man in the New World,* edited by R. Shutler, pp. 13-42. Sage Publications, Beverly Hills.

1986 Getting One's Berings. *Natural History* 95(11):8-19.

Flannery, K. V.

1968 Archaeological Systems Theory and Early Mesoamerica. In *Anthropological Archaeology in the Americas,* edited by Betty J. Meggers, pp. 67-87. Anthropological Society of Washington.

1982 The Golden Marshalltown: A Parable for the Archaeology of the 1980s. *American Anthropologist* 84: 265-278.

Fleagle, J. G., K. W. Samonds, and D. M. Hegsted

1975 Physical Growth of Cebus Monkeys, Cebus Albiforms, during Protein or Calorie Deficiency. *American Journal of Clinical Nutrition* 28:246-253.

Flenniken, J. J.

1978 Reevaluation of the Lindenmeier Folsom: A Replication Experiment in Lithic Technology. *American Antiquity* 43(3):473-480.

Fletcher A. and F. LaFleshe

1911 *The Omaha Tribe.* University of Nebraska Press, Lincoln.

Flint, R. F.

1971 *Glacial and Quaternary Geology.* John Wiley and Sons, New York.

Foley, R.

1981 A Model of Regional Archaeology Structure. *Proceedings of the Prehistoric Society* 47:1-17.

Forbis, R. G.

1968 Fletcher: A Paleo-Indian Site in Alberta. *American Antiquity* 33:1-10.

1985 The McKean Complex as Seen from Signal Butte. In *McKean/ Middle Plains Archaic: Current Research*, edited by M. Kornfeld and L. C. Todd, pp. 21-29. Occasional Papers on Wyoming Archaeology 4. Laramie.

1992 The Mesoindian (Archaic) Period in the Northern Plains. *Revista de Arqueologia Americana* 5:27-69.

Forbis, R. G. and J. D. Sperry

1953 An Early Man Site in Montana. *American Antiquity* 18:127-133.

Ford, J. A. and G. R. Willey

1941 An Interpretation of the Prehistory of the Eastern United States. *American Anthropologist* 43(3):325-363.

Ford, R. I.

1979 Gathering and Gardening: Trends and Consequences of Hopewell Subsistence Strategies. In *Hopewell Archaeology: The Chillicothe Conference*, edited by D. Brose and N. Greber, pp; 234-238. Kent State University Press, Kent.

1984 Letter to Mary Adair, dated May, 1984.

1987 Dating Early Maize in the Eastern United States. Paper presented at the Annual Conference, Society of Ethnobiology, Gainsville, Florida.

Forman, S. L., E. A. Bettis, T. L. Kemmis, and B. B. Miller

1992 Chronological Evidence for Multiple Periods of Loess Deposition during the Late Pleistocene in Missouri and Mississippi River Valleys, United States—Implication for the Activity of the Laurentide Ice Sheet. *Palaeogeography, Palaeoclimatology, Palaeoecology* 93:71-83.

Forman, S. L., A. F. H. Goetz, and R. H. Yuhas

1992 Large-Scale Stabilized Dunes on the High Plains of Colorado; Understanding the Landscape Response to Holocene Climates with the Aid of Images from Space. *Geology* 20:145-148.

Forman, S. L. and P. Matt

1990 Stratigraphic Evidence for Late Quaternary Dune Activity near Hudson on the Piedmont of Northern Colorado. *Geology* 18:745-748.

Fowke, G.

1922 *Archaeological Investigations.* Bulletin of the Bureau of American Ethnology, No. 76, Washington, D.C.

Fowler, D. D.

1986 Conserving American Archaeological Resources. In *American Archaeology: Past and Future,* edited by D. J. Meltzer, D. D. Fowler, J. A. Sabloff, pp. 135-162. Society for American Archaeology and Smithsonian Institution Press, Washington, D.C.

Francis, J.

1991 An Overview of Wyoming Rock Art. In, *Prehistoric Hunters of the High Plains* (second edition), by G. C. Frison, pp. 397-430. Academic Press, San Diego.

Francis, J. E., L. L. Loendorf, and R. I. Dorn

1993 AMS Radiocarbon and Cation-Ratio dating of Rock Art in the Bighorn Basin of Wyoming and Montana. *American Antiquity* 58(4):711-737.

Frankel, L.

1957 The Value of Pleistocene Mollusks as Index Fossils of Wisconsin Sub-Ages in Nebraska. *Journal of Paleontology* 31:641-647.

Frankforter, W. D.

1959 A Pre-Ceramic Site in Western Iowa. *Journal of the Iowa Archeological Society* 8(4):47-72.

Frankforter, W. D. and G. A. Agogino

1960 The Simonsen Site: Report for the Summer of 1959. *Plains Anthropologist* 5(10):65-70.

Frantz, W.

1963 *Four Aksarben Sites in Dakota County, Nebraska.* Unpublished Master's thesis, University of Nebraska, Lincoln.

1964 1963 Excavations in the Elk City Reservoir. *Kansas Anthropological Association Newsletter* 9(6).

Frederick, C. D., M. D. Glascock, H. Neff, and C. M. Stevenson

1994 *Evaluation of Chert Patination as a Dating Technique: A Case Study from Fort Hood, Texas.* United States Army Fort Hood Archeological Resource Management Series, Research Report No. 32. Mariah and Associates. Austin.

Frederick, C. D. and C. Ringstaff

1994 Lithic Resources at Fort Hood: Further Investigations. In *Archaeological Investigations on 571 Prehistoric Sites at Fort Hood, Bell and Coryell Counties, Texas,* edited by W. N. Trierweiler, pp. 125-181. Fort Hood Archaeological Resource Management Series 31. Mariah Associates, Austin, Tx.

Fredlund, G. G.

1989 Paleovegetational Reconstruction at the North Cove Site. In *Archaeological Investigations at the North Cove Site, Lake Harlan County, Nebraska*, edited by M. J. Adair. U.S. Army Corps of Engineers, Kansas City District.

1991 *A Comparison of Pleistocene and Holocene Vegetation in the Central Great Plains of North America—Palynological Evidence from Cheyenne Bottoms, Kansas.* Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

1993 Paleoenvironmental Interpretations of Stable Carbon, Hydrogen, and Oxygen Isotopes from Opal Phytoliths, Eustis Ash Pit, Nebraska. In *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*, edited by D. M. Pearsall, and D. R. Piperno, pp. 36-46. MASCA Research Papers in Science and Archaeology 10. The University Museum of Archaeology and Anthropology, University of Pennsylvania, Philadelphia.

1995 A Late Quaternary Pollen Record from Cheyenne Bottoms, Kansas. *Quaternary Research* 43:67-79.

Fredlund, G. G. and P. J. Jaumann

1986 The Influence of Topography and Fire Disturbance on Late Wisconsinan Vegetation in Eastern Kansas. American Quaternary Association Ninth Meeting, Program and Abstracts, p. 81.

1987 Late Quaternary Palynological and Paleobotanical Records from the Central Great Plains. In *Quaternary Environments of Kansas*, edited by W. C. Johnson, pp.167-178. Kansas Geological Survey, Guidebook Series 5.

Fredlund, G. G., W. C. Johnson, and W. Dort, Jr.

1985 A Preliminary Analysis of Opal Phytoliths from the Eustis Ash Pit, Frontier County, Nebraska. *TER-QUA Symposium Series*, 1:147-162. Nebraska Academy of Sciences, Institute for Tertiary-Quaternary Studies.

Frisancho, A. R., S. M. Garn, and W. Ascoli

1970 Subperiosteal and Endosteal Bone Apposition during Adolescence. *Human Biology* 42:639-664.

Frison, G. C.

1970 *The Glenrock Buffalo Jump, 48CO304.* Plains Anthropologist Memoir 7.

1973 The Plains. In *The Development of North American Archaeology*, edited by J. E. Fitting, pp. 151-184. Anchor Books, Garden City.

1974 *The Casper Site: A Hell Gap Bison Kill on the High Plains.* Academic Press, New York.

1976 The Chronology of Paleo-Indian and Altithermal Cultures in the Big Horn Basin, Wyoming. In *Cultural Change and Continuity, Essays in Honor of James Bennett Griffin,* edited by C. E. Cleland, pp. 147-174. Academic Press, New York.

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

1982a The Sheeman Site, A Clovis Component. In *The Agate Basin Site: A Record of Paleoindian Occupation of the Northwestern High Plains,* edited by G. C. Frison and D. J. Stanford, pp. 143-157. Academic Press, New York.

1982b The Folsom Components. In *The Agate Basin Site: A Record of Paleoindian Occupation of the Northwestern High Plains,* edited by G. C. Frison and D. J. Stanford, pp. 37-76. Academic Press, New York.

1982c Dentition Studies. In *The Agate Basin Site: A Record of Paleoindian Occupation of the Northwestern High Plains,* edited by G. C. Frison and D. J. Stanford, pp. 240-260. Academic Press, New York.

1982d Paleo-Indian Winter Subsistence Strategies on the High Plains. In *Plains Indian Studies,* edited by D. H. Ubelaker and H. J. Viola, pp. 193-201. Smithsonian Contributions to Anthropology 30.

1983 The Lookingbill Site, Wyoming, 48FR308. *Tebiwa* 20:1-16.

1984 The Carter/Kerr-McGee Paleoindian Site: Cultural Resource Management and Archaeological Research. *American Antiquity* 49:288-314.

1987a Prehistoric Plains-Mountain, Large Mammal Communal Hunting Strategies. In *The Evolution of Human Hunting,* edited by M. H. Nitecki and D. V. Nitecki, pp. 177-211. Plenum, New York.

1987b The University of Wyoming Investigations at the Horner Site. In *The Horner Site: Type Site of the Cody Cultural Complex,* edited by G. C. Frison and L. C. Todd, pp. 93-105. Academic Press, Orlando.

1988 Paleoindian Subsistence and Settlement During Post-Clovis Times on the Northwestern Plains, The Adjacent Mountain Ranges, and Intermontane Basins. In *Americans Before Columbus: Ice Age Origins,* edited by R. C. Carlisle, pp. 83-106. Ethnology Monographs 12, Department of Anthropology, University of Pittsburgh, Pittsburgh.

1989 Experimental Use of Clovis Weaponry and Tools on African Elephants. *American Antiquity* 54:766-784.

1990 The North American High Plains Paleoindian: An Overview. *Revista Arqueologia Americana* 2:9-54.

1991a The Goshen Paleoindian Complex: New Data for Paleoindian Research. In *Clovis Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 133-151. Center for the Study of the First Americans, Oregon State University, Corvallis.

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

1991c The Clovis Cultural Complex: New data from Caches of Flaked Stone and Worked Bone Artifacts. In *Raw Material Economies Among Prehistoric Hunter-Gatherers,* edited by A. Montet-White and S. Holen, pp. 321-333. University of Kansas Publications in Anthropology 19. Lawrence.

1991d Hunting Strategies, Prey Behavior and Mortality Data. In *Human Predators and Prey Mortality,* edited by M. C. Stiner, pp. 15-30. Westview Press, Boulder.

1992 The Foothills-Mountains and the Open Plains: The Dichotomy in Paleoindian Subsistence Strategies Between Two Ecosystems. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 323-342. University Press of Colorado, Niwot.

1993 The North American Paleoindian: A Wealth of New Data but Still Much to Learn. In *Prehistory and Human Ecology of the Western Prairies and Northern Plains,* edited by J. A. Tiffany, pp. 5-16. Plains Anthropologist Memoir 27.

1996 *The Mill Iron Site.* University of New Mexico Press, Albuquerque.

Frison, G. C. and Bruce A. Bradley

1980 *Folsom Tools and Technology at the Hanson Site, Wyoming.* University of New Mexico Press. Albuquerque.

1981 Fluting Folsom Points: Archaeological Evidence. *Lithic Technology* 10(1):13-16.

1982 Fluting of Folsom Projectile Points. In *The Agate Basin Site: A Record of Paleoindian Occupation of the Northwestern High Plains,* edited by G. C. Frison and D. J. Stanford, pp. 209-212. Academic Press, New York.

Frison, G. C. and C. Craig

1982 Bone, Antler, and Ivory Artifacts and Manufacture Technology. In *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains,* edited by G. C. Frison and D. J. Stanford, pp. 161-173. Academic Press, New York.

Frison, G. C. and D. C. Grey

1980 Pryor Stemmed: A Specialized Paleo-Indian Ecological Adaptation. *Plains Anthropologist* 25:27-46.

Frison, G. C. and D. J. Stanford (editors)

1982 *The Agate Basin Site: A Record of Paleoindian Occupation of the Northwestern High Plains.* Academic Press, New York.

Frison, G. C. and L. C. Todd

1986 *The Colby Mammoth Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming.* University of New Mexico Press, Albuquerque.

Frison, G. C. and L. C. Todd (editors)

1987 *The Horner Site, The Type Site of the Cody Cultural Complex.* Academic Press, New York.

Frison, G. C. and D. A. Walker (editors)

1984 The Dead Indian Creek Site: An Archaic Occupation in the Absoroka Mountains of Northwest Wyoming. *The Wyoming Archaeologist* 27(1-2):11-122.

Frison, G. C., M. Wilson, and D. J. Wilson

1976 Fossil Bison and Artifacts from an Early Altithermal Period Arroyo Trap in Wyoming. *American Antiquity* 41(1):28-57.

Frison, G. C. and G. Ziemans

1980 Bone Projectile Points: An Addition to the Folsom Cultural Complex. *American Antiquity* 45:231-237.

Fritts, H. C.

1983 Tree-Ring Dating and Reconstructed Variations in Central Plains Climate. *Transactions of the Nebraska Academy of Sciences,* XI (Special Issue):37-41.

Frye, J. C. and O. S. Fent

1947 The Late Pleistocene Loesses of Central Kansas, *State Geological Survey of Kansas, Bulletin* 70 (3), Lawrence.

Frye, J. C. and B. A. Leonard

1951 Stratigraphy of Late Pleistocene Loesses of Kansas. *Journal of Geology* 59:287-305.

1952 *Pleistocene Geology of Kansas.* State Geological Survey of Kansas, Bulletin 99.

1955 The Brady Soil and Subdivision of Post-Sangamonian Time in the Midcontinent Region. *American Journal of Science* 253:358-364.

1957 Ecological Interpretations of Pliocene and Pleistocene Stratigraphy in the Great Plains Region. *American Journal of Science* 255:1-11.

Frye, J. C., and H. B. Willman

1973 Wisconsinan Climatic History Interpreted from Lake Michigan Lobe Deposits and Soils; In *The Wisconsinan Stage,* edited by R. F. Black, R. P. Golthwait, and H. B. Willman, pp. 135-152. Geological Society of America, Memoir 136.

Frye, J. C., H. B. Willman, and R. F. Black

1965 Outline of Glacial Geology in Illinois and Wisconsin. In *The Quaternary of the United States,* edited by H. E. Wright and D. G. Frey, pp. 42-61. Princeton University Press.

Frye, J. C., N. Plummer, R. T. Runnels, and W. B. Hladik

1949 Ceramic Utilization of Northern Kansas Pleistocene Loesses and Fossil Soils, 1949 Reports of Northern Kansas Pleistocene Studies, Part 3, *State Geological Survey of Kansas, Bulletin* 82:49-124.

Fulgham, T. and D. J. Stanford

1982 The Frasca Site: A Preliminary Report. *Southwestern Lore* 48:1-9.

Fuller, D. W.

1976 Archaeological Excavations within the El Dorado Reservation Area, Kansas (1974). Ms. on file, Butler County Planning Office, El Dorado.

1977 Archaeological Excavations within the El Dorado Reservation Area, Kansas (1975). Ms. on file, Butler County Planning Office, El Dorado.

Galinat, W. C.
1965 The Evolution of Corn and Culture in North America. *Economic Botany* 19:350-357.
1985 Domestication and Diffusion of Maize. In *Prehistoric Food Production in North America*, edited by R. Ford, pp. 245-278. Anthropological Papers, Museum of Anthropology, University of Michigan, Ann Arbor.

Galloway, E. and G. Agogino
1961 The Johnson Site: A Folsom Campsite. *Plains Anthropologist* 6:205-208.

Galm, J. and J. L. Hofman
1984 The Billy Ross Site: Analysis of a Dalton Component from the Southern Arkansas Basin of Eastern Oklahoma. *Bulletin of the Oklahoma Anthropological Society* 33: 37-73.

Gamble, C. S.
1982 Interaction and Alliance in Paleolithic Society. *Man* 17:92-107.
1986a *The Paleolithic Settlement of Europe.* Cambridge University Press. Cambridge.
1986b The Mesolithic Sandwich: Ecological Approaches and the Archaeological Record of the Early Post-Glacial. In *Postglacial Adaptations in the Temperate Regions of the Old World*, edited by M. Zvelebil, pp. 33-42. Cambridge University Press. Cambridge.

Gamble, G. C. and W. A. Boismier (editors)
1991 *Ethnoarchaeological Approaches to Mobile Campsites.* International Monographs in Prehistory, Ethnoarchaeological Series 1. Ann Arbor, Michigan.

Gant, R. D.
1963 Preliminary Report of the Gavins Point Project #2, An Archaeological Survey of Lewis and Clark Lake. Ms. on file, Fish, Game and Park Commission, Bloomfield.
1966 Nebraska State Historical Society Highway Salvage Archeology Report No. 10. Ms. on file, Nebraska State Historical Society, Lincoln.
1967 *Report of the Archaeological Investigations at the Arp Site, 39BR101, Brule County, South Dakota, 1961.* Archaeological Studies Circular 12. W. H. Over Dakota Museum, University of South Dakota, Vermillion.

Gardner, W. M.
1983 Stop Me If You've Heart This One Before: The Flint Run Paleoindian Complex Revisited. *Archaeology of Eastern North America* 11:49-64.

Garn, S. M.
1966 Malnutrition and Skeletal Development in the Pre-School Child. In *Pre-School Malnutrition: Primary Deterrent to Human Progress*, pp. 43-62. International Conference on Prevention of Malnutrition in the Pre-School Child, 1964. National Academy of Sciences-National Research Council, Washington, D.C.
1970 *The Earlier Gain and the Later Loss of Cortical Bone.* C. C. Thomas, Springfield, Illinois.
1972 The Course of Bone Gain and the Phases of Bone Loss. *Orthopedic Clinics of North America* 3:503-520.

Garn, S. M. and P. M. Schwager
1967 Age Dynamics of Persistent Transverse Lines in the Tibia. *American Journal of Physical Anthropology* 27(3):375-378.

Garn, S. M., M. A. Guzman, and B. Wagner
1969 Subperiosteal Gain and Endosteal Loss in Protein-Calorie Malnutrition. *American Journal of Physical Anthropology* 30:153-156.

Garn, S. M., C. G. Rohmenn, M. Behar, F. Viteri, and M. A. Guzman
1964 Compact Bone Deficiency in Protein-Calorie Malnutrition. *Science* 145:1444-1445.

Garrett, J. W.
1964 *Highway Archeological and Historical Salvage Program, 1961-1962.* Nebraska State Historical Society, Lincoln.

Geneste, J-M. and H. Plisson
1993 Hunting Technologies and Human Behavior: Lithic Analysis of Solutrean Shouldered Points. In *Before Lascaux, the Complex Record of the Early Upper Paleolithic*, edited by H. Knecht, A. Pike-Tay, and R. White, pp. 117-135. CRC Press, Boca Raton.

Giessen, M.
1988 Processual Analysis of the Bone, Antler and Shell Artifact Assemblage from House 2 at Annie's Site. In *St. Helena Archaeology: New Data, Fresh Interpretations*, edited by D. J. Blakeslee, pp. 133-156. J & L Reprints in Anthropology 39. Lincoln.

Gifford-Gonzalez, D.
1991 Bones Are Not Enough: Analogues, Knowledge, and Interpretive Strategies in Zooarchaeology. *Journal of Anthropological Archaeology* 10: 215-254.

Gilbert, B. M.
1969 Some Aspects of Diet and Butchering Techniques Among Prehistoric Indians in South Dakota. *Plains Anthropologist* 14:277-294.

Gilder, R. F.
1907a The Nebraska Loess Man. *Record of the Past* 6(2): 35-39.
1907b Archaeology of the Ponca Creek District, Eastern Nebraska. *American Anthropologist*, new series, 9(4):702-719.
1908 Recent Excavations at Long's Hill, Nebraska. *American Anthropologist* 10:60-73.
1909 Excavation of Earth-Lodge Ruins in Eastern Nebraska. *American Anthropologist* 11:56-84
1911 Discoveries Indicating an Unexploited Culture in Eastern Nebraska. *Records of the Past* 10(5):249-259.
1912 Prehistoric Village Sites of Harrison County, Iowa. *Annals of Iowa* 10(6):401-407.

Gile, L. H.
1979 Holocene Soils in Eolian Sediments of Bailey County, Texas. *Soil Science Society of America Journal* 43:994-1003.

Gill, G. W. and R. O. Lewis
1977 A Plains Woodland Burial from the Badlands of Western Nebraska. *Plains Anthropologist* 22(75):67-74.

Gilmore, M. R.
1913 A Study in the Ethnobotany of the Omaha Indians. *Collections of the Nebraska State Historical Society* 17:314-357.
1919 *Uses of Plants by the Indians of the Missouri River Region.* Bureau of American Ethnology, 33rd Annual Report, Smithsonian Institution, Washington D.C.
1927 Origin of the Arikara Silver Berry Drink. *Indian Notes* 4:125-127.

Gindhart, P. S.
1969 The Frequency of Appearance of Transverse Lines in the Tibia in Relation to Childhood Illnesses. *American Journal of Physical Anthropology* 31:17-22.

Goebel, T., R. Powers, and N. Bigelow
1991 The Nenana Complex of Alaska and Clovis Origins. In *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp. 49-79. Center for the Study of the First Americans, Corvallis.

Goldsmith, C. M.
1990 *Metacarpal Entheses Changes as Evidence of Labor Differences in Non-Agricultural and Agricultural American Indian Skeletons.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Tennessee, Knoxville.

Good, D. F.
1986 From Resurrection to Reburial: Skeletal Remains from 14SH338, The Old Topeka Cemetery. *Journal of the Kansas Anthropological Society* 6(7&8):120-130.

Goode, G. T. and R. J. Mallouf
1991 The Evant Cores: Polyhedral Blade Cores from North-Central Texas. *Current Research in the Pleistocene* 8:67-70.

Gooding, J. D.
1981 *The Archaeology of Vail Pass Camp.* Colorado Department of Highways, Highway Salvage Report 35. Boulder.

Gooding, J. D. and L. W. Shields
1985 *Sisyphus Shelter.* Bureau of Land Management of Colorado. Cultural Resources Series 18. Denver.

Goodman, A. H. and G. A. Clark
1981 Harris Lines as Indicators of Stress in Prehistoric Illinois Populations. In *Biocultural Adaptation: Comprehensive Approaches to Skeletal Analysis,* edited by D. L. Martin and M. P. Bumsted, pp. 35-46. Research Reports No. 20. Department of Anthropology, University of Massachusetts, Amherst.

Goodwin, H. T.
1990. *Systematics, Biogeography, and Evolution of Fossil Prairie Dogs (Genus* Cynomys). Unpublished Ph. D. dissertation, University of Kansas, Lawrence.

Goodyear, A. C.
1974 *The Brand Site: A Techno-Functional Study of a Dalton Site in Northeast Arkansas.* Arkansas Archeological Survey Research Series 7. Fayetteville.
1982 The Chronological Position of the Dalton Horizon in the Southeastern United States. *American Antiquity* 47:382-295.
1989 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleoindian Groups of North America. In *Eastern Paleoindian Lithic Resource Use,* edited by C. J. Ellis and J. C. Lothrop, pp. 1-10. Westview Press, Boulder.

Goodyear, A. C., L. M. Raab, and T. C. Klinger
1988 The Status of Archaeological Research Design in Cultural Resource Management. *American Antiquity* 43: 159-177.

Gordon, E. K. and J. Kranzush
1977 Cultural Resource Inventory Report: Boxelder Creek Watershed Project, Structure B-2. Ms. on file, Larimer County Planning Office, Fort Collins.

Gorman, F.
1972 The Clovis Hunters: An Alternative View of their Environment and Ecology. In *Contemporary Archaeology,* edited by M. P. Leone, pp. 206-221. Southern Illinois University Press, Carbondale.

Gould, R. A.
1980 *Living Archaeology.* Cambridge University Press, Cambridge.

Gould, R. A. and P. J. Watson
1982 A Dialogue on the Meaning and Use of Analogy in Ethnoarchaeological Reasoning. *Journal of Anthropological Archaeology* 1: 355-381.

Gradwohl, D. M.
1969 *Prehistoric Villages in Eastern Nebraska.* Nebraska State Historical Society, Publications in Anthropology 4.

Graham, R. W.
1976 *Pleistocene and Holocene Mammals, Taphonomy, and Paleoecology of the Friesenhahn Cave Local Fauna, Bexas County, Texas.* Unpublished Ph.D. dissertation, University of Texas, Austin.
1979 Paleoclimates and Late Pleistocene Faunal Provinces in North America. In *Pre-Llano Cultures of the Americas: Paradoxes and Possibilities,* edited by R. L. Humphrey and D. J. Stanford, pp. 49-70. The Anthropological Society of Washington, Washington, D.C.
1981 Preliminary Report on Late Pleistocene Vertebrates from the Selby and Dutton Archaeological/Paleontological Sites, Yuma County, Colorado. *Contributions to Geology, University of Wyoming* 20:33-56.
1985 Diversity and Community Structure of the Late Pleistocene Mammal Fauna of North America. *Acta Zoologica Fenn.* 170:181-182.
1986 Plant-Animal Interactions and Pleistocene Extinctions. In *Dynamics of Extinction*, edited by D. Elliot, pp. 131-154.
1987 Late Quaternary Mammalian Faunas and Paleoenvironments of the Southwestern Plains of the United States. In *Late Quaternary Mammalian Biogeography and Environments of the Great Plains and Prairies,* edited by R. W. Graham, H. A. Semken, Jr. and M. A. Graham, pp. 24-86. Illinois State Museum Scientific Papers 22, Springfield.
1990 Evolution of New Ecosystems at the End of the Pleistocene. In *Megafauna and Man: Discovery of America's Heartland,* edited L. D. Agenbroad, J. I. Mead, and L. W. Nelson, pp. 54-60. Hot Springs, South Dakota.

Graham, R. W. and E. C. Grimm
1990 Effects of Global Change on the Patterns of Terrestrial Biological Communities. *Trends in Ecology and Evolution* 5:289-292.

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

Graham, R. W. and J. L. Hofman
n.d. Paleoindian Cultures of the Great Plains. In *Prehistory of the Great Plains,* edited by W. R. Wood. University of Kansas Press, Lawrence.

Graham, R. W. and M. Kay
1988 Taphonomic Comparisons of Cultural and Noncultural Faunal Deposits at the Kimmswick and Barnhart Sites, Jefferson County, Missouri. In *Late Pleistocene and Early Holocene Paleoecology and Archeology of the Eastern Great Lakes Region,* edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 227-240. Bulletin of the Buffalo Society of Natural Sciences 33.

Graham, R. W. and E. L. Lundelius, Jr.
1984 Coevolutionary Disequilibrium and Pleistocene Extinctions. In *Quaternary Extinctions: A Prehistoric Revolution,* edited by P. S. Martin and R. G. Klein, pp. 223-249. University of Arizona Press, Tucson.

Graham, R. W. and J. I. Mead
1987 Environmental Fluctuations and Evolution of Mammalian Faunas During the Last Deglaciation of North America. In *North America and Adjacent Oceans During the Next Deglaciation,* edited by W. F. Ruddiman and H. E. Wright, Jr., pp. 371-402. The Geology of North America, Vol. K-3. Geological Society of America, Boulder.

Graham, R. W., H. Semken and M. Graham (editors)
1987 *Late Quaternary Mammalian Biogeography and Environments of the Great Plains and Prairies.* Illinois State Museum, Scientific Papers v. 22.

Gramly, R. M.
1982 *The Vail Site: A Palaeo-Indian Encampment in Maine.* Bulletin of the Buffalo Society of Natural Sciences 30.
1984 Kill Sites, Killing Ground and Fluted Points at the Vail Site. *Archaeology of Eastern North America* 12:110-121.
1993 *The Richey Clovis Cache: Earliest Americans along the Columbia River.* Persimmon Press Monographs in Archaeology, Buffalo.

Grand River Institute
1980 The Indian Hill Petroglyph Site 14EW1, Kanopolis Lake: Development of Alternative Mitigation Plans. Ms. on file, Kansas State Historical Society, Topeka.

Grange, R. T. Jr.
1962 Excavations in the Red Willow Reservoir, Nebraska, 1961. Ms. on file, Rolfsmeier Construction Company, Seward.
1963a Excavations in the Red Willow Reservoir, Nebraska. *Plains Anthropologist* 8(20).
1963b Archeological Survey of the Davis Creek Reservoir and the Calamus River Reservoir, Nebraska 1963. Ms. on file, SI-RBS, Lincoln.
1968 *Pawnee and Lower Loup Pottery.* Nebraska State Historical Society, Publications in Anthropology No. 3.
1974 *Pawnee Potsherds Revisited: Formula Dating of a Non-European Ceramic Tradition.* The Conference on Historic Site Archaeology Papers, 1972 7(4). Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

1979 An Archaeological View of Pawnee Origins. *Nebraska History* 60(2):134-160.

1980 *Archaeological Investigations in the Red Willow Reservoir*. Nebraska State Historical Society, Publication in Anthropology 9, Lincoln.

1984 Dating Pawnee Sites by the Ceramic Formula Method. *World Archaeology* 15(3):274-293.

Grant, M.

1978a Preliminary Reconnaissance of Threatened Resources in the Lower Poudre Canyon, Larimer County, Colorado. Ms. on file, U.S. Forest Service, Rocky Mountain Region, Lakewood.

1978b A General Overview of the Archeology of the Cache La Poudre River, Northern Colorado Front Range. Ms. on file, USFS, Rocky Mountain Region, Lakewood.

Gray, J. A., M. D. Francis, and W. J. Griebstein

1962 Chemistry of Enamel Dissolution. In *Chemistry and Prevention of Dental Caries*, edited by R. F. Sognnaes, pp. 164-179. C. C. Thomas, Springfield, Illinois.

Grayson, D. K.

1984 *The Establishment of Human Antiquity*. Academic Press, New York.

1986 Eoliths, Archaeological Ambiguity, and the Generation of "Middle-Range" Research. In *American Archaeology: Past and Future*, edited by D. J. Meltzer, D. Fowler and J. Sabloff, pp. 77-133. Smithsonian Institution Press.

1988 Perspectives on the Archaeology of the First Americans. In *Americans before Columbus: Ice-Age Origins*, edited by R. C. Carlisle, pp. 107-123. Ethnology Monograph 12. Department of Anthropology, University of Pittsburgh.

1991 Late Pleistocene Mammalian Extinctions in North America: Taxonomy, Chronology, and Explanations. *Journal of World Prehistory* 5:193-231.

Green, F. E.

1962 Additional Notes on Prehistoric Wells at the Clovis Site. *American Antiquity* 28:230-234.

1963 The Clovis Blades: An Important Addition to the Llano Complex. *American Antiquity* 29:145-165.

Green, J. P.

1975 McKean and Little Lake Technology: A Problem in Projectile Point Typology in the Great Basin of North America. In *Lithic Technology, Making and Using Stone Tools*, edited by Earl Swanson, pp. 159-172. Mouton, Paris.

Green, W.

1990 *Glenwood Culture Paleoenvironment and Diet: Analysis of Plant and Animal Remains from the Wall Ridge Earthlodge (13ML176), Mills County, Iowa*. Office of the State Archaeologist, Research Papers 15(6). Iowa City, Iowa.

1992 *Mills County Archaeology: The Paul Rowe Collection and Southwestern Iowa Prehistory*. Office of the State Archaeologist, Research Papers 17(5). Iowa City, Iowa.

Greenberg, J. H., C. Turner and S. Zegura

1986 The Settlement of the Americas: A Comparison of the Linguistic, Dental, and Genetic Evidence. *Current Anthropology* 27:477-497.

Greene, A. M.

1967 *The Betty Greene Site: A Late Paleo-Indian Site in Eastern Wyoming*. Unpublished Master's thesis, Department of Anthropology, University of Pennsylvania, Philadelphia.

Greenway, J.

1961 The Garcia Site. *Southwestern Lore* (News for Archaeologists) 27(3):42.

Gregg, J. B. and W. M. Bass

1970 Exostoses in the External Auditory Canals. *Annals of Otology, Rhinology, and Laryngology* 79:834-840.

1994 Erosion of the Supraorbital Plate. *Plains Anthropologist* 39(147):77-79.

Gregg, J. B. and P. S. Gregg

1987 *Dry Bones. Dakota Territory Reflected*. Sioux Printing, Sioux Falls, South Dakota.

Gregg, J. B., A. M. Holzhueter, J. P. Steele, and S. Clifford

1965 Some New Evidence on the Pathogenesis of Otosclerosis. *Laryngoscope* 75:1268-1292.

Gregg, J. B. and R. N. McGrew

1970 Hrdlicka Revisited (External Auditory Canal Exostoses). *American Journal of Physical Anthropology* 33:37-40.

Gregg, J. B., J. P. Steele, and W. M. Bass

1982 Unusual Osteolytic Defects in Ancient South Dakota Skulls. *American Journal of Physical Anthropology* 58(3):243-254.

Gregg, J. B., J. P. Steele, and A. Holzhueter

1965 Roentgenographic Evaluation of Temporal Bones from South Dakota Skulls. *American Journal of Physical Anthropology* 23:51-61.

Gregg, J. B., L. J. Zimmerman, J. P. Steele, H. Ferwerda, and P. S. Gregg

1981 Ante-mortem Osteopathology at Crow Creek. *Plains Anthropologist* 26:287-300.

Gregg, M. L.

1985 *An Overview of the Prehistory of Western and Central North Dakota*. Bureau of Land Management Montana, Cultural Resource Series 1. Billings.

1990 An Early Plains Woodland Structure in the Northeastern Plains. *Plains Anthropologist* 35(128).

Greiser, S. T.

1985 *Predictive Models of Hunter-Gatherer Subsistence and Settlement Strategies on the Central High Plains*. Plains Anthropologist Memoir 20. Lincoln.

Griffin, J. B.

1952 Some Early and Middle Woodland Pottery Types in Illinois. In *Hopewellian Communities in Illinois*, edited by T. Deuel, pp; 93-130. Illinois State Museum, Scientific Papers, No. 5, Springfield.

1985 The Formation of the Society for American Archaeology. *American Antiquity* 50(2): 261-271.

Grosser, R. D.

1970 The Snyder Site: An Archaic-Woodland Occupation in South-Central Kansas. Unpublished Master's thesis, University of Kansas, Lawrence.

1973 A Tentative Cultural Sequence for the Snyder Site, Kansas. *Plains Anthropologist* 18:228-238.

1977 Late Archaic Subsistence Patterns From the Great Plains: A Systemic Model. Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

1981 Federal Involvement in the Great Plains Archaeology. In *Method and Theory in Plains Archaeology: A Volume Dedicated to Carlyle Smith*, edited by A. E. Johnson, and L. J. Zimmerman, pp. 57-64. Special Publication of South Dakota Archaeology Society No 8, Vermillion.

Grüger, J.

1973 Studies on the Late-Quaternary Vegetation History of Northeastern Kansas. *Geological Society of America Bulletin* 84:239-250.

Gruhn, R.

1961 *The Archaeology of Wilson Butte Cave, South-Central Idaho*. Occasional Papers of the Idaho State Museum 6. Pocatello.

1988 Linguistic Evidence in Support of the Coastal Route of Earliest Entry into the New World. *Man* 23:77-100.

Gryba, E.

1983 *Sibbald Creek: 11,000 Years of Human Use of the Alberta Foothills*. Archaeological Survey of Alberta Occasional Paper No. 22. Edmonton.

1988 A Stone Age Pressure Method of Folsom Fluting. *Plains Anthropologist* 33:53-66.

Guffee, E. J.

1979 *The Plainview Site, Relocation and Archeological Investigation of a Late Paleo-Indian Kill Site in Hale County*, Texas. Archeological Research Laboratory Llano Estacado Museum, Plainview, Texas.

Guidon, N.

1986 Las Unidades Culturales de Sao Raimundo Nonato—Sudeste del Estado de Piaui—Brazil. In *New Evidence for the Pleistocene Peopling of the Americas,* edited by A. L. Bryan, pp. 157-171. Center for the Study of Early Man, Orono, Maine.

Gunnerson, D. A.

1972 Man and Bison on the Plains in the Prehistoric Period. *Plains Anthropologist* 17(55):1-10.

1974 *The Jicarilla Apaches: A Study in Survival.* Northern Illinois University Press, DeKalb.

Gunnerson, J. H.

1952 Some Nebraska Culture Pottery Types. *Plains Archaeological Conference News Letter* 5:34-49.

1960 *An Introduction to Plains Apache Archeology: The Dismal River Aspect.* Smithsonian Institution, Bureau of American Ethnology, Bulletin 173.

1968 Plains Apache Archeology: A Review. *Plains Anthropologist* 13(41):167-189.

1987 *Archaeology of the High Plains.* Bureau of Land Management, Colorado, Cultural Resource Series No. 19. Denver.

Gunnerson, J. H. and D. A. Gunnerson

1952 Appraisal of the Archeological and Paleontological Resources of the Lower Platte Basin, Nebraska: Supplement. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1971 Apachean Culture: A Study in Unity and Diversity. In *Apachean Culture History and Ethnology,* edited by K. H. Basso and M. E. Opler, pp. 7-27. University of Arizona, Anthropological Papers 21.

Gustafson, C. R. Daugherty, and D. Gilbow

1979 The Manis Mastodon Site: Early Man in the Olympic Peninsula. *Canadian Journal of Archaeology* 3:157-164.

Gutherie, H. A.

1979 *Introduction to Nutrition*. C. V. Mosby, St. Louis.

Guthrie, R. D.

1984b Mosaics, Allelochemics, and Nutrients: An Ecological Theory of Late Pleistocene Megafaunal Extinctions. In *Quaternary Extinctions: A Prehistoric Revolution,* edited by P. S. Martin and R. G. Klein, pp. 259-298. University of Arizona Press, Tucson.

1990 *Frozen Fauna of the Mammoth Steppe.* University of Chicago Press, Chicago.

Haas, D. R.

1983 *Walker Gilmore: A Stratified Woodland Period Occupation in Eastern Nebraska*. Laboratory Notebook No. 6, Department of Anthropology, University of Nebraska, Lincoln.

Haas, H., V. Holliday, and R. Stuckenrath

1986 Dating of Holocene Stratigraphy with Soluble and Insoluble Organic Fractions at the Lubbock Lake Archaeological Site, Texas: An Ideal Case Study. *Radiocarbon*, 28(2A):473-485.

Habicht-Mauche, J. A., A. A. Levendosky, and M. J. Schoeninger

1994 Antelope Creek Phase Subsistence: The Bone Chemistry Evidence. In *Skeletal Biology in the Great Plains, Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 291-304. Smithsonian Institution Press. Washington, D. C.

Hackett, C. J.

1976 *Diagnostic Criteria of Syphilis, Yaws and Treponarid (Treponematoses) and of Some Other Diseases in Dry Bones.* Springer-Verlag, Berlin.

Hall, E. S., Jr., S. C. Gerlach, and M. B. Blackman

1985 *In the National Interest: A Geographically Based Study of Anaktuvuk Pass Inupiat Subsistence Through Time* (2 volumes). North Slope Burrow. Burrow, Alaska.

Hall, R. L.

1961 *An Archaeological Investigation in the Gavins Point Area, Yankton County, South Dakota.* W. H. Over Museum, Museum News 22(7).

Hall, S. A.

1982 Late Holocene Paleoecology of the Southern Plains. *Quaternary Research* 17:391-407.

1988 Environment and Archaeology of the Central Osage Plains. *Plains Anthropologist* 33(120):203-218.

Hallberg, G. R.

1986 Pre-Wisconsin Glacial Stratigraphy of the Central Plains Region in Iowa, Nebraska, Kansas, and Missouri. In *Quaternary Glaciations in the Northern Hemisphere*, edited by V. Sibrava, D. Q. Bowen, and G. M. Richmond, pp. 11-15. Quaternary Science Reviews 5.

Hammond, G. P. and A. Rey (editors)

1940 *Narratives of the Coronado Expedition, 1540-1542.* University of New Mexico Press, Albuquerque.

Hamperl, H. and W. S. Laughlin

1959 Osteological Components of Scalping. *Human Biology* 31:80-89.

Hand, O. D.

1981 Archaeological Investigations of El Dorado Canyon State Park—Castlewood Acquisition. Ms. on file, Boulder County Planning Office, Boulder.

Hannus, L. A.

1985 The Lange/Ferguson Site—An Event of Clovis Mammoth Butchery With the Associated Bone Tool Technology. The Mammoth and its Track. Unpublished Ph.D. dissertation, Department of Anthropology, University of Utah.

1986 Report on 1985 Test Excavations at the Ray Long Site (39FA65), Angostura Reservoir, Fall River County, South Dakota. *South Dakota Archaeology* 10:48-104.

1990a Mammoth Hunting in the New World. In *Hunters of the Recent Past,* edited by L. B. Davis and B. O. K. Reeves, pp. 47-67. Unwin Hyman, London.

1990b The Lange/Ferguson Site: A Case for Mammoth Bone-Butchering Tools. In *Megafauna and Man, Discovery of America's Heartland,* edited L. D. Agenbroad, J. I. Mead, and L. W. Nelson, pp. 86-99. Hot Springs, South Dakota.

Harrington, M. R.

1971 *The Ozark Bluff Dwellers.* Museum of the American Indian, Indian Notes and Monographs 12. New York.

Harris, H. A.

1933 *Bone Growth in Health and Disease.* Oxford University Press, Cambridge, England.

Harrison, B. R. and K. L. Killen

1978 *Lake Theo: A Stratified, Early Man Bison Butchering and Camp Site, Briscoe County, Texas.* Panhandle Plains Historical Museum, Special Archaeological Report 1. Canyon, Texas.

Harrison, B. R. and H. C. Smith

1975 A Test Excavation of the Lake Theo Site, Briscoe County, Texas. *Panhandle-Plains Historical Review* 48:70-106.

Harrison, S. P., J. E. Kutzbach, C. I. Prentice, P. J. Behling, and M. T. Sykes

1995 The Response of Northern Hemisphere Extratropical Climate and Vegetation to Orbitally Induced Changes in Insolation During the Last Interglaciation. *Quaternary Research* 43:174-184.

Hartley, J. D.

1974 *The Von Elm Site: An Early Plains-Woodland Complex in North-Central Oklahoma.* Oklahoma River Basin Survey, Archaeological Site Report 28. Norman.

Hartley, R. J.
1978 Preliminary Assessment of Cultural Resources within Selected Areas of the Platte River Basin, Nebraska: Phase I. Ms. on file, U.S. Army Corps of Engineers, Omaha.

Hartwell, W. T., E. Johnson, V. T. Holliday, R. W. Ralph, and S. Lupton
1989 A Re-Evaluation of Ryan's Site: A Disturbed Plainview Cache on the Southern High Plains of Texas. *Current Research in the Pleistocene* 6:14-15.

Harvey, A. E.
1979 *Oneota Culture in Northwestern Iowa.* University of Iowa, Office of the State Archaeologist, Report No. 12.

Haspel, H. and G. C. Frison
1987 The Finley Site Bison Bone. In *The Horner Site, Type Site of the Cody Cultural Complex,* edited by G. C. Frison and L. C. Todd, pp. 475-491. Academic Press, Orlando.

Hassan, F. A.
1977 The Dynamics of Agricultural Origins in Palestine: A Theoretical Model. In *Agricultural Origins,* edited by C. Reed. The Hauge, Mouton.
1981 *Demographic Archaeology.* Academic Press, New York.

Hassler, R.
1989 The Effects of CRM: A Sociohistorical Perspective of the Department of Anthropology, University of Nebraska at Lincoln. *Plains Anthropologist* 34:111-128.

Haven, S. F.
1856 *Archaeology of the United States.* Smithsonian Contributions to Knowledge, vol. 8. no. 2. Washington, DC.

Hawley, D.
1995 *The Treasures of the Steamboat Arabia.* Arabia Steamboat Museum, Kansas City, Missouri.

Hawley, M. F.
1991 *Floyd Schultz: A Study of the Amateur in Anthropology.* Unpublished Master's thesis, Department of Anthropology, University of Kansas, Lawrence.
1993 A Keen Interest in Indians: Floyd Schultz, The Life and Work of an Amateur Anthropologist. *Kansas Archeologist* 14.

Hay, O. P.
1924 *The Pleistocene in the Middle Region of North America and its Vertebrated Animals.* Publications of the Carnegie Institute of Washington 322 A. Washington, D. C.

Hayden, B.
1982 Interaction Parameters and the Demise of Paleo-Indian Craftsmanship. *Plains Anthropologist* 27(96):109-123.

Hayden, F. V.
1862 On the Ethnography and Philology of the Indian Tribes of the Missouri Valley. *Transactions of the American Philosophical Society* 12:231-464.

Hayden, R.
1978 Preserving the Indian Petroglyphs of Kanopolis Lake. Ms. on file, Bureau of Reclamation, Lower Missouri Region, Denver.

Haynes, C. V., Jr.
1966 Elephant Hunting in North America. *Scientific American* 214:104-112.
1968 The Earliest American. *Science* 166:709-715.
1971 Time, Environment and Early Man. *Arctic Anthropology* 8:3-14.
1973 The Calio Site: Artifacts or Geofacts? *Science* 181:305-310.
1974 Archaeological Geology of Some Selected Paleo-Indian Sites. In *History and Prehistory of the Lubbock Lake Site,* edited by Craig C. Black. *The Museum Journal* 15:133-140. Lubbock.
1980 The Clovis Culture. *Canadian Journal of Anthropology* 1:115-121.
1982 Were Clovis Progenitors in Beringia? In *Paleoecology of Beringia,* edited by D. M. Hopkins, J. V. Mathews, Jr., C. E. Schweger, and S. B. Young, pp. 383-398. Academic Press, New York.
1987 Clovis Origins Update. *The Kiva* 52:83-93.
1991b Clovis-Folsom-Midland-Plainview Geochronology, Climatic Change and Extinction. Paper presented at the 56th Annual Meeting of the Society for American Archaeology. New Orleans.
1991a Geoarchaeological and Paleohydrological Evidence for a Clovis Age Drought in North America and its Bearing on Extinction. *Quaternary Research* 35:438-450.
1992 Contributions of Radiocarbon Dating to the Geochronology of the Peopling of the New World. In *Radiocarbon After Four Decades,* edited by R. E. Taylor, A. Long and R. S. Kra, pp. 355-374. Springer-Verlag, New York.
1993 Clovis-Folsom Geochronology and Climatic Change. In *From Kostenki to Clovis: Upper Paleolithic—Paleo-Indian Adaptations,* edited by O. Soffer and N. D. Praslov, pp. 219-236. Plenum Press, New York.

Haynes, C. V. and G. Agogino
1960 Geological Significance of a New Radiocarbon Date from the Lindenmeier Site. *Proceedings of the Denver Museum of Natural History* 9:1-23.
1986 *Geochronology of Sandia Cave.* Smithsonian Contributions to Anthropology, Number 32. Washington, D.C.

Haynes, C. V., R. Beukens, A. Jull and O. Davis
1992 New Radiocarbon Dates for Some Old Folsom Sites: Accelerator Technology. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 83-100. University Press of Colorado, Niwot.

Haynes, C. V., Jr., D. J. Donahue, A. J. T. Jull, and T. H. Zabel
1984 Application of Accelerator Dating to Fluted Point Paleoindian Sites. *Archaeology of Eastern North America* 12:184-191.

Haynes, C. V., Jr. and H. Hass
1974 Southern Methodist University Radiocarbon Date List I. *Radiocarbon* 16:368-380.

Haynes, C. V., Jr. and E. T. Hemmings
1968 Mammoth-Bone Shaft Wrench from Murray Springs, Arizona. *Science* 159:186-187.

Haynes, G.
1991 *Mammoths, Mastodons, and Elephants: Biology, Behavior, and the Fossil Record.* Cambridge University Press.

Haynes, H. W.
1893 Paleolithic Man in North America. *American Antiquarian* 15(1): 37-42.

Heavin, C. G.
1970 Two Nebraska Culture Storage Pits from Doniphan County, Kansas. *Plains Anthropologist* 15(47):54-62.

Hedden, J. G.
1992 *Riley Cord Roughened Ceramic Variability as Exhibited by the Assemblages from Ten Smoky Hill Sites in North-Central Kansas.* Unpublished Master's thesis, University of Kansas.

Heffner, M. L.
1973 Archeological Survey of the Lower Mud Creek Basin, Douglas and Leavenworth Counties, Kansas. Ms. on file, U.S. Army Corps of Engineers, Omaha.
1974 Temporal Variability of Some Kansas City Hopewell Projectile Points. Ms on file, Museum of Anthropology, University of Kansas, Lawrence.

Heiser, C. B., Jr.
1950 Studies on Helianthus. *American Philosophical Society, Yearbook* 1949:181-183.
1951 The Sunflower among the North American Indians. *Proceedings of the American Philosophical Society* 95:432-448.
1954 Variation and Subspeciation in the Common Sunflower, Helianthus Annuus. *American Midland Naturalist* 51:287-305.
1955 The Origin and Development of the Cultivated Sunflower. *American Biology Teacher* 17:161-167.

1976 *The Sunflower*. University of Oklahoma Press, Norman.
1985 Some Botanical Considerations of the Early Domesticated Plants North of Mexico. In *Prehistoric Food Production in North America*, edited by R. Ford, pp. 57-72. Anthropological Papers 75. Museum of Anthropology, University of Michigan, Ann Arbor.

Helgevold, M. K.
1980 Salvage Archaeology in South Dakota 1944-1969. *South Dakota Archaeology* 4:1-27.

Heller, F., X. Liu, T. Liu, and T. Xu
1991 Magnetic Susceptibility of Loess in China. *Earth and Planetary Science Letters* 103:301- 310.

Henderson, J. and G. T. Goode
1991 Pavo Real: An Early Paleoindian Site in South-Central Texas. *Current Research in the Pleistocene* 8:26-28.

Henning, D. R.
1967 Mississippian Influences on the Eastern Plains Border: An Evaluation. *Plains Anthropologist* 12:184-193.
1970 *Development and Interrelationships of Oneota Culture in the Lower Missouri River Valley*. Missouri Archaeologist 32.
1993 The Adaptive Patterning of the Dhegiha Sioux. *Plains Anthropologist* 38(146):253-264.

Hesse, I. S.
1995 *Folsom Mobility Patterns: Evidence from Non-Local Lithic Materials at the Knife River Flint Quarries*. Unpublished Master's thesis, Department of Anthropology, Northern Arizona University. Flagstaff.

Hester, J. J.
1962 A Folsom Lithic Complex from the Elida Site, Roosevelt County, New Mexico. *El Palacio* 69(2):92-113.
1966 Origins of the Clovis Culture. *Proceedings of the XXXVI International Congress of Americanists* 36:127-138.
1972 *Blackwater Draw Locality No. 1: A Stratified Early Man Site in Eastern New Mexico*. Fort Burgwin Research Center Publication 8, Southern Methodist University. Dallas.
1975 Paleoarchaeology of the Llano Estacado. In *Late Pleistocene Environments of the Southern High Plains*, edited by F. Wendorf and J. J. Hester, pp. 247-256. Fort Burgwin Research Center, Ranchos de Taos.

Hester, J. J. and M. Grady
1977 Paleoindian Social Patterns on the Llano Estacado. In *Paleoindian Lifeways*, edited by E. Johnson, pp. 78-96. The Museum Journal 17. Lubbock, Texas.

Hester, T. R., D. Gilbow, and A. D. Albee
1973 A Functional Analysis of "Clear Fork" Artifacts From the Rio Grande Plain, Texas. *American Antiquity* 38(1):90-96.

Hibbard, C. W.
1970 Pleistocene Mammalian Local Faunas from the Great Plains and Central Lowland Provinces of the United States. In *Pleistocene and Recent Environment of the Central Great Plains*, edited by W. Dort Jr. and J. K. Jones Jr., pp. 395-433. University of Kansas Press, Lawrence.

Hibben, F. C.
1941 *Evidence of Early Man in Sandia Cave, New Mexico*. Smithsonian Miscellaneous Collections 99(23).

Hill, A. T.
1932 The Ruins of a Prehistoric House in Howard County, Nebraska. *Nebraska History Magazine* 13(3):172-175.

Hill, A. T. and P. Cooper
1936a The Schrader Site. *Nebraska History Magazine* 17(4):223-252.
1936b The Champe Site. *Nebraska History Magazine* 17(4):253-270.
1936c Fremont I. *Nebraska History Magazine* 17(4):271-292.
1938 The Archeological Campaign of 1937. *Nebraska History Magazine* 18(4): 237-359.

Hill, A. T. and M. Kivett
1940 Woodland-like Manifestations in Nebraska. *Nebraska History Magazine* 18:237-359.

Hill, A. T. and W. R. Wedel
1936 Excavations at the Leary Indian Village and Burial Site, Richardson County, Nebraska. *Nebraska History Magazine* 17(1): 2-73.

Hill, M. A.
1988 The Bone Tool Assemblage of the St. Helena Phase. In *St. Helena Archaeology: New Data, Fresh Interpretations*, edited by D. J. Blakeslee, pp. 99-132. J & L Reprints in Anthropology, 39. Lincoln.

Hill, M. E.
1994 *Paleoindian Archaeology and Taphonomy of the 12 Mile Creek Site in Western Kansas*. Unpublished Master's thesis, Department of Anthropology, University of Kansas.
1996 Paleoindian Bison Remains from the 12 Mile Creek Site in Western Kansas. *Plains Anthropologist* 41(158):359-372.

Hill, M. E. and J. L. Hofman
1992 Faunal remains from the Norton Bonebed (14SC6): A New Paleoindian Site in Western Kansas. Paper presented at the 50th Annual Plains Anthropological Conference, Lincoln.
1995 Reconstructing the Formation of the Norton Bison Bone Bed in Western Kansas. Paper Presented at the 53rd Annual Meeting of the Plains Anthropological Society, Laramie.

Hill, M. E., J. L. Hofman, and L. D. Martin
1992 A Reinvestigation of the Burntwood Creek Bison Bonebed. *Current Research in the Pleistocene* 9:9-102.
1993 Bone Attritional Processes at the 12 Mile Creek Site, Kansas. *Current Research in the Pleistocene* 10: 67-69.

Hill, M. G.
1994 Subsistence Strategies by Folsom Hunters at Agate Basin, Wyoming: A Taphonomic Analysis of the Bison and Pronghorn Assemblages. Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Hillerud, J. M.
1970 *Subfossil High Plains Bison* (2 volumes). Unpublished Ph.D. dissertation, Department of Geology, University of Nebraska.

Himes, J. H.
1978 Bone Growth and Development in Protein-Calorie Malnutrition. *World Review of Nutrition and Dietetics* 28:143-187.

Himes, J. H., R. Martorel, J. P. Habicht, C. Yarbrough, R. M. Malina, and R. E. Klein
1975 Patterns of Cortical Bone Growth in Moderately Malnourished Preschool Children. *Human Biology* 47:337-350.

Hitchcock, R. K.
1982 Patterns of Sedentism Among the Basarwa of Eastern Botswana. In *Politics and History in Band Societies*, edited by E. Leascock and R. B. Lee, pp. 223-267. Cambridge University Press.

Hoard, R. J., J. R. Bozell, S. R. Holen, M. D. Glascock, H. Neff, and J. M. Elam
1993 Source Determination of White River Group Silicates from two Archaeological Sites in the Great Plains. *American Antiquity* 58:698-710.

Hoard, R. J., S. R. Holen, M. D. Glascock, H. Neff, and J. M. Elam
1992 Neutron Activation Analysis of Stone from the Chadron Formation and a Clovis Site on the Great Plains. *Journal of Archaeological Science* 19:655-665.

Hodge, F. W.
1900 Pueblo Ruins in Kansas. *American Anthropologist* 2(4): 778.

Hoffman, J. J.
1968 *The La Roche Site*. River Basin Surveys, Publications in Salvage Archaeology, No. 11, Smithsonian Institution, Washington D.C.

Hofman, J. L.
1977 A Technological Analysis of Clear Fork Gouge Production. *Bulletin of the Oklahoma Anthropological Society* 26:105-121.

1978 Gouge Production Strategies: Toward the Study of Archaic Local Groups on the Southern Plains. *Wyoming Contributions to Anthropology* 1:154-164. Laramie.

1986a Vertical Movement of Artifacts in Alluvial and Stratified Deposits. *Current Anthropology* 27(2):163-171.

1986b *Hunter-Gatherer Mortuary Variability: Toward an Explanatory Model.* University Microfilms International, Publication 86-11599. Ann Arbor.

1987 The Occurrence of Folsom Points in Oklahoma. *Current Research in the Pleistocene* 4:57-59.

1988 Folsom Research in Western Oklahoma: Rethinking the Folsom Occupation of the Southern Plains. *Transactions of the 23rd Regional Archaeological Symposium for Southeastern New Mexico and Western Texas,* pp. 6-30. Southwestern Federation of Archaeological Societies. Amarillo.

1989 Prehistoric Culture-History: Hunters and Gatherers in the Southern Great Plains. In *From Clovis to Comanchero: Archaeological Overview of the Southern Great Plains,* by J. L. Hofman, et al., pp. 25-60. Arkansas Archeological Survey Research Series 35. Fayetteville.

1990a Cedar Creek: A Folsom Locality in Southwestern Oklahoma. *Current Research in the Pleistocene* 7:19-23.

1990b Salt Creek, Recent Evidence from the Eastern Folsom Margin in Central Oklahoma. *Plains Anthropologist* 35(132):367-374.

1990c Paleoindian Mobility and Utilization of Niobrara or Smoky Hill Jasper on the Southern Plains. *The Kansas Anthropologist* 9(2):1-13.

1991a Folsom Land Use: Projectile Point Variability as a Key to Mobility. In *Raw Material Economies Among Prehistoric Hunter-Gatherers,* edited by A. Montet-White and S. Holen, pp. 335-355. University of Kansas Department of Anthropology Publications in Anthropology 19. Lawrence.

1991b Sites, Localities, and Isolates: A Regional Perspective on Southern Plains Folsom Evidence. Presented at the Society for American Archaeology Meeting, New Orleans. In *Folsom Archaeology*, edited by P. Jodry and D. J. Stanford, in press. Smithsonian Institution Press.

1991c Terminal Pleistocene Archaeology of the Northwestern Oklahoma Area: Clovis and Folsom Evidence. In *A Prehistory of the Plains Border Region,* edited by B. J. Carter and P. A. Ward, pp. 38-49. Guidebook of the 9th Annual Meeting of the South-Central Friends of the Pleistocene. Oklahoma State University, Stillwater.

1992a Recognition and Interpretation of Folsom Technological Variability on the Southern Plains. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 193-224. University Press of Colorado, Boulder.

1992b An Ode to Collections Lost. In *Guide to the Identification of Certain American Indian Projectile Points,* by Robert E. Bell, Special Bulletin No. 1, Oklahoma Anthropological Society (1992 edition). Norman.

1993 An Initial Survey of the Folsom Complex in Oklahoma. *Bulletin of the Oklahoma Anthropological Society* 41:71-105.

1994a Paleoindian Aggregations on the Great Plains. *Journal of Anthropological Archaeology* 13(4):.341-370.

1994b Kansas Folsom Evidence. *Kansas Anthropologist* 15(2):31-43.

1994c Folsom Fragments, Site Types, and Prehistoric Behavior. Paper presented at the 52nd Annual Plains Anthropological Conference, Lubbock.

1995a The Busse Cache: A Clovis-Age Find in Northwestern Kansas. *Current Research in the Pleistocene* 12:17-19.

1995b Dating Folsom Occupations on the Southern Plains: The Lipscomb and Waugh Sites. *Journal of Field Archaeology* 22(4):421-437.

1996a Implications of a Tiny Folsom Bead: Some Big Issues in Paleoindian Research. Paper presented at the 61st Annual Meeting of the Society for American Archaeology, New Orleans.

1996b Changing the Plains Archaic. In *Changing Perspectives of the Archaic in the Northwestern Plains and Rocky Mountains,* edited by M. L. Larson and J. Francis. University of South Dakota Press. in press.

Hofman, J. L., D. S. Amick, and R. O. Rose

1990 Shifting Sands: A Folsom-Midland Assemblage from a Campsite in Western Texas. *Plains Anthropologist* 35(129):221-253.

Hofman, J. L., R. L. Brooks, J. S. Hays, D. W. Owsley, R. L. Jantz, M. K. Marks, and M. H. Manhein

1989 *From Clovis to Comanchero: Archeological Overview of the Southern Great Plains.* Arkansas Archeological Survey Research Series No. 35.

Hofman, J. L. and J. G. Enloe (editors)

1992 *Piecing Together the Past: Applications of Refitting Studies in Archaeology.* BAR International Series 578. Oxford.

Hofman, J. L. and I. S. Hesse

1996 Kansas Clovis. Paper Presented at the 54th Annual Plains Anthropological Conference, Iowa City.

Hofman, J. L., M. E. Hill, Jr., W. C. Johnson, and D. T. Sather

1995 Norton: An Early-Holocene Bison Bone Bed in Western Kansas. *Current Research in the Pleistocene* 12:19-21.

Hofman, J. L. and E. E. Ingbar

1988 A Folsom Hunting Overlook in Eastern Wyoming. *Plains Anthropologist* 33 (121):337-350.

Hofman, J. L., D. Sather, and M. E. Hill

1992 Broken Rocks from the Norton Bonebed: Lithics from a Late Paleoindian Site in Western Kansas. Paper presented at the 50th annual meeting of the Plains Anthropological Society, Lincoln.

Hofman, J. L. and L. C. Todd

1990 The Lipscomb Bison Quarry: 50 Years of Research. *Transactions of the 25th Regional Archeological Symposium for Southeastern New Mexico and Western Texas,* pp. 43-58. Midland, Texas.

1995 Lipscomb: Just Another Paleoindian Bison Bonebed? (Tyranny in the Archaeological Record of Specialized Hunters). Paper presented at the Annual Meeting of the Society for American Archaeology, Minneapolis.

Hofman, J. L., L. C. Todd and M. B. Collins

1991 Identification of Central Texas Edwards Chert at the Folsom and Lindenmeier Sites. *Plains Anthropologist* 36(137):297-308.

Hofman, J. L., L. C. Todd, C. B. Schultz, and W. J. Hendy

1991 The Lipscomb Bison Quarry: Continuing Investigation at a Folsom Kill-Butchery Site on the Southern Plains. *Bulletin of the Texas Archeological Society* 60:149-189.

Hofman, J. L. and D. G. Wyckoff

1991 Clovis Occupation in Oklahoma. *Current Research in the Pleistocene* 8:29-32.

Holder, P.

1970 *The Hoe and the Horse on the Plains. A Study of Cultural Development Among North American Indians.* University of Nebraska Press, Lincoln.

Holder, P. and J. Wike

1949 The Frontier Culture Complex, A Preliminary Report on a Prehistoric Hunters' Camp in Southwestern Nebraska. *American Antiquity* 14:260-266.

1950 The Allen Site (FT-50): Archeological Evidence of an Early Hunters' Camp on Medicine Creek, Frontier County, Nebraska. UUAP 11

Holen, S. R.

1983a A Preliminary Report of the South Loup River Survey. Ms. on file Nebraska State Historical Society, Lincoln.

1983b *Lower Loup Lithic Procurement Strategy at the Gray Site, 25CX1.* Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

1986 The Angus Mammoth: A Reappraisal. Paper presented at the Plains Anthropological Conference, Denver, Colorado.

1989 The Native American Occupation of the Sand Hills. In *An Atlas of the Sand Hills.* Resource Atlas 5, Conservation and Survey Division, Nebraska Geological Survey, edited by A. Bleed and C. Flowerday. University of Nebraska, Lincoln.

1991 Bison Hunting Territories and Lithic Acquisition Among the Pawnee: An Ethnohistoric and Archaeological Study. In *Raw Material Economies Among Prehistoric Hunter-Gatherers,* edited by A. Montet-White and S. Holen, pp. 399-411. University of Kansas, Publications in Anthropology 19.

1993 The Lovewell Mammoth: A Late Wisconsinan Man/Mammoth Association in Northcentral Kansas. Paper presented at the Flint Hills Conference, Wichita.

1994 Did Someone Eat the La Sena Mammoth? *Nebraska History Magazine* 75(1):88.

Holen, S. R. and R. K. Blasing

1989 Two Late Pleistocene Sites in the Central Plains: Preliminary Statements. Paper presented at the Plains Anthropological Conference. Sioux Falls, South Dakota.

Holen, S. R., R. K. Blasing, D. W. May, and C. L. Burres

1990 La Sena Site: A Mammoth Bone Processing Site in Late Wisconsinan Loess. Paper presented at the 48th Plains Anthropological Conference, Oklahoma City, Oklahoma.

Holen, S. R. and D. W. May

1994 Sites Without Lithics: Mammoth Bone Processing Sites in Late Wisconsinan Loess in Nebraska. Paper presented at the 27th Canadian Archaeological Association Meeting, Edmonton.

Holien, C. W.

1982 *Origin and Geomorphic Significance of Channel-Bar Gravel of the Lower Kansas River.* Master's thesis, University of Kansas.

Holliday, V. T.

1982 *Morphological and Chemical Trends in Holocene Soils at the Lubbock Lake Archaeological Site, Texas.* Unpublished Ph.D. dissertation, University of Colorado, Boulder.

1985 New Data on the Stratigraphy and Pedology of the Clovis and Plainview Sites, Southern High Plains. *Quaternary Research* 23:388-402.

1987a Geoarchaeology and Late Quaternary Geomorphology of the Middle South Platte River, Northeastern Colorado. *Geoarchaeology: An International Journal* 2 :317-329.

1987b A Re-examination of Late-Pleistocene Boreal Forest Reconstructions for the Southern High Plains. *Quaternary Research* 28:238-244.

1989 Middle Holocene Drought on the Southern High Plains. *Quaternary Research* 31:74-82.

Holliday, V. T. (editor)

1986 *Guidebook to the Archaeological Geology of Classic Paleoindian Sites on the Southern High Plains, Texas and New Mexico.* Geological Society of America Guidebook, Department of Geography, Texas A&M University, College Station.

Holliday, V. T. (editor)

1988 *Guidebook to the Archaeological Geology of the Colorado Piedmont and High Plains of Southeastern Wyoming.* Geological Society of America, Annual Meeting, Denver.

Holliday, V. T., C. V. Haynes, Jr., J. L. Hofman, and D. J. Meltzer

1994 Geoarchaeology and Geochronology of the Miami (Clovis) Site, on the Southern High Plains of Texas. *Quaternary Research* 41:234-244.

Holliday, V. T., E. Johnson, H. Haas and R. Stuckenrath

1983 Radiocarbon Ages from the Lubbock Lake Site, 1950-1980: Framework for Cultural and Ecological Change on the Southern High Plains. *Plains Anthropologist* 28:165-182.

1985 Radiocarbon Ages from the Lubbock Lake Site, 1981-1984. *Plains Anthropologist* 30:277-291.

Holliday, V. T., and D. J. Meltzer

1996 Geoarchaeology of the Midland (Paleoindian) Site, Texas. *American Antiquity* 61:755-771.

Hollimon, S. E. and D. W. Owsley

1994 Osteology of the Fay Tolton Site: Implications for Warfare during the Initial Middle Missouri Variant. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 345-353. Smithsonian Institution Press, Washington, D.C.

1995 *Stratigraphy and Paleoenvironments of Late Quaternary Valley Fills on the Southern High Plains.* Geological Society of America Memoir 186. Boulder.

Holman, J. A.

1976 Paleoclimatic Implications of "Ecologically Incompatible" Herpetological Species (Late Pleistocene: Southeastern United States). *Herpetologica* 32:290-295.

1984 Herpetofaunas of the Duck Creek and Williams Local Faunas (Pleistocene-Illinoian) of Kansas. In *Contributions in Quaternary Vertebrate Paleontology-A Volume in Memoriam to John E. Guilday,* edited by H. H. Genoways and M. R. Dawson, pp. 20-38. Special Publications of Carnegie Museum of Natural History, No. 8.

Holmes, W. H.

1892 Modern Quarry Refuse and Paleolithic Theory. *Science* 20:295-297.

1902 Fossil Human Remains Found Near Lansing, Kansas. *American Anthropologist* 4:743-752.

1919 *Handbook of Aboriginal American Antiquities.* Bureau of American Ethnology, Bulletin 60, 51-39.

Holzhueter, A. M., J. B. Gregg, and S. Clifford

1965 A Search for Stapes Footplate Fixation in an Indian Population, Prehistoric and Historic. *American Journal of Physical Anthropology* 23:35-40.

Hopkins, D. M.

1975 Time-Stratigraphic Nomenclature for the Holocene Epoch. *Geology* 3:10.

Hotopp, J.

1978a Glenwood: A Contemporary View. In *The Central Plains Tradition: Internal Development and External Relationships,* edited by D. J. Blakeslee, pp. 109-133. Office of the State Archaeologist, University of Iowa, Report 11.

1978b *A Reconsideration of Settlement Patterns, Structures, and Temporal Placement of the Central Plains Tradition in Iowa.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Iowa, Iowa City.

1982 Some Observations on the Central Plains Tradition in Iowa. In *Plains Indian Studies: A Collection of Essays in Honor of John C. Ewers and Waldo R. Wedel,* edited by D. H. Ubelaker and H. J. Viola, pp. 173-192. Smithsonian Contributions to Anthropology 30.

Howard, C. D.

1973 A Study of the Clear Fork Gouge. *Bulletin of the Texas Archaeological Society* 44:51-60.

Howard, E. B.

1935 Evidence of Early Man in North America. *The Museum Journal* 24: 61-171.

1936 The Occurrence of Flints and Extinct Animals in Fluvial Deposits Near Clovis, New Mexico, Part 1: Introduction. *Proceedings of the Academy of Natural Sciences of Philadelphia* 87:299-303.

1939 Folsom and Yuma Points from Saskatchewan. *American Antiquity* 4(3):277-279.

1943 The Finley Site: Discovery of Yuma Points in Situ Near Eden, Wyoming. *American Antiquity* 8:224-234.

Howard, J. H.

1964 Archeological Investigations in the Toronto Reservoir Area, Kansas. BAE-B 189, RBS-P 38

1970 1969 Archaeological Investigations at the Weston and Hogshooter Sites, Osage and Washington Counties. *Bulletin of the Oklahoma Anthropological Society* 19:61-99.

Howard, J. H. and R. S. Gant

1965 Archaeological Salvage Investigations in the Gavins Point Reservoir Area, Lewis and Clark Lake, Nebraska and South Dakota 1963 and 1964. Ms. on file, NPS, Midwest Archeological Center, Lincoln.

1966 *Report of the Archaeological Salvage Investigations in the Gavins Point Reservoir Area, Lewis and Clark Lake, Nebraska and South Dakota 1963 and 1964.* University of South Dakota Archaeological Circular No. 11, W. H. Over Museum, Pierre.

Hrdlicka, A.

1903 The Lansing Skeleton. *American Anthropologist* 5:323- 330.

1907 *Skeletal Remains Suggesting or Attributed to Early Man in North America.* Bureau of American Ethnology, Bulletin 33.

1912 Early Man in America. *American Journal of Science* 34: 543-554.

1918 *Recent Discoveries Attributed to Early Man in America.* Bureau of American Ethnology Bulletin 66.

1928 The Origins and Antiquity of Man in America. *Bulletin of the New York Academy of Medicine* 4: 802-816.

Huckell, B.

1978 Hudson-Meng Chipped Stone. In *The Hudson-Meng Site: An Alberta Bison Kill in the Nebraska High Plains,* by L. D. Agenbroad, pp. 153-191. The University Press of America.

1982 *The Distribution of Fluted Points in Arizona: A Review and an Update.* University of Arizona, Arizona State Museum, Archaeological Series 145. Tucson.

Hudson, L.

1982 *Changes in Pawnee Lithic Economy in the Eighteenth and Nineteenth Centuries.* Unpublished Master's thesis, Department of Anthropology, University of Iowa, Iowa City.

Hughes, J. T.

1949 Investigations in Western South Dakota and Northeastern Wyoming. *American Antiquity* 14:266-277.

1980 Some Early and Northerly Occurrences of the Clear Fork Gouge. In *Papers on the Prehistory of Northeast Mexico and Adjacent Texas,* edited by J. F. Epstein, T. R. Hester, and C. Graves, pp. 143-146. Center for Archaeological Research Special Report 9, University of Texas at San Antonio.

Hughes, R. E.

1995 Source Identification of Obsidian from the Trowbridge Site (14WY1), A Hopewell Site in Kansas. *Midcontinental Journal of Archeology* 20(1):105-113.

Hughey, D. V.

1980 An Overview of Great Plains Physical Anthropology. In *Anthropology on the Great Plains*, edited by W. R. Wood and M. Liberty, pp. 52-67. University of Nebraska Press, Lincoln.

Hummert, J. R.

1982 Skeletal Analysis of Burials at Site 5AH244 in the City of Aurora. Ms. on file, Aurora Historical Society, Aurora, Colorado.

1983 Cortical Bone Growth and Dietary Stress Among Subadults from Nubia's Batn El Hajar. *American Journal of Physical Anthropology* 62:167-176.

Humphrey, J. D. and C. R. Ferring

1994 Stable Isotopic Evidence for Latest Pleistocene and Holocene Climatic Change in North-Central Texas. *Quaternary Research* 41:200-213.

Humphrey, R. and D. Stanford (editors)

1979 *Pre-Llano Cultures of the Americas: Paradoxes and Possibilities.* Anthropological Society of Washington.

Hunt, W. J., Jr.

1973 An Archaeological Survey of Proposed Reservoirs within the Middle Big Nehema River Drainage. Ms. on file, NPS, Midwest Archeological Center, Lincoln.

Hurst, C. T.

1943 A Folsom Site in a Mountain Valley of Colorado. *American Antiquity* 8:250-253.

n.d. Preliminary Appraisal of the Gateview Damsite of the Gunnison-Arkansas Project. Ms. on file, SI-RBS, Lincoln.

Hurt, W. R., Jr.

1952 *Report of the Investigations of the Scalp Creek Site 39GR1 and the Ellis Creek Site 39GR2, Gregory County, South Dakota.* Archaeological Studies Circular No. 4. South Dakota Archaeological Commission, Pierre.

1957 *The Swan Creek Site 39WW7, Walworth County, South Dakota.* Reminder, Inc., Pierre, South Dakota

1961 Archaeological Work at the Tabor and Arp Sites. *Museum News* 22(8):1-6. Vermillion.

1966 The Altithermal and the Prehistory of the Northern Plains. *Quaternaria* 8:101-114.

1969 Seasonal Economic and Settlement Patterns of the Arikara. *Plains Anthropologist* 14:32-37.

Hurt, W. R., Jr., W. G. Buckles, E. Fugle, and G. A. Agogino

1962 Report of the Investigations of the Four Bear Site, 39DW2, Dewey County, South Dakota, 1958-1959. Ms. on file, W. H. Over Museum, State University of South Dakota, Vermillion.

Husted, W. M.

1969 *Bighorn Canyon Archeology.* Smithsonian Institution, River Basin Surveys, Publications in Salvage Archaeology 12.

Hyde, G. E.

1959 *Indians of the High Plains.* University of Oklahoma Press, Norman.

Hyland, D. C. and T. R. Anderson

1990 Blood Residue Analysis of the Lithic Assemblage from the Mitchell Locality, Blackwater Draw, New Mexico. *Plains Anthropologist Memoir* 24 Appendix A:105-110.

Hylton, A. R., J. M. Bednar, D. R. Evans, R. E. Gustafson, and W. B. House (Compilers)

1973 Social, Economic and Environmental Assessment of the Blue River Basin, Vicinity of Kansas City, Missouri and Kansas. Ms. on file, Environmental Protection Agency, Kansas City.

Ingbar, E. E.

1985 Chipped Stone Assemblages from the McKean Site (48CK7) As Indicators of Settlement and Subsistence Patterns. In *McKean/Middle Plains Archaic: Current Research,* edited by M. Kornfeld and L. C. Todd, pp. 87-94. Occasional Papers on Wyoming Archaeology 4. Laramie.

1992 The Hanson Site and Folsom on the Northwestern Plains. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 169-192. University Press of Colorado, Niwot.

1994 Lithic Material Selection and Technological Organization. In *The Organization of North American Prehistoric Chipped Stone Tool Technologies,* edited by P. Carr, pp. 45-56. International Monographs in Prehistory. Ann Arbor.

Ingbar, E. E. and G. C. Frison

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

Irving, W. N.

1971 Recent Early Man Research in the North Arctic. *Arctic Anthropology* 8:68-82.

Irwin, C. and H. Irwin

1957 The Archaeology of the Agate Bluff Area, Colorado. *Plains Anthropologist* 8:15-38.

Irwin, H. T.

1968 *The Itama: Early Late Pleistocene Inhabitants of the Plains of the United States and Canada and the American Southwest.* Unpublished Ph.D. dissertation, Harvard University.

1970 Archeological Investigations at the Union Pacific Mammoth Kill Site, 1961. *National Geographic Society Research Reports 1961-1962 Projects*:123-125.

1971 Developments in Early Man Studies in Western North America, 1960-1970. *Arctic Anthropology* 8(2):42-67.

Irwin, H. T. and C. C. Irwin

1959 *Excavations at the LoDaiska Site in the Denver, Colorado Area.* Denver Museum of Natural History Proceedings No. 8.

Irwin, H. T. and H. M. Wormington

1970 Paleo-Indian tool types of the Great Plains. American Antiquity 35(1):24-36.

Irwin-Williams, C. and H. J. Irwin

1966 *Excavations at Magic Mountain: A Diachronic Study of Plains-Southwest Relations.* Denver Museum of Natural History Proceedings No. 12.

Irwin-Williams, C., H. J. Irwin, G. A. Agogino, and C. V. Haynes, Jr.

1973 Hell Gap: Paleo-Indian Occupation on the High Plains. *Plains Anthropologist* 18:40-53.

Ives, J. C.

1955 Glenwood Ceramics. *Journal of the Iowa Archeological Society* 4(3-4):2-32.

Jackson, L. J. and P. T. Thacker

1992 Harold J. Cook and Jesse D. Figgins: A New Perspective on the Folsom Discovery. In *Rediscovering Our Past: Essays on the History of America,* edited by J. E. Reyman, pp. 217-240. World Wide Archaeological Series 2, Avebury.

Jackson, R. C.

1960 A Revision of the Genus Iva L. *University of Kansas, Science Bulletin* 41:793-876

Jacobson, G. L., E. C. Grimm, and T. Webb, III

1987 Patterns and Rates of Vegetation Change in Eastern North America from Full Glacial to Mid-Holocene Time. In *North America and Adjacent Oceans During the Last Deglaciation,* edited by W. F. Ruddiman and H. E. Wright, Jr., pp. 277-288. Geology of North America, Volume K3, Geological Society of America, Boulder, Colorado.

Jantz, R. L.

1974 The Redbird Focus: Cranial Evidence in Tribal Identification. *Plains Anthropologist* 19(63):5-13.

1977 Craniometric Relationships of Plains Populations: Historical and Evolutionary Implications. In *Trends in Middle Missouri Prehistory: A Festschrift Honoring the Contributions of Donald J. Lehmer,* edited by W. R. Wood, pp. 162-176. Plains Anthropologist 22(78), pt. 2, Memoir 13.

Jantz, R. L. and D. W. Owsley

1984 Temporal Changes in Limb Proportionality Among Skeletal Samples of Arikara Indians. *Annals of Human Biology* 11:157-163.

1985 Patterns of Infant and Early Childhood Mortality in Arikara Skeletal Populations. In *Status, Structure and Stratification: Current Archaeological Reconstructions,* edited by M. Thompson, M. T. Garcia, and F. J. Kense, pp. 209-213. Proceedings of the Sixteeth Annual Conference of the Archaeological Association of the University of Calgary, Calgary, Alberta, Canada.

1994 White Traders in the Upper Missouri: Evidence from the Swan Creek Site. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 189-201. Smithsonian Institution Press, Washington, D.C.

Jantz, R. L., D. W. Owsley and P. Willey

1978 Craniometric Relationships of Central Plains Populations. In *The Central Plains Tradition: Internal Development and External Relationships,* edited by D. J. Blakeslee, pp. 144-156. Office of the State Archaeologist, University of Iowa, Report 11.

1981 Craniometric Variation in the Northern and Central Plains. In *Progress in Skeletal Biology of Plains Populations,* edited by R. L. Jantz and D. H. Ubelaker, pp. 19-30. Plains Anthropologist 26(94, pt. 2) Memoir 17.

Jantz, R. L. and D. H. Ubelaker (editors)

1981 *Progress in Skeletal Biology of Plains Populations.* Plains Anthropologist 26 (94, pt. 2) Memoir 17.

Jaumann, P. J.

1991 *Evidence for Late Quaternary Boreal Environments in Arkansas River Valley, South-Central Kansas—Theoretical Aspects of Paleoecology and Climatic Inferences.* Unpublished Master's thesis, University of Kansas, Lawrence.

Jefferson, T.

1944 *The Life and Selected Writings of Thomas Jefferson,* edited by A. Koch and W. Redden. Modern Library, New York.

Jelinek, A.

1967 Man's Role in the Extinction of Pleistocene Faunas. In *Pleistocene Extinctions, the Search for a Cause,* edited by P. S. Martin and H. E. Wright, Jr., pp. 193-200. Yale University Press, New Haven.

1992 Perspectives from the Old World on the Habitation of the New. *American Antiquity* 57(2):193-388.

Jenness, D. (editor)

1933 *The American Aborigines: Their Origins and Antiquities.* University of Toronto Press, Toronto.

Jennings, J. D.

1955 The Archaeology of the Plains: An Assessment (With Special Reference to the Missouri River Basin). Report to the National Park Service. University of Utah, Department of Anthropology.

1974 *Prehistory of North America* (2nd edition). McGraw-Hill, New York.

1978 Origins. In Ancient Native Americans, edited by J. D. Jennings, pp. 1-41. W. H. Freeman and Co., San Francisco.

1985 River Basin Surveys: Origins, Operations, and Results, 1945-1969. *American Antiquity* 50(2): 281-296.

Jennings, J. D. (editor)

1978 *Ancient Native Americans.* W. H. Freeman and Co., San Francisco.

Jepsen, G. L.

1953 Ancient Buffalo Hunters of Northwestern Wyoming. *Southwestern Lore* 9:19-25.

Jochim, M. A.

1991 Archaeology as Long Term Ethnography. *American Anthropologist* 93 (2):308-321.

Jodry, M. A.

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

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

1995 Technological and Economic Strategies at a Folsom Bison Kill/ Butchery Campsite, Site Structural Studies at Stewart's Cattle Guard, Colorado. Dissertation Proposal. Washington University

Jodry, M. A., V. Spero, M. Turner, and J. Turner

1993 Black Mountain Hunting Camp, Paleoindians in the High Country. Rocky Mountain Anthropology Conference. Jackson Hole, Wyoming.

Jodry, M. A. and D. J. Stanford

1992 Stewart's Cattle Guard Site: An Analysis of Bison Remains in a Folsom Kill-Butchery Campsite. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 101-168. University Press of Colorado, Niwot.

John, E. A. H.

1975 *Storms Brewed in other Men's Worlds, The Confrontation of Indians, Spanish, and French in the Southwest, 1540-1795.* Texas A & M University Press, College Station.

Johnson, A. E.

1957 Appraisal of the Archaeological Resources of the Toronto Reservoir, Greenwood and Woodson Counties, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1968 Archaeological Investigations in the Clinton Reservoir Area, Eastern Area. Ms. on file, U.S. Army Corps of Engineers, Kansas City.

1970 Archaeological Investigations at the Budenbender Site, Tuttle Creek Reservoir, North-Central Kansas, 1957. Ms. on file, U.S. Army Corps of Engineers, Kansas City.

1973 Archaeological Investigations at the Budenbender Site, Tuttle Creek Reservoir, North-Central Kansas, 1957. *Plains Anthropologist* 18(62), pts. 1-2:271-299.

1976 A Model of the Kansas City Hopewell Subsistence-Settlement System. In *Hopewellian Archaeology of the Lower Missouri Valley*, edited by A. E. Johnson. University of Kansas, Publications in Anthropology 8, Lawrence.

1979 Kansas City Hopewell. In *Hopewell Archaeology: The Chillicothe Conference*, edited by D. S. Brose and N. Greber, pp. 86-98. Kent State University Press, Kent, Ohio.

1980 *Archaic Prehistory on the Prairie Plains Border.* University of Kansas Publications in Anthropology No. 12. Lawrence.

1983 Late Woodland in the Kansas City Locality. *Plains Anthropologist* 28:99-108.

1983 Phase IV Archeological Investigations at El Dorado Lake, Butler County, Kansas, Summer 1980. Ms. on file, Kansas State Historical Society, Topeka.

1991 Kansas Origins: An Alternative. *Plains Anthropologist* 36:57-65.

1992 Early Woodland in the Trans-Missouri West. *Plains Anthropologist* 37(139):129-138.

n.d. Plains Woodland. Ms on file, Department of Anthropology, University of Kansas, Lawrence.

Johnson, A. E. and A. S. Johnson

1975 K-Means and Temporal Variability in Kansas City Hopewell Ceramics. *American Antiquity* 40:283-295.

Johnson, A. E. , C. A. Johnson II, B. Logan, N. O'Malley, and R. J. Ziegler

1980 Prehistoric Cultural Resources of Tuttle Creek Lake, Kansas. Ms. on file, NPS, Midwestern Archeological Center, Lincoln.

Johnson, A. E., R. L. Stephenson, and F. H. Roberts, Jr.

1957 Appraisal of the Archeological Resources of the Toronto Reservoir, Greenwood and Woodson Counties, Kansas. SI-RBS. Ms. on file, Museum of Anthropology, University of Kansas, Lawrence.

Johnson, A. E. and W. R. Wood

1980 Prehistoric Studies on the Plains. In *Anthropology on the Great Plains*, edited by W. R. Wood and M. Liberty, pp. 35-51. University of Nebraska Press, Lincoln.

Johnson, D. L., P. Dawano, and E. Ekker

1980 Clovis Strategies of Hunting Mammoth *(Mammuthus Columbi). Canadian Journal of Anthropology* 1(1):107-114.

Johnson, D. L. and D. Watson-Stegner

1990 The Soil-Evolution Model as a Framework for Evaluating Pedoturbation in Archaeological Site Formation. In *Archaeological Geology of North America*, edited by N. P. Laska and J. Donahue, pp. 541-560. Geological Society of America Centennial Volume 4. Boulder.

Johnson, E. (Eileen)

1977 Animal Food Resources of Paleoindians. In *Paleoindian Lifeways*, edited by E. Johnson. The Museum Journal 17:65-77, Lubbock.

1985 Current Developments in Bone Technology. In *Advances in Archaeological Method and Theory*, volume 8, edited by Michael B. Schiffer, pp.157-235. Academic Press, New York.

Johnson, E. (Eileen) (editor)

1977 *Paleo-Indian Lifeways.* The Museum Journal, XVII. Lubbock.

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

Johnson, E. (Eldon)

1973 *The Arvilla Complex.* Minnesota Prehistoric Archaeology Series 9.

1975 *Faunal and Floral Material from a Kansas City Hopewell Site: Analysis and Interpretation.* Occasional Papers of the Museum, Texas Tech University, No. 36, Lubbock.

Johnson, E. and V. T. Holliday

1993 Les Cultures Prehistoriques des Southern High Plains (USA) dans leurs Contextes Stratigraphique et Paleoclimatique. *L'Anthropologie* (Paris) 97(4):651-673.

Johnson, F.

1961 A Quarter Century of Growth in American Archaeology. *American Antiquity* 27(1):1-6.

Johnson, L., Jr.

1987 A Plague of Phases: Recent Sociocultural Taxonomy in Texas Archaeology. *Bulletin of the Texas Archaeological Society* 57:1-26.

1989 *Great Plains Interlopers in the Eastern Woodlands during Late Paleo-Indian Times.* Texas Historical Commission, Office of the State Archeologist Report 36. Austin.

Johnson, P. C.

1972 *Mammalian Remains Associated with Nebraska Phase Earth Lodges in Mills County, Iowa.* Unpublished Master's thesis, Department of Geology, University of Iowa, Iowa City.

Johnson, W. C.

1990 Age Determinations on the Gilman Canyon Formation and Brady Paleosol in Kansas (abs.): American Quaternary Association Program and Abstracts, 21.

1991a Buried Soil Surfaces Beneath the Great Bend Prairie of Central Kansas and Archaeological Implications. *Current Research in the Pleistocene* 8:108-110.

1991b Late Pleistocene and Holocene Eolian Stratigraphy of the Central Kansas and Paleoenvironmental Reconstructions (abs.). Geological Society of America Abstracts with Programs 23:p.A284.

1993a *Surficial Geology and Stratigraphy of Phillips County, Kansas, with Emphasis on the Quaternary Period.* Kansas Geological Survey Technical Series, No.1.

1993b *INQUA Paleopedology Commission 6 Field Guide.* Kansas Geological Survey Open File Report 93-30.

1996a Archaeological Geology and Geomorphology. In *The DB Site: Data Recovery Plan for a Stratified Prehistoric Upland Occupation Fort Leavenworth, Kansas*, edited by B. Logan, pp. 15-22.

1996b *Magnetic and Stable Isotope (^{13}C) Parameters as Indicators of Late-Quaternary Environments on Fort Riley, Kansas.* U. S. Army Construction Engineering Research Laboratory.

Johnson, W. C. (editor)

1987 *Quaternary Environments of Kansas.* Kansas Geological Survey Guidebook Series 5. Lawrence.

Johnson, W. C. and A. Arbogast

1993 *Geologic Map of Phillips County, Kansas.* Kansas Geological Survey, Map Series 29, 1 sheet, scale 1:50,000.

Johnson, W. C., N. Cheney, and C. W. Martin

1990 The Koehn-Schneider Mammoth Site of Western Kansas. *Current Research in the Pleistocene* 7:113-115.

Johnson, W. C. and B. Logan

1990 Geoarchaeology of the Kansas River Basin, Central Great Plains. In *Archaeological Geology of North America*, edited by N. P. Lasca and J. Donahue, pp. 267-299. Geological Society of America, Decade of North American Geology, Centennial Special Volume 4.

Johnson, W. C. and C. W. Martin

1987 Holocene Alluvial-Stratigraphic Studies from Kansas and Adjoining States of the East-Central Plains. In *Quaternary Environments of Kansas*, edited by W. C. Johnson, pp. 109-122. Kansas Geological Survey, Guidebook Series 5.

Johnson, W. C. and D. W. May

1992 The Brady Geosol as an Indicator of the Pleistocene/Holocene Boundary in the Central Great Plains, American Quaternary Association Program and Abstracts with Programs 1992.

Johnson, W. C., D. W. May, and R. D. Mandel

1996 A Data Base of Alluvial Radiocarbon Ages from the Central Great Plains (Kansas and Nebraska). *Current Research in the Pleistocene* 13 (in press).

Johnson, W. C., D. W. May, and V. L. Souders

1990 Age and Distribution of the Gilman Canyon Formation of Nebraska and Kansas (abs.). American Quaternary Association, Programs with Abstracts. 22:p.A87.

Johnson, W. C., D. W. May, and S. Valastro

1993 A 36,000-Year Chrono-, Bio-, and Magnetostratigraphic Record from Loess of South-Central Nebraska (abs.). Association of American Geographers, 89th Annual Meeting, Abstracts.

Johnson, W. C. and K. Park

1993 Stop 13, Bignell Hill Roadcut. In *INQUA Paleopedology Commission 6 Field Guide*, edited by W. C. Johnson, pp. 1-18. Kansas Geological Survey Open-File Report 93-30.

1996 Loess-Derived Magnetic Signatures of Global Warming Events in the Central Great Plains. Program and Abstracts of the Fourteenth Biennial Meeting, American Quaternary Association.

Johnson, W. C. , K. Park, E. Diekmeyer, and D. R. Muhs

1993 Chronology, Stratigraphy, and Depositional Environments of the Late Wisconsin (Peoria) Loess of Kansas and Nebraska. Geological Society of America. Abstract with Programs, A-59.

Johnston, R. B.

1967 *The Hitchell Site*. Publications in Salvage Archaeology No. 3. Smithsonian Institution River Basin Surveys, Lincoln.

Jones, B. A.

1968 Archeological Investigations in the Perry Reservoir, Jefferson County, Kansas, 1965. Ms. on file, U. S. Army Corps of Engineers, Omaha.

1975 Archaeological Survey in the Lyons Creek Watershed, Dickinson, Geary, Marion, and Morris Counties, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

1976a Phase II Archaeological Survey Investigation in the Upper Wakarusa Watershed Wabaunsee, Shawnee, Douglas, and Osage Counties, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

1976b Phase III Archaeological Test Investigations at the Palmer Site, 14OS363, Upper Wakarusa Watershed, Osage County, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

Jones, B. A. and M. Nemec

1986 The Riggs House. Ms. on file, Museum of Anthropology, University of Kansas, Lawrence.

Jones, B. A. and T. A. Witty, Jr.

1980 The Gilligan Site, 14OS332. In *Salvage Archaeology of the John Redmond Lake, Kansas*, edited by T. A. Witty, Jr., pp. 67-125. Anthropological Series 8. Kansas State Historical Society, Topeka.

Jones, C. H.

1970 Journal Notes for 24NC20. Ms. on file, Nebraska State Historical Society, Lincoln.

Jones, P. R. M. and R. F. A. Dean

1959 The Effects of Kwashiorkor on the Development of the Bone and Knee. *Pediatrics* 54:176-184.

Jones, S. and R. Bonnichsen

1994 The Anzick Clovis Burial. *Current Research in the Pleistocene* 11:42-44.

Judge, W. J.

1970 Systems Analysis and the Folsom-Midland Question. *Southwestern Journal of Anthropology* 26:40-51.

1973 *Paleoindian Occupation of the Central Rio Grande Valley in New Mexico*. University of New Mexico Press, Albuquerque.

Judge, W. J. and J. Dawson

1972 Paleo-indian Settlement Technology in New Mexico. *Science* 176(440):1210-1216.

Kainer, Ronald E.

1974 A Brief Descriptive Summary of the Spring Gulch Site, Larimer County, Colorado. *Southwestern Lore* 40(3-4):137-141.

1976 *Archaeological Investigations at the Spring Gulch Site (5LR252)*. Unpublished Master's thesis, Department of Anthropology, Colorado State University, Fort Collins.

Kapp, R. O.

1965 Illinoian and Sangamon Vegetation in Southwestern Kansas and Adjacent Oklahoma. *University of Michigan Museum of Paleontology Contributions* 19:167-169. Ann Arbor.

Kapp, R. O.

1970 Pollen Analysis of Pre-Wisconsin Sediments. In *Pleistocene and Recent Environments of the Central Great Plains*, edited by W. R. Dort, Jr. and J. K. Jones, Jr., pp. 143-155. University of Kansas Press, Lawrence.

Kay, M.

1982 *Holocene Adaptations within the Lower Pomme de Terre River Valley, Missouri*. Report to the U. S. Army Corps of Engineers, Kansas City District.

1983 Archaic Period Research in the Western Ozark Highland, Missouri. In *Archaic Hunters and Gatherers in the American Midwest*, Phillips, J. L. and J. A. Brown, editors, pp. 41-70. Academic Press, New York.

1986 Phillips Spring: A Synopsis of Sedalia Phase Settlement and Subsistence. In *Foraging, Collecting and Harvesting: Archaic Period Subsistence and Settlement in the Eastern Woodlands*, edited by S. Neusius, pp. 275-288. Occasional Paper 6. Center for Archaeological Investigations, Southern Illinois University, Carbondale.

Kay, M., F. King and C. Robinson

1980 Cucurbits from Phillips Spring: New Evidence and Interpretations. *American Antiquity* 45:806-822.

Keith, A.

1915 *Antiquity of Man*. William and Norgate, London.

Kelley, M. A.

1980 *Disease and Environment: A Comparative Analysis of Three Early American Indian Skeletal Collections*. Unpublished Ph.D. dissertation, Department of Anthropology, Case Western University, Cleveland.

Kelley, M. A., S. P. Murphy, D. R. Levesque, and P. S. Sledzik

1994 Respiratory Disease Among Protohistoric and Early Historic Plains Indians. In *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence*, edited by D. W. Owsley and R. L. Jantz, pp. 123-130. Smithsonian Institution Press, Washington, D.C.

Kelly, J. H.

1966 *Archaeological Investigations in the Tuttle Creek Reservoir Area*. Midwest Archeological Center, National Park Service, Department of the Interior, Lincoln.

Kelly, R. L.

1983 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research* 39:277-306.

1988 Three Sides of a Biface. *American Antiquity* 53(4):717-734.

1995 *The Foraging Spectrum*. Smithsonian Institution Press, Washington, D. C.

Kelly, R. L. and L. C. Todd

1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53:231-244.

Kelly, T. C.

1982 Criteria for Classification of Plainview and Golondrina Projectile Point. *La Tierra* 9(3):2-25.

Keyes, C. R.

1949 Four Iowa Archaeologies with Plains Affiliations. In *Proceedings of the 5th Plains Conference for Archaeology,* assembled by John L. Champe, pp. 96-97. Notebook No. 1, Laboratory of Anthropology, University of Nebraska, Lincoln.

Keyser, J. D.

1986 The Evidence for McKean Complex Plant Utilization. *Plains Anthropologist* 31(113):225-235.

Keyser, J. D. and C. M. Davis

1985 Lightning Spring and Red Fox: McKean Research in the Grand River Drainage. In *McKean/Middle Plains Archaic: Current Research. Occasional Papers on Wyoming Archaeology* 4, edited by M. Kornfeld and L. C. Todd, pp. 123-136. Department of Anthropology, University of Wyoming. Laramie.

Keyser, J. D. and J. L. Fagan

1993 McKean Lithic Technology at Lightning Spring. *Plains Anthropologist, Memoir* 27:37-52.

Kidder, A. V.

1924 *An Introduction to the Study of Southwestern Archaeology, with a Preliminary Account of the Excavations at Pecos.* Papers of the Southwestern Expedition, Phillips Academy, No. 1. Yale University Press, New Haven.

Kiehl, M.

1953 The Glen Elder and White Rock Sites in North Central Kansas. Abstract, in Proceedings of the Nebraska Academy of Sciences, May 1.

King, F. B.

1982 Plant Remains from the Yeo Site (23CL199). In *The Yeo Site (23CL199): A Kansas City Hopewell Limited Activity Site in Northwestern Missouri, and Some Theories,* by P. A. O'Brien, Appendix I, pp. 54-56. Plains Anthropologist 27(95):37-54.

1985 Early Cultivated Cucurbits in Eastern North America. In *Prehistoric Food Production in North America*, edited by R. I. Ford, pp 73-98. Museum of Anthropology, University of Michigan, Anthropological Papers No. 75, Ann Arbor.

King, J. E.

1981 Late Quaternary Vegetational History of Illinois. *Ecological Monographs* 51(1):43-62.

King, M. K.

1996 *Results of Phase III Archeological Investigations at the Shawnee Mill Site, 14JO365, Johnson County, Kansas.* Contract Archeology Publication Number 14, Kansas State Historical Society.

Kivett, M. F.

1947a *Preliminary Appraisal of the Archeological and Paleontological Resources of the Harlan County Reservoir, Nebraska.* Smithsonian Institution, River Basin Survey, Missouri Basin Project.

1947b Preliminary Appraisal of the Archeological and Paleontological Resources of Kanopolis Reservoir, Ellsworth County, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1947c Preliminary Appraisal of the Archeological and Paleontological Resources of Kirwin Reservoir, Phillips County, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1947d Preliminary Appraisal of the Archeological and Paleontological Resources of Enders Reservoir, Chase County, Nebraska. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1947e Preliminary Appraisal of the Archeological and Paleontological Resources of the Medicine Creek Reservoir, Frontier County, Nebraska. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1947f Preliminary Appraisal of the Archeological and Paleontological Resources of the Cherry Creek Reservoir, Arapahoe County, Colorado. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1947g Preliminary Appraisal of the Archeological and Paleontological Resources of the Wray Creek Reservoir, Yuma County, Colorado. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1948 Archeology and Climatic Implications in the Central Plains. In *Proceeding of the Sixth Plains Archeological Conference,* edited by Jesse D. Jennings, pp. 88-89. University of Utah, Department of Anthropology, Anthropological Papers 11.

1949 Archeological Investigations in the Medicine Creek Reservoir, Nebraska. *American Antiquity* 14(4):278-284.

1951 Archaeological Investigations Swanson Lake Project, Hitchcok County, Southwestern Nebraska in 1950. Ms. on file, Nebraska State Historical Society, Lincoln.

1952 *Woodland Sites in Nebraska.* Nebraska State Historical Society, Publications in Anthropology 1, Lincoln.

1953 *The Woodruff Ossuary: A Prehistoric Burial Site in Phillips County, Kansas.* Bureau of American Ethnology, Bulletin 154.

1958 Notes and News, Nebraska. *American Antiquity* 23:337.

1961 Preliminary Appraisal of the Archeological Resources of the Red Willow Reservoir, Hayes Frontier, and Willow Counties, Nebraska 1961. NSHS-PA on file, SI-RBS, Lincoln.

1962 Logan Creek Complex: Site 25BT3. Paper presented at the 17th Plains Conference, Lincoln, Nebraska. Ms. on file, Nebraska State Historical Society. Lincoln.

1969 Letter Report to John G. Poehling, Woodcliff Inc., Valley, Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.

1970 Early Ceramic Environmental Adaptations. In *Pleistocene and Recent Environments of the Central Great Plains,* edited by W. Dort, Jr. and J. K. Jones, Jr. Department of Geology Special Publication 3. University of Kansas Press, Lawrence.

n.d. The Harlan County Reservoir Technological Report. Ms. on file, SI-RBS, Lincoln.

Kivett, M. F. and G. Metcalf

1949 Preliminary Appraisal of the Archeological Resources of the Davis Creek Reservoir, Nebraska. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1991 *The Prehistoric People of the Medicine Creek Reservoir, Frontier County, Nebraska.* U.S. Department of the Interior, Bureau of Reclamation, Great Plains Region, Grand Island, Nebraska.

Kivett, M. F. and J. M. Shippee

1947 Preliminary Appraisal of the Archaeological and Paleontological Resources of the Harlan County Reservoir, Nebraska. SI-RBS, Ms. on file, the Smithsonian Institution, Washington, DC.

Kivett, M. F. and W. R. Wedel

1947 Memorandum Report on Archeological Investigations at Medicine Creek Reservoir, Nebraska, by the River Basin Surveys, Smithsonian Institution, March 29-August 20, 1948. MS on file, SI-RBS, Lincoln.

Klein, R. G.

1973 The Relevance of Old World Archaeology to the First Entry of Man into the New World. *Quaternary Research* 5:391-394.

Kleiss, H. J. and J. G. Fehrenbacher

1973 Loess Distribution as Revealed by Mineral Variations. *Soil Science Society of America Proceedings* 37:291-295.

Klepinger, L.

1972 An Early Human Skeleton from the Snyder Site, 14BU9, Butler County, Kansas. *Plains Anthropologist* 16(53):183-189.

Klepinger, L. and W. M. Bass

1971 Human Skeletal Material from Taylor Mound 14DP3, Doniphan County, Kansas. *Plains Anthropologist* 16:183-189.

Klinger, T. C., L. L. Ayres, and S. M. Imhoff

1987 Tuttle Creek: Test Excavations at 14MH148 Marshall County, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

Klippel, W. E.

1969 Mowry Bluff and Nuzum Artifacts: Chipped Stone. In *Two House Sites in the Central Plains: An Experiment in Archaeology,* edited by W. R. Wood, pp. 23-33, 73-76. Plains Anthropologist 14(44), pt. 2, Memoir 6.

1971 *Graham Cave Revisited, A Reevaluation of its Cultural Position During the Archaic.* Missouri Archaeological Society Memoir 9.

Knox, J. C.

1976 Concept of the Graded Stream. In *Theories of Landform Development*, edited by W. M. Melhorn and R. C. Flemal, pp. 169-98.

1978 Holocene Alluvial Chronologies and the Great Plains Middle Holocene Cultural Hiatus. Geological Society of America, Abstracts with Program, North-Central Section 10:259.

1983 Responses of River Systems to Holocene Climates. In *Late Quaternary Environments of the United States-v.2 Holocene*, edited by H. E. Wright, Jr., pp. 26-41. University of Minnesota Press, Minneapolis.

Knudson, R.

1983 *Organizational Variability in Late Paleo-Indian Assemblages.* Reports of Investigations 60, Washington State University, Laboratory of Anthropology, Pullman.

Koch, A. K.

1857 *Mastodon Remains in the State of Missouri, Together with Evidence of the Existence of Man Contemporaneously with the Mastodon.* Transactions of the Academy of Sciences, St. Louis 1: 61-64.

Kolb, K., M. E. Nelson and R. J. Zakrzewski.

1975 The Duck Creek Molluscan Fauna (Illionian) from Ellis County, Kansas. *Transactions of the Kansas Academy of Science* 78:63-74.

Kollmorgen, H. L

1963 Isopachyous Map and Study on Thickness of Peoria Loess in Nebraska. *Soil Science Society Proceedings*, 445-458.

Kornfeld, M.

1988 The Rocky Foolsm Site: A Small Folsom Assemblage from the Northwestern Plains. *North American Archaeologist* 9(3):197-222.

1996 The Big-Game Focus. *Current Anthropology* 37(4):629-657.

Kornfeld, M. (editor)

1991 *Approaches to Gender Processes on the Great Plains.* Plains Anthropologist Memoir 26.

Kornfeld, M. and G. C. Frison

1985 McKean Site: A 1983 Preliminary Analysis. In *McKean/Middle Plains Archaic: Current Research*, edited by M. Kornfeld and L. C. Todd, pp. 31-44. Occasional Papers on Wyoming Archaeology, 4. Department of Anthropology, University of Wyoming. Laramie.

1995 Paleoindian Occupation of the High Country: The Case of Middle Park, Colorado. Ms. in possession of authors.

Kornfeld, M., J. Miller, L. C. Todd, J. Saysette, and G. C. Frison

1992 Paleoindian Occupation in a Portion of Colorado's Middle Park: Preliminary Report on Several Sites with Goshen Complex Manifestations. Paper presented at the 50th Plains Anthropological Conference, Lincoln.

Kornfeld, M. and L. C. Todd (editors)

1985 *McKean/Middle Plains Archaic: Current Research.* Occasional Papers on Wyoming Archaeology 4. Laramie.

Kramer, C. (editor)

1979 *Ethnoarchaeology: Implications of Ethnography for Archaeology.* Columbia University Press, New York.

Kranzush, K. J.

1982 Preliminary Report-Investigation of 5LR42 and the Carter Lake Reservoir Dam No. 1 Outlet Works (FERC Project No s4626). Ms. on file, Bureau of Reclamation, Engineer and Research Center, Denver.

Krause, R. A.

1969 Correlation of Phases in Central Plains Prehistory. In *Two House Sites in the Central Plains: An Experiment in Archaeology*, edited by W. R. Wood, pp. 82-96. Memoir 6, Plains Anthropologist 14(pt.2).

1970 Aspects of Adaptation among Upper Republican Subsistence Cultivators. In *Pleistocene and Recent Environments of the Central Great Plains*, edited by W. Dort, Jr. and J. K. Jones, Jr., pp. 103-115. University of Kansas, Lawrence.

1982 The Central Plains Tradition Revisited: A Critical Review of Recent Interpretations. *Plains Anthropologist* 27(95):75-82.

1989 Toward a History of Great Plains Systematics. *Plains Anthropologist* 34(126):281-292.

1995 Continuities from Woodland to Upper Republican Potting Practices in North Central Kansas and South Central Nebraska. Paper presented at the 53rd Plains Conference, Laramie, Wyoming.

Kreutzer, L. A.

1988 Megafaunal Butchering at Lubbock Lake, Texas: a Taphonomic Reanalysis. *Quaternary Research* 30:221-231.

Krieger, Alex D.

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

Kroeber, A. L.

1939 *Cultural and Natural Areas of Native North America.* University of California Publications in American Archaeology and Ethnology No 38, Berkeley.

1948 *Anthropology.* Harcourt, Brace, and World, New York.

Küchler, A. W.

1964 *Potential Natural Vegetation of the Conterminous United States.* American Geographical Society, Special Publication, 36.

1974 A New Vegetation Map of Kansas. *Ecology* 55(3):586-604.

Kudrass, H. R., H. Erlenkeuser, R. Vollbrecht, and W. Weiss

1991 Global Nature of the Younger Dryas Cooling Event Inferred from Oxygen Isotope Data from Sulu Sea Core. *Nature* 349:406-409.

Kukla, G. J.

1977 Pleistocene Land-Sea Correlations I. Europe. *Earth Science Reviews* 13: 307-374.

1987 Loess Stratigraphy in Central China. *Quaternary Science Reviews* 6:191-219.

Kukla, G. J. and Z. An

1989 Loess Stratigraphy in Central China. *Paleogeography, Paleoclimatology, and Paleoecology* 72:203-225.

Kukla, G., F. Heller, X. M. Liu, T. C. Xu, T. S. Liu, and Z. An

1988 Pleistocene Climates in China Dated by Magnetic Susceptibility. *Geology* 16: 811-814.

Kurman, M. H.

1985 An Opal Phytolith and Palynomorph Study of Extant and Fossil Soils in Kansas (U.S.A.). *Palaeogeography, Palaeoclimatology, Palaeoecology* 49:217-235.

Kurten, B. and E. Anderson

1980 *Pleistocene Mammals of North America.* Columbia University Press, New York.

Kutzbach, J. E.

1981 Monsoon Climate of the Early Holocene-Climatic Experiment with the Earth's Orbital Parameters for 9,000 Years Ago. *Science* 214:p.61.

1985 Modeling of Paleoclimate. *Advances in Geophysics* 28:159-196.

1987 Model Simulations of Climatic Patterns During the Deglaciation of North America. In *North America and Adjacent Oceans During the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright Jr., pp. 425-446. Geological Society of America, The Geology of North America, Vol. K-3.

Kutzbach, J. E. and T. Webb III

1991 Late Quaternary Climatic and Vegetational Change in Eastern North America: Concepts, Models, and Data. In *Quaternary Landscapes*, edited by L. C. K. Shane and E. J. Cushing, pp. 175-217. University of Minnesota Press, Minneapolis.

Kutzbach, J. E. and H. E. Wright, Jr.

1985 Simulation of the Climate of 18,000 Yr BP; Results for the North American/North Atlantic/European Sector. *Quaternary Science Reviews* 4:147-187.

Kvamme, K. L.

1982 A Reexamination of Roper's Trend-Surface Analysis of Central Plains Radiocarbon Dates. *Plains Anthropologist* 27(98):305-308.

1985 In Defense of Roper (1976). *Plains Anthropologist* 30(109):263-264.

Lahren, L. A.

1976 *The Myers-Hindman Site: An Exploratory Study of Human Occupation Patterns in the Upper Yellowstone Valley from 7000 B.C. to A.D. 1200.* Anthropologos Researches International, Inc. Livingston, Montana.

Lahren, L. A. and R. Bonnichsen

1974 Bone Foreshafts from a Clovis Burial in Southwestern Montana. *Science* 186:147-150.

Lallo, J. W., G. J. Armelagos, and R. P. Mensforth

1977 The Role of Diet, Disease, and Physiology in the Origin of Porotic Hyperostosis. *Human Biology* 49:471-485.

Langdon, S. P., P. Willey, and R. W. Cummins

1993 The South Dakota Reburial Program and the Discovery of a Possible Prehistoric Dwarf. *Plains Anthropologist, Memoir* 27 33(145):271-281.

Langdon, S. P., P. Willey, P. H. Moore-Jansen, R. L. Jantz, L. Meadows, and R. W. Cummins

1989 *Human Skeletons from the South Dakota Archaeological Research Center.* Department of Archaeology, University of Tennessee, Knoxville. Submitted to South Dakota Archaeological Research Center, Rapid City.

Largent, F. B., Jr., M. R. Waters, and D. L. Carlson

1991 The Spatiotemporal Distribution of Folsom Projectile Points in the State of Texas. *Plains Anthropologist* 36(137):323-341.

Larsen, C. S.

1985 Dental Modifications and Tool Use in the Western Great Basin. *American Journal of Physical Anthropology* 67:393-402.

Larson, M. L.

1990 *Early Plains Archaic Technological Organization: The Laddie Creek Example.* Unpublished Ph.D. dissertation, University of California, Santa Barbara.

1991 1991 Excavations at 48FR308, The Helen Lookingbill Site: A Preliminary Report. *Wyoming Archaeologist* 34(3-4):69-82.

Larson, M. L. and J. Francis (editors)

1996 *Changing Perspectives of the Archaic in the Northwestern Plains and Rocky Mountains.* University of South Dakota Press. in press.

Larson, M. L., M. Kornfeld, and J. P. Matheson

1992 Archaeological Research at the Hutton-Pinkham Site, Eastern Colorado. *Southwestern Lore* 58(2):1-15.

Latady, W. R., Jr. and K. H. Dueholm

1985 A Preliminary Study of the Modern Vegetation and Possible Resources at the McKean Site. In *McKean/Middle Plains Archaic: Current Research*, edited by M. Kornfeld and L. C. Todd, pp. 79-86. Occasional Papers on Wyoming Archaeology 4. Department of Anthropology, University of Wyoming, Laramie.

Leach, L. L.

1970 *Archaeological Investigations at Deluge Shelter in Dinosaur National Monument.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Leaf, G. R.

1976 An Archaeological Research Design and Salvage Mitigation Plan for the El Dorado Reservoir, Butler County, Kansas. Ms. on file, U.S. Army Corps of Engineers, Tulsa.

1977 A Preliminary Shoreline Reconnaissance and A Management Program for the Cultural Resources of Kanopolis Lake, Ellsworth County, Kansas. Ms. on file, U.S. Army Corps of Engineers, Omaha.

1978 Finding, Managing and Studying Prehistoric Cultural Resources at El Dorado Lake , Kansas (Draft Report). Ms. on file, U.S. Army Corps of Engineers, Tulsa.

Leaf, G. R. (editor)

1979 *Finding, Managing, and Studying Prehistoric Cultural Resources at El Dorado Lake, Kansas (Phase I).* University of Kansas Museum of Anthropology Research Series 2. Lawrence.

Lee, M. B.

1986a Pony Creek Archeology: Results of a Phase II Cultural Resources Survey, Pony Creek Watershed, Brown and Nemaha Counties, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

1986b History and Historic Archeology of Kanopolis Lake Area. Ms. on file, Kansas State Historical Society, Topeka.

Lee, R. B.

1972 Population Growth and the Beginnings of Sedentary Life Among the !Kung Bushmen. In *Population Growth: Anthropological Implications*, edited by B. Spooner, pp. 329-342. MIT Press, Cambridge.

Lee, R. B. and I. Devore

1968 *Man the Hunter.* Aldine, Chicago.

Lees, W. B.

1984 *An Intensive Archaeological Survey of the Proposed Browning-Ferris Wyandotte Landfill Project Area, Wyandotte County, Kansas.* Environmental Systems Analysis, Kansas City. Submitted to Browning-Ferris Industries, Kansas City.

1985 Perspectives on the Development of Historical Archaeology on the Great Plains. Paper presented at the 50th meeting of the Society for Archaeology, Denver.

1986 *Jotham Meeker's Farmstead, Historical Archaeology at the Ottawa Baptist Mission, Kansas.* Anthropological Series Number 13, Kansas State Historical Society, Topeka.

1994 When the Shooting Stopped, the War Began. In *Look to the Earth; Historical Archaeology and the American Civil War*, edited by C. R. Geier, Jr. and S. E. Winter, pp. 39-59. University of Tennessee Press, Knoxville.

Lees, W. B. and D. Shockley

1986 *History and Historic Archeology of the Kanapolis Lake Area.* U.S. Army Corps of Engineers, Kansas City District.

Lehman, S. J. and L. D. Keigwin

1992 Sudden Changes in North Atlantic Circulation During the Last Deglaciation. *Nature* 356:757-762.

Lehmer, D. J.

1954 *Archeological Investigations in the Oahe Dam Area, South Dakota, 1950-1951.* Bureau of American Ethnology, Bulletin 158.

1970 Climate and Culture History in the Middle Missouri Valley. In *Environments of the Central Great Plains*, edited by W. Dort and J. K. Jones, pp. 117-129. University of Kansas Press, Lawrence.

1971 *Introduction to Middle Missouri Archaeology.* Anthropological Papers of the National Park Service, No 1. Washington D.C.

1977 Epidemics Among the Indians of the Upper Missouri. In *Reprints in Anthropology* 8:105-111. J & L Reprint Company, Lincoln.

Lehmer, D. J. and D. Jones

1968 Arikara Archaeology: The Bad River Phase. In *Smithsonian Institution Surveys in Salvage Archaeology* 7. Smithsonian Institution Press, Washington, D.C.

Lehmer, D. J. and W. R. Wood

1977 Buffalo and Beans. *Reprints in Anthropology* 8:85-89. J & L Reprint Company, Lincoln.

Leigh, D. S.

1994 Roxana Silt of the Upper Mississippi Valley: Lithology, Source, and Paleoenvironment. *Geological Society of America Bulletin* 106:430-442.

Leigh, D. S. and J. C. Knox

1994 Loess of the Upper Mississippi Valley Driftless Area. *Quaternary Research* 42:30-40.

Leigh, R. W.

1925 Dental Pathology of Indian Tribes of Varied Environmental and Food Conditions. *American Journal of Physical Anthropology* 8:179-199.

Lemke, R. W., W. M. Laird, M. J. Tipton, and R. M. Lindvall

1965 Quaternary Geology of the Northern Great Plains. In *The Quaternary of the United States,* edited by H. E. Wright, Jr. and D. J. Frey, pp 15-27. Princeton University Press.

Leonard, A. R.

1952 *Illinoian and Wisconsinan Molluscan Faunas in Kansas.* Kansas University, Paleontological Contributions. Mollusca, Art.4.

Leonard, R. and G. Jones

1987 Elements of an Inclusive Evolutionary Model for Archaeology. *Journal of Anthropological Archaeology* 6:199-219.

Leonhardy, F. C. (editor)

1966 *Domebo: A Paleo-Indian Mammoth Kill in the Prairie-Plains.* Contributions of the Museum of the Great Plains, Number 1.

Leonhardy, F. C. and A. Anderson

1966 Archaeology of the Domebo Site. In *Domebo: A Paleo-Indian Mammoth Kill in the Prairie-Plains,* edited by F. C. Leonhardy, pp. 14-26. Contributions of the Museum of the Great Plains, Number 1.

Lesser, A.

1979 Caddoan Kinship Systems. *Nebraska History Magazine* 60(2):260-271.

Lesser, A. and G. Weltfish

1932 *Composition of the Caddoan Linguistic Stock.* Smithsonian Miscellaneous Collections 87(6). Washington, D.C.

Leverett, F.

1899 *The Illinois Glacial Lobe.* U.S. Geological Survey Monograph 38.

Libby, W. F.

1955 *Radiocarbon Dating.* University of Chicago Press, Chicago.

Lightfoot, K. G.

1995 Culture Contact Studies; Redefining the Relationship Between Prehistoric and Historical Archaeology. *American Antiquity* 60(2):199-217.

Lintz, C. R.

1986 *Architecture and Community Variability Within the Antelope Creek Phase of the Texas Panhandle.* Oklahoma Archeological Survey, Studies in Oklahoma's Past 14.

Lintz, C. R. and J. L. Anderson (editors)

1989 *Temporal Assessment of Diagnostic Materials from the Pinon Canyon Maneuver Site.* Colorado Archaeological Society Memoir 4.

Lintz, C. R., A. Treece, and F. Oglesby

1995 The Early Archaic Structure at the turkey Bend Ranch Site (41CC112), Concho County. In *Advances in Texas Archaeology,* edited by J. E. Bruseth and T. Pertula, pp. 155-185. Texas Historical Commission. Austin.

Lippincott, K. A.

1976 *Settlement Ecology of Solomon River Upper Republican Sites in North Central Kansas.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Missouri.

1978 Solomon River Upper Republican Settlement Ecology. In *The Central Plains Tradition: Internal Development and External Relationships,* edited by D. J. Blakeslee, pp. 81-93. Office of the State Archaeologist, The University of Iowa, Report 11.

Lischka, J. J., M. E. Miller, R. B. Reynolds, D. Dahms, K. Joyner-McGuire, D. McGuire

1983 *An Archaeological Inventory of North Park, Jackson County, Colorado.* Bureau of Land Management Colorado, Cultural Resources Series 14. Denver.

Lister, R. H.

1962 Archeological Survey of the Blue Mesa Reservoir, Colorado. SL 28(30) on file, SI-RBS, Lincoln.

Lobdell, John E.

1973 *The Scoggin Site: An Early Middle Period Bison Kill.* Unpublished Master's thesis. Department of Anthropology, University of Wyoming. Laramie.

1974 The Scoggin Site: A Study in McKean typology. *Plains Anthropologist* 19:123-128.

Logan, B.

1985 *O-Keet-Sha: Culture History and Its Environmental Context- The Archaeology of Stranger Creek Basin, Northeastern Kansas.* Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

1988 The Plains Village Frontier in the Kansas City Locality. *The Missouri Archaeologist* 49:3-25.

1990a *Archaeological Investigations in the Plains Village Frontier, Northeastern Kansas.* Project Report No. 70. University of Kansas, Museum of Anthropology, Lawrence.

1990b The Richland Crematorium: New Evidence of Plains Woodland Mortuary Practices in the Central Plains. *Plains Anthropologist* 35(128):103-124.

1993 *Phasing in White Rock: Archaeological Investigations in Lovewell Reservoir, Jewell County, Kansas, 1992.* Project Report No. 79. University of Kansas, Museum of Anthropology, Lawrence.

1994 The White Rock Phase and Late Prehistoric Dynamics of the Central Plains. Paper presented at the 52nd Annual Plains Anthropological Conference, Lubbock, TX.

1995a *Archaeological Investigation of the White Rock and Warne Sites, Lovewell Reservoir, Jewell County, Kansas-1994.* Project Report No. 90. University of Kansas, Museum of Anthropology, Lawrence.

1995b Late Prehistoric Oneota Migration to the Central Plains. Paper presented at the 60th Annual Meeting of the Society for American Archaeology, Minneapolis, Minnesota.

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

1996 Oneota Far West: The White Rock Phase. Paper Presented at the 54th Plains Anthropological Conference, Iowa City.

1997 *Prehistoric Settlement of the Lower Missouri Uplands: The View from the DB Ridge.* Project Report Series No. 92. University of Kansas, Museum of Anthropology, Lawrence.

Logan, B (editor)

1983 *Archaeological Investigations in the Stranger Creek, Bucks Creek, and Mud Creek Drainage Systems, Northeast Kansas Phase II.* Project Report No. 52. University of Kansas, Museum of Anthropology, Lawrence.

1987 *Archaeological Investigations in the Clinton Lake Project Area Northeastern Kansas: National Register Evaluation of 27 Prehistoric Sites.* Kaw Valley Engineering and Development, Junction City. Submitted to U.S. Army Corps of Engineers, Kansas City District.

1990 *Archaeological Investigations in the Perry Lake Project Area, Northeastern Kansas; National Register Evaluation of 17 Sites.* Kaw Valley Engineering and Development, Junction City. Submitted to the U.S. Army Corps of Engineers, Kansas City District.

1993 *Quarry Creek: Excavation, Analysis and Prospect of a Kansas City Hopewell Site, Fort Leavenworth, Kansas.* Project Report No. 80. University of Kansas, Museum of Anthropology, Lawrence.

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

Logan, B. and W. E. Banks

1994 *White Rock Revised: Archaeological Investigation of the Warne and White Rock Sites, Jewell County, Kansas, 1993.* Project Report No. 85. University of Kansas, Museum of Anthropology, Lawrence.

Logan, B. and M. Fosha
1991 Quixote and Reichart: Archeological Investigation of the Grasshopper Falls Phase Habitation Sites in the Perry Lake Project Area, Northeastern Kansas. *The Kansas Anthropologist* 12(2):11-31.

Logan, B. and J. Hedden
1990 14JO46. In *Archaeological Investigations in the Plains Village Frontier, Northeastern Kansas*, edited by Brad Logan, pp. 92-110. University of Kansas, Museum of Anthropology, Project Report Series, No. 70, Lawrence.
1992 *Archaeological Survey of Lovewell Reservoir, Jewell County, Kansas, 1991.* University of Kansas, Museum of Anthropology, Project Report Series, No. 77.
1993 Shadow Glen: A Late Pomona Variant Occupation in the Lower Kansas River Basin. *The Kansas Anthropologist* 14(2):10-30.

Logan, B., L. D. Martin and J. F. Neas.
1991 Late Pleistocene Hemiauchenia from North Central Kansas. *Current Research in the Pleistocene* 8:97-99.

Logan, B. and L. W. Ritterbush
1994 Late Prehistoric Cultural Dynamics in the Lower Kansas River Basin. *Central Plains Archaeologist* 4(1):1-25.

Logan, W. D.
1976 *Woodland Complexes in Northeastern Iowa.* National Park Service Publications in Anthropology 15, Washington D.C.

Loomis, F. B.
1924 Artifacts Associated with the Remains of a Colombian Elephant at Melbourne, Florida. *American Journal of Science* 8:503-508.
1925 The Florida Man. *Science* 62:436.

Loosle, B. N.
1991 *Social Interactions Among the Late Plains Village Populations in the Central Plains.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Kansas, Lawrence.

Lopinot, N. H.
1992 Spatial and Temporal Variability in Mississippian Subsistence: The Archaeobotanical Record. In *Late Prehistoric Agriculture: Observations from the Midwest*, edited by William I. Woods, pp. 44-94. Studies in Illinois Archaeology No 8. Illinois Historic Preservation Agency.
1994 A New Crop of Data on the Cahokian Polity. In *Agricultural Origins and Development in the Midcontinent*, edited by William Green, pp. 127-154. Office of the State Archaeologist, The University of Iowa, Report 19. Iowa City.

Lowie, R. H.
1954 *Indians of the Plains.* McGraw-Hill, New York.

Lubbock, J.
1895 *Prehistoric Times, As Illustrated by Ancient Remains, and the Manners and Customs of Modern Savages.* Williams and Norgate, London.

Ludwickson, J.
1975 *The Loup River Phase and the Origins of Pawnee Culture.* Unpublished Master's thesis, University of Nebraska, Lincoln.
1978 Central Plains Tradition Settlements in the Loup River Basin: The Loup River Phase. In *The Central Plains Tradition: Internal Development and External Relationships*, edited by D. L. Blakeslee, pp. 94-108. Report No. 11, Office of the State Archaeologist, Iowa City, Iowa.

Ludwickson, J., D. Blakeslee, and J. O'Shea
1981 *Missouri National Recreational River: Native American Cultural Resources.* Wichita State University Publications In Anthropology No. 3. Wichita State University, Wichita, Kansas.

Ludwickson, J. and R. Bozell
1989 Phase 1 and Phase 2 Archaeological Evaluation of the Soucek Site (25KX73), Verdigre Northwest Project [BRO-7054(9)], Knox County, Nebraska. Ms. on file, National Parks Service, Interagency Archaeological Service, Denver.
1993 Perspectives on the Late Prehistory of the South Bend Locality. In *Nebraska Phase Archeology in the South Bend Locality*, by J. R. Bozell and J. Ludwickson, pp. 109-133. Nebraska State Historical Society, Lincoln.

Lugn, A. L.
1935 The Pleistocene Geology of Nebraska. *Bulletin of the Nebraska Geological Survey* 2(10):378.
1968 The Origin of Loesses and Their Relation to the Great Plains in North America. In *Loess and Related Eolian Deposits of the World*, edited by C. B. Schultz and J. C. Frye, pp. 139-182. University of Nebraska Press, Lincoln.

Lundelius, E. L.
1972 Vertebrate Remains from the Gray Sands. In *Blackwater Locality No. 1, A Stratified Early Man Site in Eastern New Mexico*, by J. J. Hester, pp. 148-163. Fort Burgwin Research Center, Southern Methodist University.
1989 The Implications of Disharmonious Assemblages for Pleistocene Extinctions. *Journal of Archaeological Science* 16:407-417.

Lundelius, E. L., R. W. Graham, E. Anderson, J. Guilday, J. A. Holman, D. Steadman, and S. D. Webb
1983 Terrestrial Vertebrate Faunas. In *Late Quaternary Environments of the United States, Volume 1, The Late Pleistocene*, edited by S. C. Porter, Jr. pp. 311-353. University of Minnesota Press, Minneapolis.

Lutenegger, A. J.
1985 Desert Loess in the Midcontinent U.S.A.(abs.): First International Conference on Geomorphology, Manchester, England, Abstracts of Papers, p. 138.

Lutz, B. J., T. R. Farmer, and C. Muceus
1978 A Cultural Resources Inventory of the Wildcat Reservoir, Morgan County for the Riverside Irrigation District and Public Service Company of Colorado. Ms. on file, Fort Morgan County Planning Office, Fort Morgan.

Lyell, C.
1863 *The Geological Evidence of the Antiquity of Man*, edited G. W. Childs, Philadelphia.

Lyman, R. L.
1994 *Vertebrate Taphonomy.* Cambridge University Press.

Lynch, T. F.
1990 Glacial Age Man in South America? A Critical Review. *American Antiquity* 55(1):12-36.

Lynott, M. J., T. W. Boutton, J. E. Price, and D. E. Nelson
1986 Stable Carbon Isotopic Evidence for Maize Agriculture in Southeast Missouri and Northeast Arkansas. *American Antiquity* 51:51-68.

Maat, P. B. and W. C. Johnson
1996 Thermoluminescence and New ^{14}C Age Estimates for Late Quaternary Loesses in Southwestern Nebraska. *Geomorphology*. 17:115-128.

Madole, R. F.
1994 Stratigraphic Evidence of Desertification in the West-Central Great Plains within the Past 1000 Yr. *Geology* 2(6):483-486.

Malde, H.
1960 Geologic Age of the Claypool Site, Northeastern Colorado. *American Antiquity* 26:236-243.
1988 Geology of the Frazier Site, Kersey, Colorado. In *Guidebook to the Archaeological Geology of the Colorado Piedmont and High Plains of Southeastern Wyoming*, edited by V. T. Holliday, pp. 85-90. Department of Geography, University of Wisconsin, Madison.

Mallam, R. C.
1971 Speak Up. *Nebraskaland* March:3,12.

Malone, J. A. and A. H. Rohn
1980 Survey and Assessment of the Cultural Resources, Marion Lake Project. Ms. on file, U.S. Army Corps of Engineers, Dallas.

Malloui, R. J.

1989 A Clovis Quarry Workshop in the Callahan Divide: the Yellow Hawk Site, Taylor County. *Plains Anthropologist* 34(124):81-103.

1990 Hell Gap Points in the Southern Rolling Plains of Texas. *Current Research in the Pleistocene* 7:32-35.

1994 Sailor-Helton: A Paleoindian Cache from Southwestern Kansas. *Current Research in the Pleistocene* 11:44-46.

Mandel, R. D.

1987a Late-Quaternary Environments of the Great Plains: Implications for Cultural Resource Management. In *Kansas Prehistoric Archaeological Preservation Plan*, edited by K. Brown and A. Simmons, pp. IV-1-28. Office of Archaeological Research, Museum of Anthropology, Lawrence.

1987b Geomorphology of the Wakarusa River Valley, Northeastern Kansas. In *Archaeological Investigation in the Clinton Lake Project Area: National Register Evaluation of 27 Prehistoric Sites*, edited by B. Logan, pp. 20-34. U.S. Army Corps of Engineers, KANSAS CITY, MISSOURI.

1988 Geomorphology of the Smoky Hill River Valley at Kanopolis Lake. In *An Archaeological and Geomorphological Survey of Kanopolis Lake, North-Central Kansas*, edited by L. J. Schmits, pp. 49-72. U.S. Army Corps of Engineers, KANSAS CITY, MISSOURI.

1990 *Holocene Landscape Evolution in the Pawnee River Valley, Southwestern Kansas.* Unpublished Ph.D. dissertation, University of Kansas.

1991 Geomorphology. In *Cultural Resource Investigations for the U.S. Highway 166 Corridor*, edited by C. M. Schoen, pp. 8-59. Kansas Historical Society, Topeka.

1992 Soils and Holocene Landscape Evolution in Central and Southwestern Kansas., in *Soils in Archaeology*, edited by V. T. Holliday, pp. 41-117. Smithsonian Institution Press, Washington D.C.

1993 Geomorphology. In *Cultural Resources Investigations for the U.S. Highway 166 Corridor*, edited by M. F. Hawley, pp. 24-75.

1994 *Holocene Landscape Evolution in the Pawnee River Valley, Southwestern Kansas.* Kansas Geological Survey, Bulletin 236, Lawrence and Kansas State Historical Society, Topeka.

1995 Geomorphic Controls of the Archaic Record in the Central Plains of the United States. In *Archaeological Geology of the Archaic Period in North America*, edited by E. A. Bettis III. Geological Society of the America Special Paper 297.

Mann, R. W. and S. P. Murphy

1990 *Regional Atlas of Bone Disease. A Guide to Pathologic and Normal Variation in the Human Skeleton.* C. C. Thomas, Springfield, Illinois.

Mann, R. W., D. W. Owsley, and K. J. Reinhard

1994 Otitis Media, Mastoiditis, and Infracranial Lesions in Two Plains Indian Children. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence*, edited by D. W. Owsley and R. L. Jantz, pp. 131-146. Smithsonian Institution Press, Washington, D.C.

Manz, K. and D. J. Blakeslee

1988 The Faunal Remains from Annie's Site and the Limitations of Subsistence Analysis. In *St. Helena Archaeology: New Data, Fresh Interpretations*, edited by D. J. Blakeslee, pp. 157-171. J & L Reprints in Archaeology 39, Lincoln.

Marshall, J. O.

1965 Recent Excavations in the Elk City Reservoir. *Kansas Anthropological Association Newsletter* 11(2).

1966a Archeological Survey of the Big Hill Reservoir Area Labette County, Kansas. *Kansas Anthropological Association Newsletter 12* (4).

1966b An Interpretive Summary of the Archeological Evidence from the Elk City Reservoir, Montgomery County, Kansas. *Kansas Anthropological Association Newsletter* 12(1).

1966c Salvage Archeology in the Elk City Reservoir, 1965. *Plains Anthropologist* 11(32).

1966d Appraisal of the Archeological Resources of the Big Hill Reservoir, Labette County, Kansas. Ms. on file, National Parks Service, Midwest Region, Omaha.

1967a Historical Society Archeology in the Perry Reservoir, 1967. *Kansas Anthropological Association Newsletter* 13(4).

1967b Salvage Archeology in the Elk City Reservoir, 1966. *Plains Anthropologist* 12(36).

1969a Appraisal of the Archaeological Resources of the Grove Reservoir Shawnee County, Kansas. Ms. on file, U.S. Army Corps of Engineers, Kansas City.

1969b *The Glen Elder Focus: The Cultural Affiliations of Archeological Material from the Glen Elder Site, 14ML1.* Department of Anthropology, University of Nebraska, Lincoln. Submitted to the National Park Service, Midwest Region, U.S. Department of the Interior.

1972 *The Archeology of the Elk City Reservoir: A Local Archeology Sequence in Southeast Kansas.* Kansas State Historical Society, Anthropological Series 6, Topeka.

1974 The Cultural Affiliation of Archaeological Material from the Glen Elder Site, 14ML1. Unpublished Master's thesis, Department of Anthropology, University of Nebraska.

Marshall, J. O., K. R. Turner, and W. M. Bass

1972 The Archeology of the Elk City Reservoir: A Local Archaeological Sequence in Southeast Kansas Volumes 1 and 2. Ms. on file at U.S. Army Corps of Engineers, Omaha.

Marshall, J. O. and T. A. Witty

1967 The Bogan Site, 14GE1, An Historic Pawnee Village An Appraisal of an Archeological Site in the Milford Reservoir, Geary County, Kansas. Ms. on file, University of Nebraska, Lincoln.

Martin, C. W.

1990 *Late Quaternary Landform Evolution in the Republican River Basin, Nebraska.* Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

1992 The Response of Fluvial Systems to Climate Change: An Example from the Central Great Plains. *Physical Geography* 13:101-114.

1993 Radiocarbon Ages on Late Quaternary Loess Stratigraphy of Nebraska and Kansas, Central Great Plains, U.S.A. *Quaternary Science Reviews*, 12:179-188.

Martin, D. L., A. H. Goodman, and G. J. Armelagos

1985 Skeletal Pathologies as Indicators of Quality and Quantity of Diet. In *The Analysis of Prehistoric Diets*, edited by R. I. Gilbert, Jr. and J. H. Mielke, pp. 227-277. Academic Press, New York.

Martin, H. T.

1909 Further Notes on the Pueblo Ruins of Scott County. *Kansas University Science Bulletin* 5(2):11-22.

Martin, L. D. and R. S. Hoffman.

1987 Pleistocene Faunal Provinces and Holocene Biomes of the Central Great Plains. In *Quaternary Environments of Kansas*, edited by W. C. Johnson, pp. 159-165. State Geological Survey of Kansas, Guidebook Series 5.

Martin, L. D. and J. Martin

1987 Equability in the Late Pleistocene. In *Quaternary Environments of Kansas*, edited by W. C. Johnson, pp. 123-127. State Geological Survey of Kansas, Guidebook Series 5.

Martin, L. D., R. A. Rogers, and A. M. Neuner

1985 The Effect of the End of the Pleistocene on Man in North America. In *Environments and Extinctions: Man in Late Glacial North America*, edited by J. I. Mead and D. J. Meltzer, pp. 15-30. Center for the Study of Early Man, Orono, Maine.

Martin, L. D., K. N. Whetstone, J. D. Chorn, and C. D. Frailey

1979 *Survey of Fossil Vertebrates from East-Central Kansas, Kansas River Bank Stabilization Study.* Report submitted to the U. S. Army Corps of Engineers, Kansas City District.

Martin, P. S.

1990 Who or What Destroyed Our Mammoths? In *Megafauna and Man: Discovery of America's Heartland*, edited by L. D. Agenbroad, J. I. Mead, and L. W. Nelson, pp. 108-117. Hot Springs, South Dakota.

Martin, P. S. and R. G. Klein (editors)

1984 *Quaternary Extinctions: A Prehistoric Revolution*. University of Arizona Press, Tucson.

Martin, P. S. and H. G. Wright (editors)

1967 *Pleistocene Extinctions: the Search for a Cause.* Yale University Press, New Haven.

Mason, R. J.

1962 The Paleo-Indian Tradition in Eastern North America. *Current Anthropology* 3:227-278.

Mason, R. J. and C. Irwin

1960 An Eden-Scottsbluff Burial in Northeastern Wisconsin. *American Antiquity* 26(1):43-57.

Masters, C.

1984 Dental Evidence for Subsistence Patterns Among Nebraska Groups. Paper presented at the Forty-second Plains Conference, October 17, Lincoln.

1987 *Dental Pathologies and Attrition of Some Prehistoric Eastern Great Plains Groups: Implications for Subsistence.* Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

Mathewes, R. W., L. E. Heuser, and R. T. Patterson

1993 Evidence for a Younger Dryas-like Cooling Event on the British Columbia Coast. *Geology* 21: 101-104.

Mattes, M. J.

1947a Historical Aspects of Kirwin Reservoir, North Fork , Solomon River, Kansas. National Parks Service. Ms. on file, SI-RBS, Lincoln.

1947b Project Report on Historical Aspect of Kanopolis Reservoir on Smoky Hill River, Kansas. National Parks Service-A. Ms. on file, SI-RBS, Lincoln.

Mattes, M. J. and R. H. Mattison

1953 Report on Historic Sites in the Gavin's Point Reservoir Area, Missouri River. Ms. on file, Smithsonian Institution, Washington, DC.

Mattison, R. H.

1953 Report on Historic Sites in the Gavins Point Reservoir Area, Missouri River. National Parks Service-R. Ms. on file, SI-RBS, Lincoln.

1956 *Report on Historic Sites Adjacent to the Missouri River, Between Big Siuox River and Fort Randall Dam, Including those in the Gavin's Point Reservoir Area (South Dakota and Nebraska).* South Dakota Historical Commission 28.

May, D. W.

1986 *Holocene Alluviation, Soil Genesis, and Erosion in the South Loup Valley, Nebraska.* Unpublished Ph.D. dissertation, Department of Geography, University of Wisconsin, Madison.

1989 Holocene Alluvial Fills in the South Loup Valley, Nebraska. *Quaternary Research* 32:117-120.

1990 The Potential for Buried Archaeological Sites along the Fullerton and Elba Canals, North Loup and Loup River Valleys, Nebraska. Ms. on file, U.S. Department of the Interior, Bureau of Reclamation, Grand Island, Nebraska.

1991 Radiocarbon Ages of the Elba Valley Fill in Cooper's Canyon, Elba, Nebraska. *Proceedings of the Nebraska Academy of Sciences* 111:59-60.

1992 Late-Holocene Episodes of Valley-Bottom Aggradation and Erosion in the South Loup River Basin, Nebraska. *Physical Geography* 13:115-132.

May D. W. and S. R. Holen

1993 Radiocarbon Ages of Soils and Charcoal in Late Wisconsinan Loess, South-Central Nebraska. *Quaternary Research* 39:55-58.

May, D. W. and V. L. Souders

1988 Radiocarbon Ages for the Gilman Canyon Formation in Dawson County, Nebraska,(abs.), *Proceedings of the Nebraska Academy of Sciences* 108:47-48.

McBurney, C. B. M.

1976 *Early Man in the Soviet Union, the Implications of Some Recent Discoveries.* British Academy, London. Oxford University Press.

McCance, R. A.

1960 Severe Undernutrition in Growing and Adult Animals. *British Journal of Nutrition* 14:59-73.

McClung, C. E.

1908 Restoration of the Skeleton of *Bison occidentalis*. *Kansas University Bulletin* 4: 249-252.

McCracken, H. (editor)

1978 *The Mummy Cave Project in Northwestern Wyoming.* The Buffalo Bill Historical Center, Cody.

McGee, W. J. and C. Thomas

1905 *The History of North America.* George Barrie and Sons, London.

McGimsey, C. R.

1972 *Public Archeology*. Seminar Press, New York.

McHenry, H.

1968 Transverse Lines in Long Bones of Prehistoric California Indians. *American Journal of Physical Anthropology* 29(1):1-17.

McHugh, W. P., G. D. Gardner, and J. Donahue

1982 *Before Smith's Mill: Archaeological and Geological Investigations* (2 vols). GAI Consultants, Monroeville, Pennsylvania. Submitted to U.S. Army Corps of Engineers, Kansas City District.

McKay, E. D.

1979 Stratigraphy of Wisconsinan and Older Loesses in Southwestern Illinois. In *Geology of Western Illinois,* pp. 37-67. Illinois State Geological Survey, Guidebook 14.

McKay, J. and L. J. Schmits

1986 *The Euro-American and Afro-American Communities of Quindaro: Phase III Archeological and Historical Evaluations of Browning-Ferris Industries Wyandotte County, Kansas, Landfill.* Cultural Resource Report Number 40, Environmental Systems Analysis, Kansas City, Kansas.

McKenzie, G. F. and S. Holen.

1983 The Great Oasis Component at the Bill Packer Site (25SM9). Ninety-third Annual Meeting, Nebraska Academy of Science, Abstract.

McKern, W. C.

1939 The Midwestern Taxonomic Method as an Aid to Archaeological Study. *American Antiquity* 4: 301-313.

McMillan, R. B. and W. E. Klippel

1981 Post-Glacial Environmental Change and Hunting-Gathering Societies of the Southern Prairie Peninsula. *Journal of Archaeological Science* 8:215-245.

McMullen, T. L.

1978 Mammals of the Duck Creek Local Fauna, Late Pleistocene of Kansas. *Journal Mammalia* 59:374-386.

MacNeish, R. S.

1976 Early Man in the New World. *American Scientist* 64(3):316-327.

1992 The Earliest North Americans. Paper presented at the American Association for the Advancement of Science Meeting, Chicago, Illinois.

McNerney, M. J.

1987 The Effigy Complex of the Nebraska Phase and the Problem of Nebraska Phase-Mississippian Relationships. *Journal of the Iowa Archeological Society* 34:21-50.

McNett, Jr., C. W. (editor)

1985 *Shawnee Minisink: A Stratified Paleoindian-Archaic Site in the Upper Delaware Valley of Pennsylvania.* Academic Press, Orlando.

McWilliams, R.

1965 Periodontal Pathologies of a Sample of the Skeletal Material from the Sully Site, 39SL4, Sully County, South Dakota. Ms. on file, Department of Anthropology, University of Kansas, Lawrence.

Mead, J. I. and D. J. Meltzer

1984 North American Late Quaternary Extinctions and the Radiocarbon Record. In *Quaternary Extinctions, A Prehistoric Revolution*, edited by P. S. Martin and R. G. Klein, pp. 440-450. University of Arizona Press, Tucson.

Mead, J. and D. J. Meltzer (editors)

1985 *Environments and Extinctions: Man in Late Glacial North America*. Center for the Study of Early Man, University of Maine, Orono.

Meadows, L.

1988 Determining Congenital Hip Dislocation Among the Arikara. Ms. on file, Department of Anthropology, University of Tennessee, Knoxville.

Mehringer, P. J. , Jr.

1988 Clovis Cache Found: Weapons of Ancient Americans. *National Geographic* 174:500-503.

1989 Of Apples and Archaeology. *Universe* 1(2):2-9. Washington State University, Pullman.

Mehringer, P. J. and F. Foit, Jr.

1990 Volcanic Ash Dating of the Clovis Cache at East Wenatchee, Washington. *National Geographic Research* 6(4):495-503.

Meltzer, D. J.

1983 The Antiquity of Man and the Development of American Archaeology. In *Advances in Archaeological Method and Theory*, edited by M. S. Schiffer, pp. 1-52. Academic Press, Orlando.

1985 North American Archaeology and Archaeologists, 1879-1934. *American Antiquity* 50(2): 249-260.

1987 The Clovis Paleoindian Occupation of Texas: Results of the TAS Survey. *Bulletin of the Texas Archeological Society* 56:27-68.

1988 Late Pleistocene Human Adaptations in Eastern North America. *Journal of World Prehistory* 2(1):1-52.

1989a Why Don't We Know When the First People Came to America? *American Antiquity* 54:471-490

1989b Was Stone Exchanged Among Eastern North American Paleo-Indians? In *Eastern Paleo-Indian Lithic Resource Use*, edited by C. Ellis and J. Lothrop, pp. 11-39. Westview Press, Boulder.

1991a On "Paradigms" and "Paradigm Bias" in Controversies Over Human Antiquity in America. In *The First Americans: Search and Research*, edited by T. D. Dillehay and D. J. Meltzer, pp. 13-49. CRC Press, Boco Raton.

1991b Altithermal Archaeology and Paleoecology at Mustang Springs, on the Southern High Plains of Texas. *American Antiquity* 56:236-267.

1993a *In Search of the First Americans*. Smithsonian Institution. St. Remy Press, Montreal.

1993b Is There a Clovis Adaptation? In *From Kostenki to Clovis: Upper Paleolithic-Paleo-Indian Adaptations*, edited by O. Soffer and N. D. Praslov, pp. 293-310. Plenum Press, New York.

1994 The Discovery of Deep Time: A History of Views on the Peopling of the Americas. In *Method and Theory for Investigating the Peopling of the Americas*, edited by R. Bonnichsen and D. G. Steele, pp. 7-26. Center for the Study of the First Americans, Oregon State University, Corvallis.

Meltzer, D. J., J. M. Adovasio and T. D. Dillehay

1994 On a Pleistocene Human Occupation at Pedra Furada, Brazil. *Antiquity* 68:695-714.

Meltzer, D. J. and B. D. Smith

1986 Paleo-Indian and Early Archaic Subsistence Strategies in Eastern North America. In *Foraging, Collecting and Harvesting: Archaic Period Subsistence and Settlement in the Eastern Woodlands*, edited by S. Neusius, pp. 1-30. Occasional Papers 6, Center for Archaeological Investigations, Southern Illinois University. Carbondale.

Meltzer, D. J., D. D. Fowler, and J. A. Sabloff (editors)

1986 *American Archaeology: Past and Future*. Society for American Archaeology, and Smithsonian Institute Press, Washington.

Mensforth, R. P., C. O. Lovejoy, J. W. Lallo, and G. J. Armelagos

1978 The Role of Constitutional Factors, Diet, and Infectious Disease in the Etiology of Porotic Hyperostosis and Periosteal Reactions in Prehistoric Infants and Children. *Medical Anthropology* 2:1-59.

Merbs, C. F.

1983 *Patterns of Activity-Induced Pathology in a Canadian Inuit Population*. Archaeological Survey of Canada Paper, Mercury Series 119. National Museum of Man, Ottawa, Ontario, Canada.

1989 Trauma. In *Reconstruction of Life from the Skeleton*, edited by M. Y. Iscan and K. A. R. Kennedy, pp. 161-190. A. R. Liss, New York.

Meserve, F. G. and E. H. Barbour

1932 Association of an Arrow Point With Bison Occidentalis in Nebraska. *Bulletin of the Nebraska State Museum* 1: 239-242.

Meston, L. K.

1972 Archaeological Investigations in the White River Region, Northwest Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.

Metcalf, M. D.

1974 *Archaeological Excavations at Dipper Gap: A Stratified Butte Top Site in Northeastern Colorado*. Unpublished Master's thesis, Colorado State University, Fort Collins.

1985 Comments on the McKean Symposium Papers. In *McKean/Middle Plains Archaic: Current Research*, edited by M. Kornfeld and L. C. Todd, pp. 181-187. Occasional Papers on Wyoming Archaeology 4. Laramie.

Metcalf, M. D. and K. D. Black

1991 *Archaeological Excavations at the Yarmony Pit House Site, Eagle County, Colorado*. Bureau of Land Management, Colorado State Office, Cultural Resource Series 31. Denver.

Meyer, D.

1985 A Component in the Scottsbluff Tradition: Excavations at the Niska Site. *Canadian Journal of Archaeology* 9(1):1-35.

Meyers, H. C.

1950 Preliminary Appraisal of the Archeological Resources of Platoro, Reservoir Site, Platoro, Colorado. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

Michlovic, M. G.

1986 Cultural Evolutionism and Plains Archaeology. *Plains Anthropologist* 31(113):207-218.

Mick, L. S

1982. Preliminary Report on Faunal Remains (25FT3). *Nebraska Archaeological Newsletter* 1:9-17.

1983 *An Ecological Evaluation of Faunal Diversity in the Central Plains Tradition*. Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

Miller, B. B.

1978 A Radiocarbon-dated (Wisconsinan) Molluscan Fauna from Southeastern Kansas. *Journal of Paleontology* 52:993-1002.

Miller, M. E.

1980 Archaeological Investigations at Site 48LR1420 Along Seminoe Reservoir in South-Central Wyoming. Ms. on file, Wyoming State Archaeologists Office. Department of Anthropology, University of Wyoming.

1985 Interassemblage Variability Among Five Middle Plains Archaic Bison Kills. In *McKean/Middle Plains Archaic: Current Research*, edited by M. Kornfeld and L. C. Todd, pp. 147-154. Occasional Papers on Wyoming Archaeology 4. Laramie.

1986 Preliminary Investigations at the Seminoe Beach Site, Carbon County, Wyoming. *Wyoming Archaeologist* 29(1-2):83-96.

Miller, E.
1994 Evidence for Prehistoric Scalping in Northeastern Nebraska. *Plains Anthropologist* 39(148):211-219.
Miller, M. E., B. R. Waitkus, and D. G. Eckles
1986 Butler-Rissler: A Plains Woodland Occupation Site along the North Platte River in Central Wyoming. Paper presented at the 49th Plains Conference, Denver.
Miller, P.
1982 An Intensive Cultural Resource Survey at the Tuttle Creek Lake, Pottawatomie and Riley Counties. Ms. on file, the Museum of Anthropology University of Kansas.
Miller, S. J.
1982 The Archaeology and Geology of an Extinct Megafauna/Fluted-Point Association at Owl Cave, the Wasden Site, Idaho: A Preliminary Report. In *Peopling of the New World*, edited J. E. Ericson, R. E. Taylor, and R. Berger, pp. 81-96. Ballena Press Anthropological Papers 23, Los Altos.
1983 Osteo-Archaeology of the Mammoth-Bison Assemblage at Owl Cave, the Wasden Site, Idaho. In *Carnivores, Human Scavengers and Predators: A Question of Bone Technology*, edited by G. M. LeMoine and A. S. MacEachern, pp. 55-93. Archaeological Association, Department of Archaeology, University of Calgary, Alberta.
Mitchell, D. D.
1842 Annual Report of the Office of Superintendent of Indian Affairs. House Executive Documents 2 (pp. 423-427). 27th Congress, 3rd Session (Ser. 418). Washington, D.C.
Mix, A. C.
1987 The Oxygen Isotope Record of Glaciation. In *North America and Adjacent Oceans during the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright, Jr., pp. 111-135. The Geology of North America, vol. K-3.
Molcyzk, L.
1969 Report of Lower Loup Indian Burial Excavation. Ms. on file, Nebraska State Historical Society, Lincoln.
Mollgaard, H. T., K. Lorenzen, I. G. Hansen, and P. E. Christensen
1946 On Phytic Acid, Its Importance in Metabolism and Its Enzymatic Cleavage in Bread Supplemented with Calcium. *Chemical Journal* 40:599-603.
Montet-White, A.
1968 *The Lithic Industries of the Illinois Valley in the Early and Middle Woodland Period*. Anthropological Papers No. 35, Museum of Anthropology, University of Michigan, Ann Arbor.
Montgomery, J. and J. Dickenson
1992 Additional Blades from Blackwater Draw Locality No. 1. Paper presented at the 50th Annual Plains Anthropological Conference, Lincoln, NE.
Montgomery, R. L.
1986 *A Paleodemographic Comparison of a Protohistoric Pawnee Site (25NC3) with a Historic Pawnee Site (25PK1)*. Unpublished Master's thesis, Department of Geography and Anthropology, Louisiana State University, Baton Rouge.
Moore, C. E.
1990 Osteological Report on the Skeletons from 14WY402. Ms. on file, Kansas State Historical Society, Topeka.
Moore K. R.
1983 A Research Design for a Cultural Resources Sample Survey in the Harlan Lake Project Lands West of U.S. Highway 183, Harlan County, Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.
Moore, P. S. and W. H. Birkby
n.d. Archeological Investigations in Melvern Reservoir, Osage County, Kansas. Ms. on file, SIRBS, Lincoln.
Moore, P. S., W. H. Birkby, and C. S. Smith
1964 *Archeological Investigations in Melvern Reservoir, Osage County, Kansas, 1962*. Museum of Anthropology, University of Kansas. Submitted to the National Park Service, U.S. Department of the Interior.
Moore, P. S., W. H. Birkby, C. S. Smith, W. M. Bass, and J. D. Featherstone (Compilers)
1962 Archeological Investigations in Melvern Reservation, Osage County, Kansas 1962. SI-RBS on file, SI-RBS, Lincoln.
Moore, T. P.
1846 Annual Report from the Upper Missouri Agency. In House Executive Documents 4. 29th Congress, 2nd Session (Ser. 497), pp. 288-296. U.S. Government Printing Office, Washington, D.C.
Moore-Jansen, P. H.
1990 Osteological Data for Site 14RW310. Ms. on file, Kansas State Historical Society, Topeka.
Moorhead, S. K.
1992 Affluence and Disease: The Impact of European Contact on Health in the Plains. *Nebraska Anthropologist* 9(1):33- 37.
Morey, D. F.
1982 *A Study of Subsistence and Seasonality in the Central Plains*. Technical Report 82-12, Division of Archaeological Research, Department of Anthropology, University of Nebraska.
Morlan, R. E.
1987 The Pleistocene Archaeology of Beringia. In *The Evolution of Human Hunting*, edited by M. Nitecki and D. Nitecki, pp. 267-307. Plenum Publishing Corporation.
1988 Pre-Clovis People: Early discoveries of America. In *Americans Before Columbus: Ice Age Origins*, edited by R. C. Carlisle, pp. 31-44. University of Pittsburgh, Department of Anthropology, Ethnology Monographs 12.
1993 A Compilation and Evaluation of Radiocarbon Dates in Saskatchewan. Saskatchewan Archaeology 13:3-84.
1994 Oxbow Bison Procurement as Seen from the Harder Site, Saskatchewan. *Journal of Archaeological Science* 21:757-777.
Mörner, N. A.
1976 The Pleistocene-Holocene Boundary—A Proposed Boundary-Stratotype in Gothenburg, Sweden. *Boreas* 5:193-275.
Moorman, E. H.
1953 Preliminary Survey and Appraisal of the Archeological Resources of Strawn and Toronto Reservoirs, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.
Morner, N. A.
1976 The Pleistocene-Holocene Boundary—A Proposed Boundary-Stratotype in Gothenburg, Sweden. *Boreas* 5:193-275.
Morris, E. A., R. C. Blakeslee, and K. Thompson
1985 Preliminary Description of McKean Sites in Northeastern Colorado. In *McKean/Middle Plains Archaic: Current Research*, edited by M. Kornfeld and L. C. Todd, pp. 11-20. Occasional Papers on Wyoming Archaeology 4. Laramie.
Morris, E. A. and J. R. Marcotte
1975 Archaeological Reconnaissance of the Cabin Creek-East Dillon Rebuild Project, Clear Creek and Summit Counties, Colorado. Ms. on file, Summit County Planning Office, Dillon.
Morris, E. A., K. L. Kvamme, N. T. Ohr, M. D. Metcalf, and H. M. Davidson (Compilers)
1979 The Archeology of the Boxelder Project: A Water Control Project in Larimer County North Central Colorado, 1972-1979 (and Addendum). Ms. on file, U.S. Soil Conservation Service, Technical Service Center, Portland.

Morris E. A., M. D. Metcalf, and H. M. Davidson
1974 Final Report of the 1972-1973 Archaeological Reconnaissance of Proposed Reservoir Areas in the Boxelder Creek Watershed, Larimer County, Colorado. Ms. on file, Soil Conservation Service, Denver.

Morrow, T. A. and J. E. Morrow
1994 A Preliminary Survey of Iowa Fluted Points. *Current Research in the Pleistocene* 11:47-48.

Morse, D.
1969 *Ancient Disease in the Midwest.* Illinois State Museum Reports of Investigations, No. 15. Illinois State Museum, Springfield.

Morse, D. F.
1971 The Hawkins Cache: A Significant Dalton Find in Northeast Arkansas. *Arkansas Archeologist* 12:9-20.
1982 A Paleo-Indian/Early Archaic Cemetery Possibility in Arkansas. In *Peopling of the New World,* edited by J. E. Ericson, R. E. Taylor, and R. Berger. Ballena Press

Morse, D. F. and A. Goodyear
1973 The Significance of the Dalton Adz in Northeast Arkansas. *Plains Anthropologist* 18(62):316-322.

Morton, S.
1839 *Crania Americana.* J. Dobson, Philadelphia.

Mosimann, J. and P. Martin
1975 Simulating Overkill by Paleoindians. *American Scientist* 63:304-313.

Moss, J. H., K. Bryan, G. W. Holmes, L. Satterthwaite, Jr., H. P. Hansen, C. B. Schultz, and W. D. Frankforter
1951 *Early Man in the Eden Valley.* University of Pennsylvania, Museum Monographs 6. Philadelphia.

Mott, R. J., D. R. Grant, and S. Occhietti
1986 Late-Glacial Climatic Oscillation in Atlantic Canada Equivalent to Alleod/Younger Dryas Event. *Nature* 323:247-250.

Mudge, B. F.
1896 Traces of the Moundbuilders in Kansas. *Transaction of Kansas Academy of Science* 2:69-71.

Mueller, J. W. (editor)
1975 *Sampling In Archaeology.* University of Arizona Press, Tucson.

Muhs, D. R.
1985 Age and Paleoclimatic Significance of Holocene Sand Dunes in Northeastern Colorado. *Annals of the Association of Geographers,* 75: 566-582.

Muhs, D. R. and Holliday, V. T.
1995 Active Dune Sand on the Great Plains in the 19th Century: Evidence from Accounts of Early Explorers. *Quaternary Research* 43:198-208.

Muller, J. D. and J. M. Schock
1964 Appraisal of the Archeological Resources of the Milford Reservoir, Kansas. Ms. on file, SI-RBS, Lincoln.

Mulloy, W. M.
1954 The McKean Site in Northeastern Wyoming. *Southwestern Journal of Anthropology* 10(4):432-460.
1958 *A Preliminary Historical Outline for the Northwestern Plains.* University of Wyoming Publications 22(1).
1959 The James Allen Site, Near Laramie, Wyoming. *American Antiquity* 25:112-116.

Munson, P. J.
1990 Folsom Fluted Projectile Points East of the Great Plains and Their Biogeographical Correlates. *North American Archaeologist* 11(3):255-272.

Murphy, T.
1959 The Changing Pattern of Dentine Exposure in Human Tooth Attrition. *American Journal of Physical Anthropology* 17:167-178.

Murrell, R. I.
1977 Human Skeletal Remains. In *The Talking Crow Site: A Multicomponent Earthlodge Village in the Big Bend Region, South Dakota,* edited by C. S. Smith, pp. 157-165. University of Kansas Publications in Anthropology, No. 9, Lawrence.

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

Myers, T. P., R. G. Corner, and L. G. Tanner
1981 Preliminary Report on the 1979 Excavations at the Clary Ranch Site. *Transactions of the Nebraska Academy of Sciences* 9:1-7.

Myers, T. P. and R. Lambert
1983 Meserve Points: Evidence of a Plains-Ward Extension of the Dalton Horizon. *Plains Anthropologist* 28(100):109-114

Myers, T. P., M. Voorhies and R. G. Corner
1980 Spiral Fractures and Bone Pseudotools at Paleontological Sites. *American Antiquity* 45:483-490.

Nasatir, A. P. (Editor)
1952 *Before Lewis and Clark. Documents Illustrating the History of the Missouri, 1785-1804* (2 vols.). St. Louis Historical Documents Foundation, St. Louis.

Nathan, M. (editor)
1980 Survey and Testing of Archaeological Resources at Clinton Lake, Kansas. Ms. on file, University of Kansas, Lawrence.

Naze, B.
1986 The Folsom Occupation of Middle Park, Colorado. *Southwestern Lore* 52(4):1-32.
1994 *The Crying Woman Site: A Record of Prehistoric Human Habitation in the Colorado Rockies.* Unpublished Master's thesis, Colorado State University, Fort Collins.

Nelson, D., R. Morlan, J. Vogel, J. Southon and C. R. Harington
1986 New Dates on Northern Yukon Artifacts: Holocene Not Upper Pleistocene. *Science* 232:749-751.

Nelson, N. C.
1933 The Antiquity of Man in America in the Light of Archaeology. *The American Aborigines: Their Origins and Antiquity,* edited by D. Jenness, pp. 87-130. University of Toronto Press, Toronto

Nelson, S. M.
1979 Archaeological Investigation in the Chatfield Reservoir, Colorado. Ms. on file, County Planning Office, Castle Rock.

Neuman, R. W.
1963 *Archeological Salvage Investigations in the Lovewell Reservoir Area, Kansas.* Smithsonian Institution, Bureau of American Ethnology, Bulletin 185, River Basin Surveys Papers, No. 32.
1975 *The Sonota Complex and Associated Sites on the Northern Great Plains.* Nebraska State Historical Society Publications in Anthropology, Number Six. Nebraska State Historical Society, Lincoln.

Neuman, R. W., E. R. Kendle, and L. A. Witt
1964 Prehistoric Artifacts from the Little Nemaha River Drainage, Otoe County, Nebraska. *Plains Anthropologist* 9(23):22-28.

Neuner, A. M.
1975 *Evolution and Distribution of the Spermophilus richardsonii Complex of Ground Squirrels in the Middle and Late Pleistocene: A Multivariate Analysis.* Unpublished Masters thesis, University of Kansas, Lawrence.

Nichols, J.
1990 Linguistic Diversity and the First Settlement of the New World. *Language* 66:475-521.

Nickel, C.
1973 *Two Archaeological Sites in the Perry Reservoir Region, Jefferson County, Kansas.* Unpublished Master's thesis, Wichita State University, Wichita.

Nickel, R. K.
1977 The Study of Archaeologically Derived Plant Remains from the Middle Missouri Subarea. *Plains Anthropologist Memoir* 13 (Part 2) 22:53-58.

Nickels, M. K.

1971 *An Analysis of the Skeletal Material from Sugar Creek Ossuary (23PL58).* Unpublished Master's thesis, Department of Anthropology, University of Kansas, Lawrence.

Nickens, P. R.

1977 An Isolated Burial of Probable Woodland Association from Golden Gate Canyon, Colorado. *Plains Anthropologist* 22(76):117-122.

1993 A Profile of the Cultural Resources of Colorado. Ms. on file, Colorado Historical Society, Denver.

Niven, L. B. and M. G. Hill

1995 Seasonality Studies and Plains Archaic Bison Hunting. Paper presented at the 53rd Annual Plains Anthropological Conference. Laramie.

Nordt, L. C., T. W. Boutton, C. T. Hallmark, and M. R. Waters

1994 Late Quaternary Vegetation and Climate Changes in Central Texas Based on the Isotopic Composition of Organic Carbon. *Quaternary Research* 41:109-120.

O'Brien, M. J. and T. D. Holland

1990 Variation, Selection, and the Archaeological Record. In *Archaeological Method and Theory,* Vol. 2, edited by M. B. Schiffer, pp. 31-79. University of Arizona Press, Tucson.

1992 The Roll of Adaptation in Archaeological Explanation. *American Antiquity* 57:36-59.

O'Brien, P. J.

1971 Valley Focus Mortuary Practices. *Plains Anthropologist* 16(53):165-182.

1972 A Clovis Point from the Waterville, Kansas Area. *Plains Anthropologist* 17(55):60-64.

1976 Milford Lake Shoreline Archaeological Survey. Ms. on file, Museum of Anthropology, University of Kansas, Lawrence.

1977a Milford Lake, A Cultural Resource Management Plan. Ms. on file, U.S. Army Corps of Engineers, Omaha.

1977b *Cultural Resources Survey of Smithville Lake, Missouri.* Kansas State University, Manhattan. Submitted to U.S. Army Corps of Engineers, Kansas City District.

1978a Steed-Kisker: A Western Mississippian Settlement System. In *Mississippian Settlement Patterns,* edited by B. D. Smith, pp. 1-19. Academic Press, New York, pp. 1-19.

1978b Steed-Kisker and Mississippian Influences in the Central Plains. In *The Central Plains Tradition: Internal Development and External Relationships,* edited by D. J. Blakeslee, pp. 67-80. Office of the State Archaeologist, University of Iowa, Report 11.

1981 Steed-Kisker: A Cultural Interpretation. *The Missouri Archaeologist* 42:97-108.

1982 The Yeo Site (23CL199): A Kansas City Hopewell Limited Activity Site in Northwestern Missouri and Some Theories. *Plains Anthropologist* 27(95):37-56.

1983 Cultural Resources Survey of Council Grove Lake, Kansas. Ms. on file, U.S. Army Corps of Engineer, Missouri River Division, Omaha.

1984a The Tim Adrian Site (14NT604): A Hell Gap Quarry Site in Norton County, Kansas. *Plains Anthropologist* 29:41-56.

1984b *Archeology in Kansas.* University of Kansas Museum of Natural History, Public Education Series 9. Lawrence.

1986 Prehistoric Evidence for Pawnee Cosmology. *American Anthropologist* 88(4):939-946.

1988 Ancient Kansas City Borders and Trails. *The Missouri Archaeologist* 49:27-39.

1993 Steed-Kisker: The Western Periphery of the Mississippian Tradition. *Midcontinental Journal of Archaeology* 18:61-96.

O'Brien, P. J., M. Caldwell, J. Jilka, L. Toburen, and B. Yeo

1979 The Ashland Bottoms Site (14RY603): A Kansas City Hopewell Site in North-Central Kansas. *Plains Anthropologist* 23:1-20.

O'Brien, P. J., B. Chandler, J. Merklin, L. Paris, M. Saul, L. Schwiekhard, and K. Smith

1987 The Huse Corncrib, and Archeological Site Context. *Journal of the Kansas Anthropological Association* 8:54-84

O'Brien, P. J. and W. P. McHugh

1987 Mississippian Solstice Shrines and a Cahokian Calendar: An Hypothesis Based on Ethnohistory and Archaeology. *North American Archaeologist* 8:227-247.

O'Brien, P. J. and H. B. Rager

1983 Cultural Resources Survey of Council Grove Lake, Kansas. Ms. on file, U.S. Army Corps of Engineers, Tulsa District.

Ochsenius, C. and R. Gruhn (editors)

1979 *Taima-Taima: A Late Pleistocene Paleo-Indian Kill Site in Northernmost South America, Final Report of the 1976 Excavations.* South American Quaternary Documentation Program.

O'Connell, J. F.

1987 Alyawara Site Structure and Its Archaeological Implications. *American Antiquity* 52:74-108.

O'Connell, J. F., K. Hawkes, and N. G. Blurton-Jones

1992 Patterns in the Distribution, Site Structure and Assemblage Composition of Hadza Kill-Butchery Sites. *Journal of Archaeological Science* 19:319-345.

Ohr, N. T., K. L. Kvamme, E. A. Morris

1979 The Lykins Valley Site (5LR263): A Stratified Locality on Boxelder Creek, Larimer County, Colorado. Ms. on file, U.S. Soil Conservation Service, Technical Service Center, Portland.

O'Leary, M. H.

1981 Carbon Isotope Fractionation in Plants. *Photochemistry* 20 (4):55367.

Oliver, S. C.

1962 *Ecology and Cultural Continuity as Contribution Factors in the Social Organization of the Plains Indians.* University of California Publications in American Archaeology and Ethnology 48.

Olsen, S. L. and P. Shipman

1994 Cutmarks and Perimortem Treatment of Skeletal Remains of the Northern Plains. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 377-387. Smithsonian Institution Press, Washington, D.C.

Olson, Byron L.

1978 Excavations at Site 5BL70. In *The Mount Albion Complex, A Study of Prehistoric Man and the Altithermal,* by J. B. Benedict and B. L. Olson, pp. 76-138. Center for Mountain Archaeology, Ward, Colorado.

O'Neil, B. P., M. J. Tate, M. Tammers, and L. J. Scott

1986 Evaluative Testing of Archaeological Sites at the Proposed Senac Dam Site, Arapahoe County, Colorado. Ms. on file, City of Aurora Planning Office, Aurora.

O'Rourke, D. H. and A. S. Litchty

1989 Spatial Analysis and Gene Frequency Maps of Native North American Populations. *Collections in Anthropology* 13:173-174.

Orser, C. E.

1980 Toward a Partial Understanding of Complexity in Arikara Mortuary Practice. *Plains Anthropologist* 25:113-120.

Ortner, D. J. and W. G. J. Putschar

1981 *Identification of Pathological Conditions in Human Skeletal Remains.* Smithsonian Contributions to Anthropology No. 28. Smithsonian Institution Press, Washington, D.C.

Osborn, A. J.

1982 Archaeological Survey Investigations in the South Branch and Weeping Water Creek Drainage, Cass County. Ms. on file, the Nebraska State Historical Society, Lincoln.

1987 Scientific Research Programmes: Toward a Synthesis and Evaluation of CRM Archaeology. In *Perspectives on Archaeological Resources Management in the Great Plains,* edited by A. Osborn and R. Hassler, pp. 1-67. I&O Publishing, Omaha.

1993 Snowblind in the Desert Southwest: Moisture Islands, Ungulate Ecology, and Alternative Prehistoric Overwintering Strategies. *Journal of Anthropological Research* 49(2):135-164.

Osborn, H. F.

1910 *The Age of Mammals in Europe, Asia, and North America.* MacMillan, New York.

O'Shea, J. M.

1978 *Mortuary Variability: An Archaeological Investigation with Case Studies from the Nineteenth Century Central Plains of North America and Early Bronze Age of Southern Hungary.* Unpublished Ph.D. dissertation, University of Cambridge, Cambridge, England.

1984 *Mortuary Variability. An Archaeological Investigation.* Academic Press, Inc., Orlando, Florida.

1989 Pawnee Archaeology. *Central Plains Archaeology* 1(1):49-107.

O'Shea, J. M. and P. S. Bridges

1989 The Sargent Site Ossuary (25CU28), Custer County, Nebraska. *Plains Anthropologist* 34(123):7-21.

O'Shea, J. M. and J. Ludwickson

1992 *Archaeology and Ethnohistory of the Omaha Indians; the Big Village Site.* University of Nebraska Press, Lincoln.

Ostlie, W. R.

1988 *Late-Pleistocene Vegetation Patterns of the Midwest based on Fossil Land Snail Assemblages and Plant Macrofossil Evidence.* Unpublished Master's thesis, University of Kansas.

Otte, M. and L. Keeley

1990 The Impact of Regionalism on Paleolithic Studies. *Current Anthropology* 31(5):577-582.

Over, W. H. and E. E. Meleen

1941 *A Report on an Investigation of the Brandon Village Site and the Split Rock Creek Mounds.* University of South Dakota Archaeological Studies Circular 3. University of South Dakota, Vermillion.

Oviatt, C. G., E. T. Karlstrom, and C. U. Hammer

1988 Pleistocene Loess, Buried Soils, and Thermoluminescence Dates in an Exposure Near Milford Lake, Geary County, Kansas. Abstracts with Programs 20(2):125-126.

Owen, R.

1984 The Americas: the Case Against an Ice-Age Human Population. In *The Origins of Modern Humans: A World Survey of the Fossil Evidence,* edited by F. Smith and F. Spencer, pp. 517-563. R. Liss, New York.

Owsley, D. W.

1983 Growth Arrest Lines in Tibias of Arikara Indians of the Post-Contact Period. Presentation in Symposium on Diseases, Anomalies and Abnormalities in Ancient Mid-North America, at 41st Annual Meeting of the Plains Anthropological Conference Rapid City, North Dakota.

1985 Postcontact Period Nutritional Status and Cortical Bone Thickness of South Dakota Indians. In *Status, Structure and Stratification: Current Archaeological Reconstructions,* edited by M. Thompson, M. T. Garcia, and F. J. Kense, pp. 198-208. Proceedings of the Sixteenth Annual Conference of the Archaeological Association of the University of Calgary, Calgary, Alberta, Canada.

1985-89 Skeletal Inventories and Demographic Data on File, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

1991 Temporal Variation in Femoral Cortical Thickness of North American Plains Indians. In *Human Paleopathology. Current Syntheses and Future Options,* edited by D. F. Ortner and A. C. Aufderheide, pp.105-110. Smithsonian Institution Press, Washington D.C.

1992 Demography of Prehistoric and Early Historic Northern Plains Populations. In *Disease and Demography in the Americas,* edited by J. W. Verano and D. H. Ubelaker, pp. 75-86. Smithsonian Institution Press, Washington, D.C.

1994 Warfare in Coalescent Tradition Populations of the Northern Plains. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 333-343. Smithsonian Institution Press, Washington, D.C.

Owsley, D. W. and W. M. Bass

1979 A Demographic Analysis of Skeletons from the Larson Site (39WW2) Walworth County, South Dakota: Vital Statistics. *American Journal of Physical Anthropology* 51:145-154.

Owsley, D. W., S. M. Bennett, and R. L. Jantz

1982 Intercemetery Morphological Variation in Arikara Crania from the Mobridge Site (39WW1). *American Journal of Physical Anthropology* 58(2):179-185.

Owsley, D. W., H. E. Berryman, and W. M. Bass

1977 Demographic and Osteological Evidence for Warfare at the Larson Site, South Dakota. *Plains Anthropologist Memoir* 13:119-131.

Owsley D. W. and B. Bradtmiller

1983 Mortality of Pregnant Females in Arikara Villages; Osteological Evidence. *American Journal of Physical Anthropology* 61:331-336.

Owsley, D. W. and R. L. Jantz

1985 Long Bone Lengths and Gestational Age Distributions of Post-Contact Period Arikara Indian Perinatal Infant Skeletons. *American Journal of Physical Anthropology* 68:321-328.

1989 A Systematic Approach to the Skeletal Biology of the Southern Plains. In *From Clovis to Comanchero: Archeological Overview of the Southern Great Plains,* edited by J. L. Hofman, R. L. Brooks, and D. W. Owsley, pp. 137-156. Arkansas Archeological Survey Research Survey Series 35, Fayetteville.

1994 An Integrative Approach to Great Plains Skeletal Biology. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 3-8. Smithsonian Institution Press, Washington, D.C.

Owsley, D. W., R. W. Mann, and T. G. Baugh

1994 Culturally Modified Human Bones from the Edwards I Site. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 363-375. Smithsonian Institution Press, Washington, D.C.

Owsley, D. W. and G. Potter

1993 Preliminary Review of NSHS Collections. Report on file, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Padgett, W., III

1988 The Lithics from House 2, 25DX30. In *St. Helena Archaeology: New Data, Fresh Interpretations,* edited by D. J. Blakeslee, pp. 63-78. J & L Reprints in Anthropology 39. Lincoln.

Palkovich, A. M.

1978a *A Model of the Dimensions of Mortality and Its Application to Paleodemography.* Unpublished Ph.D. dissertation, Department of Anthropology, Northwestern University, Evanston.

1978b Tuberculosis Epidemiology in Two Skeletal Samples: A Study of Disease Impact. Paper presented to the Annual Meeting of the American Association of Physical Anthropologists, Toronto, Ontario, Canada.

1981 Demography and Disease Patterns in a Protohistoric Plains Group: A Study of the Mobridge Site (39WW1). *Plains Anthropologist Memoir* 17:71-84.

Park, E.

1964 The Imprinting of Nutritional Disturbances on the Growing Bone. *Pediatrics* 33:815-862.

Park, K., M. R. Farr, and W. C. Johnson

1993 Magnetic Susceptibility Record of two Quaternary Sections, Nebraska (abs.): American Geophysical Union, Abstracts, 1993 Spring Meeting.

Parks, D. R.

1979 The Northern Caddoan Languages: Their Subgrouping and Time Depth. *Nebraska History Magazine* 60(2):197-213.

Parks, S. M.

1992 Windows to the Past: Artifacts from Historic Omaha Cemeteries. *Nebraska Anthropologist* 9(1):1-32.

Parmalee, P. W.

1977 The Avifauna from Prehistoric Arikara Sites in South Dakota. *Plains Anthropologist* 22:189-222.

1979 Inferred Arikara Subsistence Pattern Based on a Selected Faunal Assemblage from the Mobridge Site, South Dakota. *The Kiva* 44:191-218.

Paterson, W. S. B. and C. U. Hammer

1987 Ice Cores and Other Glaciological Data. In *North America and Adjacent Oceans during the Last Deglaciation,* edited by W. F. Ruddiman and H. E. Wright, Jr. Geological Society of America, The Geology of North America, v.K-3, Boulder.

Patterson, D. K.

1984 *Dental Paleopathology and Attritional Status: A Diachronic Study of Dental Paleopathology and Attritional Status of Prehistoric Ontario Pre-Iroquois and Iroquois Populations.* National Museums of Canada, Ottawa, Ontario, Canada.

Patterson, T. C.

1986 The Last 60 Years.: Towards a Social History of Americanist Archaeology in the United States. *American Anthropologist* 88(1): 7-26.

Payen, L. A.

1982 Artifacts or Geofacts at Calico: Application of the Barnes Test. In *Peopling of the New World,* edited by J. E. Ericson, R. E. Taylor, and R. Berger, pp. 193-201. Ballena Press, Los Altos, California.

Pearsall, D. M.

1989 *Paleoethnobotany: A Handbook of Procedures*. Academic Press, San Diego.

Pepperl, R. E.

1978a Archaeological Investigation Within the Tekamah-Med Creek Watershed Project Area, Burt County, Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.

1978b Background Data: Harlan County Lake, Nebraska. Ms. on file, U.S. Army Corps of Engineer, Kansas City.

1983 Comprehensive Evaluation of the Cultural Resources Inventory and Preservation Planning Needs of the Niobrara River Basin, Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.

Pepperl, R. E., C. R. Falk, and T. W. Dunlay

1978 Management Plan for Cultural Resources within the Harlan County Lake Area, Nebraska. Ms. on file, U.S. Army Corps of Engineer, Omaha.

Pepperl, R. E. and D. R. Haas

1978 Archaeological Investigation within the Briscoe Dam Project Area, Garden County, Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.

Perzigian, A. J.

1977a Teeth as Tools for Prehistoric Studies. In *Biocultural Adaptation in Prehistoric America* (Southern Anthropological Society Proceedings, No. 11), edited by R. L. Blakely, pp. 104-114. University of Georgia Press, Athens.

1977b Fluctuating Dental Asymmetry: Variation Among Skeletal Populations. *American Journal of Physical Anthropology* 47:81-88.

Perzigian, A. J., P. A. Tench, and D. J. Braun

1984 Prehistoric Health in the Ohio River Valley, In *Paleopathology at the Origin of Agriculture*, edited by M. N. Cohen and G. J. Armelagos, pp. 347-366. Academic Press, New York.

Peterson, J. and D. Watson

1993 Dating the Skidi: Ceramic Seriation and Euro-American Trade Goods from 25HW16. Paper presented at the 15th Flint Hills Archaeological Conference, Wichita, Kansas.

Peterson, R. R., Jr.

1982 The Bowlin Bridge Site (23JA38). In *Little Blue Prehistory: Archaeological Investigations at Blue Springs and Longview Lakes, Jackson County, Missouri,* edited by L. J. Schmits. U.S. Army Corps of Engineers, Kansas City District, Kansas City.

Petsche, J. E.

1974 *The Steamboat Bertrand; History, Excavation, and Architecture*. National Park Service, United States Department of the Interior, Washington D.C.

Pettipas, L.

1982 A Reconsideration of Late Paleo-Indian (Plano) Prehistory. *Manitoba Archaeological Quarterly* 6:44-77.

Pfeiffer, S. and P. King

1983 Cortical Bone Formation and Diet Among Protohistoric Iroquoians. *American Journal of Physical Anthropology* 60:23-28.

Phenice, T. W.

1969 *An Analysis of the Human Skeletal Material from Burial Mounds in North Central Kansas.* University of Kansas Publications in Anthropology Number l, Lawrence.

Philips, R. E.

1960 The Dickman Ossuary, A Prehistoric Burial Site in Custer County, Nebraska. Ms. on file, Nebraska State Historical Society, Lincoln.

1963 Four Woodland Sites in Southcentral Nebraska. *Plains Anthropologist* 8(21):176-179.

Phillips, J. L. and J. A. Brown, editors

1983 *Archaic Hunters and Gatherers in the American Midwest.* Academic Press, New York.

Phillips, P., J. A. Ford, and J. B. Griffin

1951 *Archaeological Survey in the Lower Mississippi Alluvial Valley. 1940-1947.* Papers of the Peabody Museum No 25, Cambridge.

Phillips, P. and G. R. Willey

1953 Method and Theory in American Archaeology: An Operational Basis for Culture History Integration. *American Anthropologist* 55: 615-633.

Pianka, E. R.

1983 *Evolutionary Ecology* (third edition). Harper and Row, New York.

Pierce, H. G.

1987 The Gastropods, with Notes on Other Invertebrates. In *Lubbock Lake: Late Quaternary Studies on the Southern High Plains*, edited by E. Johnson, pp. 41-48. Texas A & M University Press, College Station.

Platt, B. S. and R. J. C. Stewart

1962 Transverse Trabeculae and Osteoporosis in Bones in Experimental Protein Calorie Deficiency. *British Journal of Nutrition* 16:483-495.

Platt, C. W. M. and R. A. McCance

1964 Severe Undernutrition in Growing and Adult Animals. *British Journal of Nutrition* 18:393-408

Polyak, V. and M. Williams

1986 Gaines County Paleo-Indian Projectile Point Inventory and Analysis. *Transactions of the 21st Regional Archeological Symposium for Southeastern New Mexico and Western Texas,* pp. 25-96.

Ponte, M. R., D. B. Loope, and J. B. Swinehart

1994 Significance of Interbedded Eolian Sand and Peat Beneath Interdunes of the Central Nebraska Sand Hills. Geological Society of America, Abstracts and Programs A-62.

Porter, S. C.

1988 Landscapes of the Last Ice Age in North America. In *Americans Before Columbus: Ice-Age Origins,* edited by R. C. Carlisle, pp. 1-24. Ethnology Monographs 12, Department of Anthropology, University of Pittsburgh.

Porter, S. C. (editor)

1983 *Late Quaternary Environments of the United States,* edited by H. Wright. Volume 1. The Late Pleistocene. University of Minnesota Press, Minneapolis.

Powers, R. and J. Hoffecker

1989 Late Pleistocene Settlement in the Nenana Valley, Central Alaska. *American Antiquity* 54:263-287.

Poynter, C. M. W.

1915 A Study of Nebraska Crania. *American Anthropologist* 17: 509-524.

Prell, W. L., J. Imbrie, D. G. Martinson, J. J. Morley, N. G. Pisisas., N. J. Shackleton, and H. F. Streeter

1986 Graphic Correlation of Oxygen Isotope Stratigraphy Application to the Late Quaternary. *Paleoceanography* 1:137-162.

Preucel, R. W. (editor)

1991 *Processual and Post-Processual Archaeologies: Multiple Ways of Knowing the Past.* Southern Illinois University Center For Archaeological Investigations Occasional Paper No 10.

Price, T. D. and G. M. Feinmen

1993 *Images of the Past.* Mayfield, Mountain View, CA.

Pullen, D. L.

1976 Form and Function of a Feature at the Aker Site (23PL43). Ms. on file, Museum of Anthropology, University of Kansas, Lawrence.

Quade, L. G.

1969a An Archaeological Survey of the Wakar USA Watershed Management Area: Douglas, Osage, Shawnee, and Wabaunsee Counties, Kansas. Ms. on file, U.S. Army Corps of Engineer, Kansas City.

1969b An Archaeological Survey of the Turkey Creek Watershed Management Area: Dickinson and Marion Counties, Central Kansas. Ms. on file, Soil Conservation Service, Midwest Region, Lincoln.

1969c An Archaeological Survey of the North Black Vermillion Watershed Management Area: Marshall and Nemaha Counties, Northeast Kansas. Ms. on file, Soil Conservation Service, Midwest Region, Lincoln.

1969d An Archaeological Survey of the Mission Creek Watershed Management Area: Marshall County, Kansas and Gage and Pawnee Counties, Nebraska. Ms. on file, Midwest Archeological Center, Lincoln.

1969e An Archaeological Survey of the Irish Creek Watershed Management Area: Marshall and Pottawatomie Counties, Northeast Kansas. Ms. on file, Soil Conservation Service, Midwest Region, Lincoln.

Raab, L. M. and A. C. Goodyear

1984 Middle Range Theory in Archaeology: A Critical Review of Origins and Applications. *American Antiquity* 49: 255-268.

Raab, L. M., T. C. Klinger, M. B. Schiffer, and A. C. Goodyear

1980 Clients, Contracts, and Profits: Conflicts in Public Archaeology. *American Anthropologist* 82:539-551.

Radle, N. J.

1981 *Vegetation History and Lake-Level Changes at Saline Lakes in Northeastern South Dakota.* Unpublished Master's thesis, University of Minnesota, Minneapolis.

Ramenofsky, A. F.

1987 *Vectors of Death: The Archaeology of European Contact.* University of New Mexico Press, Albuquerque.

Rancier, J., G. Haynes, and D. J. Stanford

1982 1981 Investigations of Lamb Spring. *Southwestern Lore* 48:1-17.

Rapson, D. J.

1994 Attribute-Based Faunal Analysis at the Helen Lookingbill Site: The Early Plains Archaic Deer Bonebed Assemblage. Paper presented at the 52nd Annual Plains Anthropological Conference. Lubbock, Texas.

Rapson, D. J. and L. C. Todd

1992 Conjoins, Contemporaneity, and Site Structure: Distributional Analyses of the Bugas-Holding Site. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology*, edited by J. L. Hofman and J. G. Enloe, pp. 238-263. BAR International Series 578. Oxford.

1992 1992 Excavations at the Hudson-Meng Bison Bonebed: Analytic Approaches for Evaluating Bonebed Formation. Paper Presented at the 50th Annual Plains Anthropological Conference. Lincoln.

Ray, A. J.

1974 *Indians in the Fur Trade.* University of Toronto Press, Toronto, Ontario, Canada.

1976 Diffusion of Diseases in the Western Interior of Canada, 1830-1850. *Geographical Review* 66:141-157.

Ray, C. N.

1941 Various Types of Clear Fork Gouges. *Bulletin of the Texas Archeological and Paleontological Society* 13:152-162.

Read, D. W.

1982 Toward a Theory of Archaeological Classification. In *Essays on Archaeological Typology,* edited by R. Whallon and J. A. Brown, pp. 56-92. Center for American Archaeology Press. Evanston, Illinois.

Redder, A. J.

1985 Horn Shelter No. 2: The South End, A Preliminary Report. *Central Texas Archaeologist* 10:37-65.

Reed, E. C. and V. H. Dreeszen

1965 *Revision of the Classification of the Pleistocene Deposits of Nebraska.* Nebraska Geological Survey Bulletin, 23.

Reeder, R. L.

1980 The Sohn Site: A Lowland Nebo Hill Complex Campsite. In *Archaic Prehistory on the Prairie-Plains Border,* edited by A. E. Johnson, pp. 55-66. University of Kansas Publications in Anthropology 12. Lawrence.

Reeves, B.

1973 The Concept of an Altithermal Cultural Hiatus in Northern Plains Prehistory. *American Anthropologist* 75:1221-1253.

1978 Bison Killing in the Southwestern Alberta Rockies. In *Bison Procurement and Utilization: A Symposium,* edited by L. B. Davis and M. C. Wilson, pp. 63-78. Plains Anthropologist Memoir 14.

1990 Communal Bison Hunters of the Northern Plains. In *Hunters of the Recent Past,* edited by L. B. Davis and B. O. K. Reeves, pp. 168-194. Unwin Hyman, Boston.

Reher, C. A.

1973 A Survey of Ceramic Sites in Southeastern Wyoming. *The Wyoming Archaeologist* 16(1&2).

Reher, C. A. and G. C. Frison

1980 The Vore Site, 48CK302, A Stratified Buffalo Jump in the Wyoming Black Hills. *Plains Anthropologist Memoir* 16.

Reher, C. A., G. M. Zeimens, and G. C. Frison

1985 The Cordero Site—48CA75: A Middle Plains Archaic Bison Processing Station in the Central Powder River Basin. In *McKean/Middle Plains Archaic: Current Research,* edited by M. Kornfeld and L. C. Todd, pp. 109-121. Occasional Papers on Wyoming Archaeology 4. Laramie.

Reid, K. C.

1976 Prehistoric Trade in the Lower Missouri River Valley: An Analysis of Middle Woodland Bladelets. In *Hopewellian Archaeology in the Lower Missouri Valley*, edited by A. E. Johnson, pp. 66-99. University of Kansas, Publications in Anthropology, No. 8, Lawrence.

1980 The Achievement of Sedentism in the Kansas City Region. In *Archaic Prehistory on the Prairie-Plains Border,* edited by A. E. Johnson, pp. 29-42. University of Kansas Publications in Anthropology No. 12, Lawrence.

1983 The Nebo Hill Phase: Late Archaic Prehistory in the Lower Missouri Valley. In *Archaic Hunters and Gatherers in the American Midwest,* edited by J. A. Brown, pp. 11-39. Academic Press, New York.

1984 *Nebo Hill and Late Archaic Prehistory of the Southern Prairie Peninsula.* University of Kansas, Publications in Anthropology 15. Lawrence.

Reid, K. C. and J. A. Artz

1984 *Hunters of the Forest Edge: Culture, Time, and Process in the Little Caney Basin (1980, 1981, and 1982 Field Seasons).* University of Tulsa Laboratory of Archaeology, Contributions in Archaeology 14. Oklahoma Archeological Survey, Studies in Oklahoma's Past No. 13.

Reider, R. G.

1990 Late Pleistocene and Holocene Pedogenic and Environmental Trends at Archaeological Sites in Plains and Mountains Areas of Colorado and Wyoming. In *Archaeological Geology of North America*, edited by N. P. Lasca and J. Donahue, pp. 335-360. Geological Society of America, Centennial Volume 4.

Reinhard, K. J., L. Tieszen, K. L. Sandness, L. M. Beiningene, E. Miller, A. H. Ghazi, C. E. Miewald, and S. V. Barnum

1994 Trade, Contact, and Female Health in Northeastern Nebraska. In *In the Wake of Contact. Biological Responses to Conquest*, edited by C. S. Larsen and G. R. Milner, pp. 63-74. Wiley Liss, New York.

Renaud, E. B.

1930 Prehistoric Cultures of the Cimarron Valley, Northeastern New Mexico and Western Oklahoma. *Colorado Scientific Society Proceedings* 12(5):113-150. Denver

1931a *Archaeological Survey of Eastern Colorado, vol. 1.* Archaeological Series, Department of Anthropology, University of Denver.

1931b Prehistoric Flaked Points From Colorado and Neighboring District. *Proceedings of the Colorado Museum of Natural History.* 10(2): 6-21.

1932a *Archaeological Survey of Eastern Colorado, vol. 2.* Archaeological Series, Department of Anthropology, University of Denver.

1932b Yuma and Folsom Artifacts. *Proceedings of the Colorado Museum of Natural History.* 11(2): 5-16.

1933 *Archaeological Survey of Eastern Colorado, vol. 3.* University of Denver, Department of Anthropology.

1934a *The First Thousand Yuma-Folsom Artifacts, First Paper.* Archaeological Series, Department of Anthropology, University of Denver.

1934b *Archaeological Survey of Western Nebraska, Sixth Report.* Archaeological Survey, Department of Anthropology, University of Denver.

1935 *The Archaeological Survey of Eastern Colorado, Fourth Report.* Archaeological Survey, Department of Anthropology, University of Denver.

1937 *The Archaeological Survey of the High Western Plains, Northeastern New Mexico, Ninth Report.* Archaeological Series, Department of Anthropology, University of Denver.

Reyman, J. E. (editor)

1992 *Rediscovering Our Past: Essays on the History of American Archaeology.* Avebury, Brookfield.

Reynolds, J. D.

1970 Appraisal of the Archeological Resources of the Onaga Reservoir Pottawatomie County, Kansas. Ms. on file, U.S. Army Corps of Engineer, Kansas City.

1971 Archeological Resources of the Onaga Reservoir. *Kansas Anthropological Association Newsletter* 17(1/2):1-24.

1975 Archeological Survey for Onaga Lake, Kansas. Ms. on file, U.S. Army Corps of Engineer, Kansas City.

1977 Preliminary Report of Archeological Investigations at 14ML307, the Range Mound, Glen Elder, Kansas. *Kansas Anthropological Association Newsletter* 23(2-3):1-11.

1979a Archaeological Investigations at the Malm Anderson and Steaford Sites in Perry Reservoirs, Jefferson County, Kansas. Ms. on file, Anthropology Museum, University of Kansas.

1979b *The Grasshopper Falls Phase of the Plains Woodland.* Kansas State Historical Society Anthropological Series 7, Topeka.

1981 The Grasshopper Falls Phase: A Newly Defined Plains Woodland Cultural Historical Integration Phase in the Central Plains. *The Missouri Archaeologist* 42: 85-96.

1982a Archeological Investigations at the Cow-Killer Site, 1405347. Submitted to the Kansas City District of the U.S. Army Corps of Engineers.

1982b Chipped Stone Debitage from the William Young Site. In *The Slough Creek, Two Dog, and William Young Sites Council Grove Lake, Kansas,* by T. A. Witty, pp. 240-261. Kansas Historical Society Anthropological Series 10. Topeka.

1984a The Cow-Killer Site, Melvern Lake, Kansas. Ms. on file, U.S. Army Corps of Engineer, Missouri River Division, Omaha.

1984b Report of Initial Archeological Inspection of a Proposed Sanitary Landfill Site in Section 29 and 30, T10S, R25E, Kansas City, Kansas. Ms. on file, Kansas State Historical Society, Department of Archeology.

1987a *The Archeology of Grove Reservoir, Kansas 1969.* Kansas State Historical Society, Anthropological Series 14. Topeka.

1987b *Archeological Investigations at Old Fort Scott, 14BO302, Fort Scott, Kansas, 1968 to 1972.* National Park Service, Midwest Region, Omaha.

1990 Ceremonial Bifaces from the Whiteford Archeological Site, 14SA1. *The Kansas Anthropologist* 11(1):6-20.

Reynolds, J. D. and V. Wulfkuhle

1991 The 1991 Dig and Kansas Archeology Training Program. *Kansas Anthropological Association, Newsletter* 3(5):5-7.

Richmond, G. M. and D. S. Fullerton

1986 Summation of Quaternary Glaciations in the United States of America. *Quaternary Science Reviews* 5:183-196.

Rickey, D.

1968 Preliminary Survey History of the Lower Platte and Elkhorn Rivers in the Areas Included in the Platte River Reservoir, Skull Creek and Platte River Island Project Proposals. Ms. on file, Nebraska State Historical Society, Lincoln.

Rigaud, J. P. and J. Simek

1987 Arms Too Short to Box with God. In *The Pleistocene Old World*, edited by O. Soffer, pp. 47-60. Plenum Press, New York.

Riley, T. J.

1967 Preliminary Report of Excavations at 14ML17, Glen Elder Reservoir, Kansas. *Plains Anthropologist* 12(36).

Riley, T. J., R. Edging and J. Rosen

1990 Cultigens in Prehistoric Eastern North America, Changing Paradigms. *Current Anthropology* 31:325-341.

Riley, T. J., G. R. Walz, C. J. Bareis, A. C. Fortier, and K. E. Parker

1994 Accelerator Mass Spectrometry (AMS) Dates Confirm Early *Zea Mays* in the Mississippi River Valley. *American Antiquity* 59(3):490-497.

Rind D., D. Peteet, W. Broecker, A. McIntyre, and W. Ruddiman

1986 The Impact of Cold North Atlantic Sea Surface Temperatures on Climate: Implications for the Younger Dryas Cooling (11-10k). *Climate Dynamics* 1:3-33.

Ritchie, W. A.

1932 The Lamoka Lake Site. *Researches and Transactions of the New York State Archaeological Association* 7(4): 79-134.

Ritterbush, L. W. and B. Logan

1991 *The Schultz Archaeological Project, Phase I: A Survey of Selected Prehistoric Sites in North-Central Kansas.* University of Kansas, Museum of Anthropology, Project Report Series 73.

1992 *Analysis of Three Smoky Hill Variant Sites in North-Central Kansas: The Schultz Archaeological Project, Phase II.* University of Kansas, Museum of Anthropology, Project Report Series 78.

Roberts, F. H. H., Jr.

1934 True Folsom Points. *Literary Digest* 118(4):18.

1935a *A Folsom Complex: Preliminary Report on Investigations at the Lindenmeier Site in Northern Colorado.* Smithsonian Miscellaneous Collections 94(4).

1935b A Folsom Camp Site and Workshop. *Explorations and Field-Work of the Smithsonian Institution in 1934*, pp. 61-64.

1935c A Folsom Complex: Preliminary Report on the Investigations at the Lindenmeier Site in Northern Colorado (a Summary). *Nature* 136:535-538.

1936 *Additional Information on the Folsom Complex: Report on the Second Season's Investigations at the Lindenmeier Site in Northern Colorado.* Smithsonian Miscellaneous Collections 95(10).

1936 Recent Discoveries in the Material Culture of Folsom Man. *The American Naturalist* 70:337-345.

1937 The Folsom Problem in American Archaeology. In *Early Man*, edited by G. C. McCurdy, pp. 153-162 . J. B. Lippincott. Philadelphia.

1937 The Material Culture of Folsom Man as Revealed at the Lindenmeier Site. *Southwestern Lore* 2(4):67-73.

1938 The Lindenmeier Site in Northern Colorado Contributes Additional Data on the Folsom Complex. *Explorations and Field-Work of the Smithsonian Institution in 1937*: 115-118.

1940 Developments in the Problem of the North American Paleo-Indian. In *Essays in the Historical Anthropology of North America*, Smithsonian Miscellaneous Collections 100:51-116.

1941 Latest Excavations at the Lindenmeier Site Add to Information on the Folsom Complex. *Explorations and Field-Work of the Smithsonian Institution in 1940*:79-82.

1942 *Archaeological and Geological Investigations in the San Jon District, Eastern New Mexico.* Smithsonian Miscellaneous Collections 103 (4).

1961 The Agate Basin Complex. In *Homenaje a Pablo Martinez del Rio.* Instituto Nacional de Antropologia y Historia, pp. 125-132. Mexico City.

Roberts, R. L.

1982 Preliminary Excavations at the New Chelsea Site, 14BU1007: The Blacksmith Shop. In *Archeological Investigations at El Dorado Lake, Butler County, Kansas (Phase III)*, assembled by P. E. Brockington, Jr., pp. 551-604. Project Report Series Number 51, Museum of Anthropology, University of Kansas, Lawrence.

Roche, M. B. and G. G. Rowe

1952 The Incidence of Separate Neural Arch and Coincident Bone Variations. *Journal of Bone and Joint Surgery* 34-A(2):491-494.

Rodriguez, W. C.

n.d. Cribra Orbitalia Among the Arikara Indians. Ms. on file, Department of Anthropology, University of Tennessee, Knoxville.

Roetzel, K. A., R. A. Strachan, P. M. Emerson, and W. A. Watson

1982 Intensive Archeological Survey and Site Testing for the National Register of Historic Places, Harlan County Lake, Harlan County, Nebraska. Ms. on file, U.S. Army Corps of Engineers, Omaha.

Rogers, R. A.

1979 Archaeological Investigations in the John Redmond Reservoir Area, Kansas, 1974. Ms. on file, Midwest Archaeological Center, Lincoln.

1984 Kansas Prehistory: An Alluvial Geomorphological Perspective. Unpublished Ph.D. dissertation, University of Kansas, Lawrence.

Rogers, R. A, and L. D. Martin

1982 A Clovis Point from the Kansas River. *Transactions of the Kansas Academy of Sciences.* 85(2):78-81.

1983 American Indian Artifacts from the Kansas River. *Transactions of the Nebraska Academy of Sciences* 11:13-18.

1884 The 12 Mile Creek Site—A Reinvestigation. *American Antiquity* 49:757-764.

1985 Early Projectile Points and Pleistocene Fauna from Sandpits near Wichita, Kansas. *Transactions of the Kansas Academy of Science* 88:46-50.

Rogers, Richard A., L. D. Martin and T. D. Nicklas

1990 Ice-Age Geography and the Distribution of Native North American Languages. *Journal of Biogeography* 17:131-143.

Rogers, R. A., L. A. Rogers, R. S. Hoffmann, and L. D. Martin

1991 Native American Biological Diversity and the Biogeographic Influence of Ice Age Refugia. *Journal of Biogeography* 18:623-630.

Rogers, R. A., L. A. Rogers, and L. D. Martin.

1992 How The Door Opened: The Peopling of the New World. *Human Biology* 64(3):281-302.

Rohn, A. H., S. T. Cacioppo, and M. K. King

1980 Survey and Assessment of the Cultural Resources, Toronto Lake Project. Ms. on file, the U.S. Army Corps of Engineer, Dallas.

Rohn, A. H. and K. J. Daniel

1979 Rocky Ford Archaeology, Hillsdale Lake, Kansas. Ms. on file, the U.S. Army Corps of Engineer, Kansas City.

Rohn, A. H., K. J. Daniel, and E. J. King

1972 Chapter 4, Recorded Archaeological Resources in the Verdegris River Basin, Kansas and Oklahoma. Ms. on file, Kansas State Historical Society, Topeka.

Rohn, A. H., B. M. Larson, M. S. Davis, W. E. Unrau

1981 A Survey and Assessment of the Cultural Resources at Kaw Lake, Northern Section (Kansas). Ms. on file, the U.S. Army Corps of Engineer, Southwestern Division, Dallas.

Rohn, A. R. and M. R. Smith

1986 Assessment of the Archaeological Resources and An Evaluation of the Impact of the Copan Dam and Lake. Ms. on file, U.S. Army Corps of Engineers, Southwestern Division, Dallas.

Rohn, A. H. and B. G. Williams

1977 Supplementary Investigations at Site 14MM26, Hillsdale Lake, Eastern Kansas: 1972-1975. Ms. on file, U.S. Army Corps of Engineers, Kansas City.

Rohn, A. H. and C. Woodman

1976 Cultural Inventory for Hillsdale Lake, Kansas Volume 1-3. Ms. on file, the U.S. Army Corps of Engineers, Omaha.

Rohn, A. H., M. Stein, and G. Glover

1977 Wolf Creek Archaeology, Coffey County, Kansas. Wichita State University, Archaeology Laboratory. Wichita.

Romer, A. S.

1933 Pleistocene Vertebrates and their Bearing on the Problems of Human Antiquity. In *The American Aborigines: Their Origins and Antiquities*, edited by D. Jenness, pp. 49-84. University of Toronto Press, Toronto.

Root, M. J.

1978 Background Data for Finding, Managing, and Studying Prehistoric Cultural Resources at EL Dorado Lake, Kansas. Ms. on file, the U.S. Army Corps of Engineers, Omaha.

1979 The Paleoethnobotany of the Nebo Hill Site. *Plains Anthropologist* 24(85):239-248.

1981 *The Milbourne Site: Late Archaic Settlement in the Southern Flint Hills of Kansas.* Unpublished Master's thesis, University of Kansas, Lawrence.

Root, M. J. (editor)

1993 *Site 32DU955A: Folsom Occupation of the Knife River Flint Primary Source Area.* Project Report Number 22, Center for Northwest Anthropology, Washington State University, Pullman.

Root, M. J. and S. A. Ahler

1984 Early Man at the Knife River Flint Quarries. *North Dakota History* 51(4):12.

1994 Folsom Occupation in the Knife River Flint Quarry Area. *Current Research in the Pleistocene* 11:48-50.

Root, M. J., J. D. William, S. A. Ahler, and L. K. Shifrin
1994 Ultrathin Biface and Radial Fracture Technologies at Two Folsom Localities in the Knife River Flint Quarry Area, North Dakota. Paper presented at the 52nd Annual Plains Anthropological Conference, Lubbock.

Roper, D. C.
1976 A Trend-Surface Analysis of Central Plains Radiocarbon Dates. *American Antiquity* 41(2):181-189.
1985 Comments. *Plains Anthropologist* 30(109):259-261.
1987 Publishing Plains Anthropology: An Analysis of Participation Trends, 1971-1985. *Plains Anthropologist* 32(118): 341-350.
1988 A Site Catchment Analysis of a Single Upper Republican House, Medicine Creek, Kansas. Paper presented at the 10th Flint Hills Archaeological Conference, Topeka.
1989 *Protohistoric Pawnee Hunting in the Nebraska Sand Hills: Archeological Investigations at Two Sites in the Calamus Reservoir.* Commonwealth Resources Group, Jackson, Michigan. Submitted to the U.S. Department of the Interior, Bureau of Reclamation, Great Plains Region, Grand Island, Nebraska.
1990 Artifact Assemblage Composition and the Hunting Camp Interpretation of High Plains Upper Republican Sites. *Southwestern Lore* 56(4):1-19.
1991 *Archaeological Testing of Four Sites, Harry Strunk Lake, Frontier County, Nebraska.* Commonwealth Resources Group, Jackson, Michigan. Submitted to the U.S. Department of the Interior, Bureau of Reclamation, Great Plains Region, Grand Island, Nebraska.
1991 A Comparison of Contexts of Red Ochre Use in Paleoindian and Upper Paleolithic Sites. *North American Archaeologist* 12(4):289-301.
1992 Documentary Evidence for Changes in Protohistoric and Early Historic Pawnee Hunting Practices. *Plains Anthropologist* 37(141):353-366.
1993b Historical Processes and the Development of Social Identity. Ms. on file, Repatriation Office, National Museum of Natural History, Smithsonian Institution, Washington D.C.
1994a Spatial Dynamics and Historical Process in the Central Plains Tradition. Ms. on file with author.
1994b The Material Culture of 25DS21: A Lower Loup Hunting Camp in the Platte River Valley. *Central Plains Archaeology* 4(1):in press.

Rose, J. C., M. Kay, B. A. Burnett, and E. B. Riddick, Jr.
1982 *Analysis of Human Osteological Remains, Multi-County Areas, North Dakota.* Department of Anthropology, University of Arkansas, Fayetteville. Submitted to U.S. Army Corps of Engineers, Omaha District.

Rose, J. C., M. K. Marks, and M. Kay
1984 *Scanning Electron Microscopy of Three Molars from South Dakota.* In *Analysis of Human Osteological Remains from Multi-County Areas, South Dakota,* by J. C. Rose, M. K. Marks, M. Kay, and E. B. Riddick, Jr., pp. 250-275. Department of Anthropology, University of Arkansas, Fayetteville. Submitted to U.S. Army Corps of Engineers, Omaha District.

Rose, J. C., M. K. Marks, M. Kay, and E. B. Riddick, Jr.
1984 *Analysis of Human Osteological Remains from Multi-County Areas, South Dakota.* Department of Anthropology, University of Arkansas, Fayetteville. Submitted to U.S. Army Corps of Engineers, Omaha District.

Rossignol, J. and L. Wandsnider (editors)
1992 *Space, Time, and Archaeological Landscapes.* Plenum Press, New York.

Rowlison, D. D.
1977 A Report of Archaeological Investigations at the Big Hill Lake Project, Southeastern Kansas. Ms. on file, the U.S. Army Corps of Engineers, Dallas.
1978 1978 Investigations at Big Hill Lake. *Kansas Anthropological Association Newsletter* 24(2/3):1-8
1980 The 1978 Archaeological Investigations at the Big Hill Lake, Kansas. Ms. on file, the U.S. Army Corps of Engineer, Dallas.
1983 A Cultural-Historical Summary of Wilson Lake And the Region. *Kansas Anthropological Society Journal* 4(4/5):38-60.

Rowlinson, D. D. and T. A. Witty
1982 Cultural Resources Survey of Public Use Areas at Wilson Lake, Kansas. Ms. on file, U.S. Army Corps of Engineer, Omaha.

Ruddiman, W. F.
1985 Climate Studies in Ocean Cores. In *Paleoclimate Analysis and Modeling,* edited by A. D. Hecht, pp. 197-257. Wiley and Sons, New York.
1987 Synthesis: The Ocean/Ice Sheet Record. In *North America and Adjacent Oceans during the Last Deglaciation,* edited by W. F. Ruddiman and H. W. Wright Jr., pp. 463-478. The Geology of North America, vol. K-3.

Ruff, C.
1994 Biomechanical Analysis of Northern and Southern Plains Femora: Behavioral Implications. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 235-245. Smithsonian Institution Press, Washington, D.C.

Ruhe, R. V.
1969 *Quaternary Landscape in Iowa.* Iowa State University Press, Ames.
1976 Stratigraphy of Midcontinental Loess, U.S.A. In *Quaternary Stratigraphy of North America,* edited by W. C. Mahaney, pp. 197-211. Dowden, Hutchinson, and Ross, Stroudburg, Pennsylvania.
1983 Depositional Environments of Late Wisconsin Loess in the Midcontinental United States. In *Late Quaternary Environments of the United States-v.1, The Late Pleistocene,* edited by S. C. Porter, pp. 130-137. University of Minnesota Press, Minneapolis.

Ruhe, R. V., G. A. Miller, and W. J. Vreeken
1971 Paleosols, Loess Sedimentation and Soil Stratigraphy. In *Paleopedology-Origin, Nature and Dating of Paleosols,* edited by D. H. Yaalon. Israel University Press, Jerusalem.

Rusco, M. K.
1960 *The White Rock Aspect.* Note Book No. 4, Laboratory of Anthropology, University of Nebraska, Lincoln.

Sabo, G., III, A. M. Early, B. A. Burnett, J. P. Harcourt, J. C. Rose, and W. F. Limp
1989 *Human Adaptation in the Ozark and Ouachita Mountains.* Arkansas Archeological Survey Research Series No. 32.

Sabo, George, III, D. B. Waddell, and J. H. House
1982 *A Cultural Resource Overview of the Ozark-St. Francis National Forests, Arkansas.* Arkansas Archeological Survey, Project 497. Submitted to the USDA Forest Service, Russellville, AR.

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

Sandness, K. L.
1992 Spondylolysis: Its Occurrence in Prehistoric and Historic Great Plains Inhabitants. *Nebraska Anthropologist* 9(1&2):39-45.
1994 Lines of Arrested Growth in Central and Northern Plains Native American Skeletal Remains. Paper presented at the 21st Paleopathology Association Meetings, Denver.

Sandness, K. L. and J. R. Green
1993 Lines of Arrested Growth in Long Bones of Prehistoric and Historic Nebraska Native Americans. *Plains Anthropologist* 38(143):211-216.

Sandness, K. L. and K. J. Reinhard
1992 Vertebral Pathology in Prehistoric and Historic Skeletons from Northeastern Nebraska. *Plains Anthropologist* 37(141):299-309.

Satorius-Fox, M. R.

1982 *Paleoecological Analysis of Micro-Mammals from the Schmidt Site, Howard County, Nebraska.* Technical Report 82-13. Division of Archaeological Research, University of Nebraska.

Satterthwaite, L

1957 *Stone Artifacts at and Near the Finley Site Near Eden, Wyoming.* University Museum, Museum Monographs. Philadelphia.

Saunders, J. J.

1977 Lehner Ranch Revisited. In *Paleo-Indian Lifeways,* edited by E. Johnson, pp. 48-64. The Museum Journal, Lubbock.

1980 A Model for Man-Mammoth Relationships in Late Pleistocene North America. *Canadian Journal of Anthropology* 1:87-98.

1990 Immanence, Configuration, and the Discovery of America's Past. In *Megafauna and Man, Discovery of America's Heartland,* edited by L. D. Agenbroad, J. I. Mead, and L. W. Nelson, pp. 136-143. Hot Springs, South Dakota.

Saunders, J. J., G. A. Agogino, A. T. Boldurian, and C. V. Haynes, Jr.

1991 A Mammoth-Ivory Burnisher-Billet from the Clovis Level, Blackwater Draw Locality No. 1, New Mexico. *Plains Anthropologist* 36(137):359-363.

Saunders, J. J. and E. Daeschler

1994 Descriptive Analyses and Taphonomical Observations of Culturally-Modified Mammoths Excavated at "The Gravel Pit," Near Clovis, New Mexico in 1936. *Proceedings of the Academy of Natural Sciences of Philadelphia* 145:1-28.

Saunders, J. J., E. Daeschler and B. Dawson-Saunders

1990 A Clovis Unit of Measure. Paper presented at the 48th Plains Anthropological Conference, Oklahoma City.

Saunders, J. J., C. V. Haynes, Jr., D. J. Stanford, and G. A. Agogino

1990 A Mammoth-Ivory Semifabricate from Blackwater Locality No. 1, New Mexico. *American Antiquity* 55:112-119.

Schanfield, M., M. H. Crawford, J. B. Dossetor, and H. Gershowitz

1990 Immunoglobulin Allotypes in Several North American Eskimo Populations. *Human Biology* 62:773-790.

Schermer, S. J., A. K. Fisher, and D. C. Hodges

1994 Endemic Treponematosis in Prehistoric Western Iowa. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 109-121. Smithsonian Institution Press, Washington, D.C.

Schiffer, M. B.

1976 *Behavioral Archaeology.* Academic Press, New York.

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

Schiffer, M. B. and G. J. Gumerman (editors)

1977 *Conservation Archaeology: A Guide for Cultural Resource Management Studies.* Academic Press, New York.

Schlesier, K. H. (editor)

1994 *Plains Indians. A.D. 500-1500: The Archaeological Past of Historic Groups.* University of Oklahoma Press, Norman.

Schmits, L. J.

1973 An Assessment of the Prehistoric Cultural Resources of the Neosho (Grand) River Valley and An Evaluation of the Impact of the Proposed Riverbank Stabilization Project. Ms. on file, the Kansas State Historical Society, Topeka.

1978 The Coffey Site—Environment and Cultural Adaptation at a Prairie-Plains Archaic Site. *Midcontinental Journal of Archaeology* 3:69-185.

1980a Holocene Fluvial History and Depositional Environments at the Coffey Site, Kansas. In *Archaeological Prehistory on the Prairie-Plains Border,* edited by A. E. Johnson, pp. 79-106. University of Kansas Publications in Anthropology 12. Lawrence.

1980b The Williamson , Slab and Dead Hickory Sites. In *Salvage Archaeology of the John Redmond Lake, Kansas,* edited by T. A. Witty, Jr., pp. 13-66, 126-132, 133-162. Kansas State Historical Society Anthropological Series 8. Topeka.

1981 Archaeological and Geological Investigations at the Coffey Site, Tuttle Creek Lake, Kansas. Ms. on file, Interagency Archaeological Services Branch, Rocky Mountain Region, National Park Service, Denver.

1982 The May Brook Site, Jackson County, Missouri. *The Missouri Archaeologist* 43:1-67.

1983 Archaeological Inventory and Evaluation at Milford, Melvern, and Pomona Lakes, Eastern Kansas. Cultural Resources Management Report and Appendexes, No. 20, Overland Park.

1984 Archaeological Inventory and Evaluation at Milford, Melvern, and Pomona Lakes, Eastern Kansas.

1986 Archaeological Survey and Testing of Perry Lake, Jefferson County, Kansas. Ms. on file, the Kansas State Historical Society, Topeka.

1987a The Diskau Site: A Paleoindian Occupation in Northeast Kansas. *Current Research in the Pleistocene* 4:69-70.

1987b The Williamson Site and The Late Archaic El Dorado Phase in Eastern Kansas. *Plains Anthropologist* 32(116):153-174.

Schmits, L. J. and B. C. Bailey

1986 Prehistoric Chronology and Settlement-Subsistence Patterns in the Little Blue Valley, Western Missouri. In *Prehistory of the Little Blue River Valley, Western Missouri: Archaeological Investigations at Blue Springs Lake,* edited by L. J. Schmits. Submitted to the U.S. Army Corps of Engineers, Kansas City District, Kansas City.

Schmits, L. J. and B. C. Bailey

1986 Prehistoric Chronology and Settlement-Subsistence Patterns in the Little Blue Valley, Western Missouri. In *Prehistory of the Little Blue River Valley, Western Missouri: Archaeological Investigations at Blue Springs Lake,* edited by L. J. Schmits. U.S. Army Corps of Engineers, Kansas City District, Kansas City.

Schmits, L. J., B. A. Jones, and T. A. Witty

1980 Salvage Archaeology of the John Redmond Lake, Kansas: The Williamson, Balb and Dead Hickory Sites: The Gilligan Site: Human Skeletal Material From a Late Archaic Site in Kansas. Ms. on file, National Parks Service, Midwest Archaeological Center, Lincoln.

Schmits, L., R. Mandel, J. McKay, and J. Hedden

1987 National Register Evaluation of Cultural Resources at Tuttle Creek Lake, Eastern Kansas. Ms. on file, Kansas State Historical Society, Topeka.

Schmits, L. J., K. C. Reid, and N. O'Malley

1980 Dead Hickory Tree: A Plains Village in East Central Kansas. *Missouri Archaeologist* 41:1-56.

Schneider, F. E.

1982 A Preliminary Investigation of Paleo-Indian Cultures in North Dakota. *Manitoba Archaeological Quarterly* 6 (4):16-43.

Schock, J. M.

1965 14L08, A Hunting Camp in Logan County, Kansas. *Kansas Anthropological Association Newsletter* 10(7-9):6-8.

Schoen, C. M.

1994 *The Martin Farmstead, A Family Farm in Republic County, Kansas.* Highway Salvage Archeology Popular Report Number 2, Kansas State Historical Society, Topeka.

Schoen, C. and P. Bleed

1989 *The Archaeology of the Lincoln Pottery Works, 25LC42.* Department of Anthropology, University of Nebraska, Lincoln.

Schoolcraft, H. R.

1854 *Historical and Statistical Information Respecting the History, Condition , and Prospects of the Indian Tribes of the United States,* Part IV, Philadelphia.

Schultz, C. B.

1932 Association of Artifacts and Extinct Mammals in Nebraska. *Bulletin of the Nebraska State Museum* 1(33): 271-282.

1934 The Pleistocene Mammals of Nebraska. In *The Geology and Mammalian Fauna of the Pleistocene of Nebraska*, Table A, pp. 357-393. Nebraska State Museum Bulletin 1(41), Part 2.

1943 Some Artifact Sites of Early Man in the Great Plains and Adjacent Areas. *American Antiquity* 8: 242-249.

1949 The Lime Creek Sites. UNLA-NB 1.

Schultz, C. B. and L. C. Eiseley

1935 Paleontological Evidence of the Antiquity of the Scottsbluff Bison Quarry and its Associated Artifacts. *American Anthropologist* 37:306-318.

Schultz, C. B. and W. D. Frankforter

1946 The Geologic History of the Bison in the Great Plains, A Preliminary Report. *Bulletin of the University of Nebraska State Museum* 3:1-10.

1948 *Preliminary Report on the Lime Creek Sites: New Evidence of Early Man in Southwestern Nebraska.* Bulletin of the University of Nebraska State Museum 3(4).

1949 *The Lime Creek Sites.* University of Nebraska Liberal Arts-News Bulletin 1.

Schultz, C. B., G. C. Lueninghoener, and W. D. Frankforter.

1951 A Graphic Resumé of the Pleistocene of Nebraska (with Notes on the Fossil Mammalian Remains). *Bulletin of the University of Nebraska State Museum* 3:1-41.

Schultz, C. B., L. D. Martin and W. Dort.

1994 Stratigraphic Nomenclature and Depositional Environment of the Loess in Nebraska. *TER-QUA. Symposium Series* 2:147-154.

Schultz, C. B. and T. M. Stout

1945 Pleistocene Loess Deposits of Nebraska. *American Journal of Science* 243:231-244.

1948 Pleistocene Mammals and Terraces in the Great Plains. *Geological Society of America, Bulletin* 59:553-591.

Schultz, F. and A. C. Spaulding

1948 A Hopewellian Burial Site in the Lower Republican Valley, Kansas. *American Antiquity* 30:306-313.

Schultz, G. E.

1965 Pleistocene Vertebrates from the Butler Spring Local Fauna, Meade County, Kansas. *Papers of the Michigan Academy of Science, Arts, Letters* 50:235-265.

Schultz, P. D.

1977 Task Activity and Anterior Tooth Grooving in Prehistoric California Indians. *American Journal of Physical Anthropology* 46:87-92.

Schultz, R. S.

1969 Allison's Ranch. *Kansas Anthropological Association Newsletter* 15(4):1-8.

Schuyler, R. L.

1971 The History of American Archaeology: An Examination of Procedure. *American Antiquity* 36(4):383-409.

Schwiekhard, L. S. and P. J. O'Brien

1982 Sample Archaeological Survey of Milford Lake Public Use Area, Kansas. Ms. on file, the U.S. Army Corps of Engineer, Omaha.

Scott, D. D.

1976 Ethnic Identification of an Historic Sac Burial from Northeastern Kansas. *Plains Anthropologist* 21(72):131-139.

Scott, D. D. and T. G. Birkedal

1972 The Archaeology and Physical Anthropology of the Gahagan- Lipe Site with Comments on Colorado Woodland Mortuary Practices. *Southwestern Lore* 38(3):1-17.

Scott, E. C.

1979 Dental Wear Scoring Technique. *American Journal of Physical Anthropology* 51:213-218.

Scott, L. J.

1982 Pollen and Fiber Analysis of the McEndree Ranch Site, 5 BA30, Southwestern Colorado. *Southwestern Lore* 48(2):18-24.

Scott, S. L.

1993 Faunal Remains. In *Archaeological Investigations at the Marvin Colson Site, 25FT158, Frontier County, Nebraska,* by D C. Roper. U.S. Department of the Interior, Bureau of Reclamation, Great Plains Region.

Sears, P. B.

1961 A Pollen Profile from the Grassland Province. *Science* 134:2038-2039.

Seelen, R. M.

1961 *A Preliminary Report of the Sedalia Complex.* Missouri Archaeological Society Newsletter 153.

Sellards, E. H.

1916a Discovery of Fossil Human Remains in Florida in Association with Extinct Vertebrates. *American Journal of Science* 42: 1-8

1916b Human Remains from the Pleistocene of Florida. *Science* 44: 615-617.

1952 *Early Man in America: A Study of Prehistory.* The University of Texas Press, Austin.

1955 Fossil Bison and Associated Artifacts from Milnesand, New Mexico. *American Antiquity* 20:336-344.

Sellards, E., G. Evans and G. Meade

1947 Fossil Bison and Associated Artifacts from Plainview, Texas. *Geological Society of America, Bulletin* 58:927-954.

Sellet, F. and G. C. Frison

1994 Paper presented at the Annual Meeting of the Society for American Archaeology, Anaheim, California.

Semken, H. A., Jr.

1983 Holocene Mammalian Biogeography and Climatic Change in the Eastern and Central United States. In *Late Quaternary Environments of the United States, vol. 2, The Holocene,* edited by H. E. Wright, Jr., pp. 182-207. University of Minnesota Press, Minneapolis.

Semken, H. A., Jr. and C. R. Falk

1987 Late Pleistocene/Holocene Mammalian Faunas and Environmental Changes on the Northern Plains of the United States. In *Late Quaternary Mammalian Biogeography and Environments of the Great Plains and Prairies,* edited by R. W. Graham, H. A. Semken, and M. A. Graham, pp. 176-313. Illinois State Museum Scientific Papers 22

Shane, L. C. K.

1987 Late-Glacial Vegetational and Climatic History of the Allegheny Plateau and the till plains of Ohio and Indiana. *Boreas* 16:1-20.

Shane, L. C. K. and Anderson, K. H.

1993 Intensity, Gradients and Reversals in Late Glacial Environmental Changes in East-Central North America. *Quaternary Science Reviews* 12: 307-320.

Shanks, M. and C. Tilley

1987 *Re-Constructing Archaeology.* Cambridge University Press, Cambridge.

1994 *Reconstructing Archaeology: Theory and Practice.* 2nd edition. Routledge, New York.

Sharrock, S. R.

1974 Crees, Cree-Assineboines, and Assineboines: Interethnic Social Organization in the Far Northern Plains. *Ethnohistory* 21(2):95-122.

Shaw, L. and G. C. Frison

1979 Pre-Clovis Occupation at Little Canyon Creek Cave. Paper presented at the Annual Meeting of the Society for American Archaeology.

Shaw, R. D.

1974 *The Houston Site (25BT1): A Nebraska Phase Site from Burt County, Nebraska.* Unpublished Master's thesis, Department of Anthropology, Washington State University.

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

Shelley, P. and G. A. Agogino
1983 Agate Basin Technology: An Insight. *Plains Anthropologist* 28(100):115-119.

Shermis, S.
1969 *The Paleopathography of the Leavenworth Site (39CO9), Corson County, South Dakota.* Unpublished Master's thesis, Department of Anthropology, University of Kansas, Lawrence.
1984 Domestic Violence in Two Skeletal Populations. *OSSA: International Journal of Skeletal Research* 9(11):143-151.

Shetrone, H. C.
1939 *The Mound-Builders.* Appleton, New York.

Shields, W. L.
1980 Preliminary Investigations at the McEndree Ranch Site, 5BA30. *Southwestern Lore* 46(3):1-17.

Shimek, B.
1903 The Loess and Lansing Man. *American Geologist* 32: 353-369.
1908 Nebraska "Loess Man." *Bulletin of the Geological Society of America* 19:243-254.

Shimkin, E. M.
1978 The Upper Paleolithic in North-Central Eurasia: Evidence and Problems. In *Views of the Past, Essays in Old World Prehistory and Paleoanthropology,* edited by L. G. Freeman, pp. 193-315. The Hague. Mouton.

Shiner, J. L.
1975 The Clear Fork Gouge Revisited. *Bulletin of the Texas Archaeological Society* 46:179-188. Austin.

Shippee, J. M.
1948 Nebo Hill, A Lithic Complex in Western Missouri. *American Antiquity* 14:29-32.
1960 A Mississippian House from Western Missouri. *American Antiquity* 26(2):281-283.
1967 *Archaeological Remains in the Area of Kansas City: The Woodland Period, Early, Middle, and Late.* Missouri Archaeological Society, Research Series, No. 5, Columbia.
1972 *Archaeological Remains in the Kansas City Area.* Missouri Archaeological Society, Research Series 9.

Shumard, C. B.
1974 *Palynology of a Lacustrine Sink-Hole Facies and the Geologic History of a (Late Pleistiocene ?) Basin in Clark County, Southwestern Kansas.* Unpublished Master's thesis, Wichita State University, Wichita, Kansas.

Shutler, R., Jr.
1968 Tule Springs: Its Implications in Early Man Studies in North America. In *Early Man in Western North America,* edited by C. Irwin-Williams, pp. 29-26.

Shutler, R. (editor)
1983 *Early Man in the New World.* Sage Publications, Beverly Hills.

Sias, R. D.
n.d. Reconnaissance Report on Recreational Use and Development, Dolores Project, McPhee Reservoir, San Juan Sub-Basin, Upper Colorado River Basin, Colorado. Ms. on file, SI-RBS, Lincoln.

Sigstad, J. S.
1969 Mowry Bluff and Nuzum Artifacts: Pottery. In *Two House Sites in the Central Plains,* edited by W. R. Wood, pp. 17-23, 69-73. Plains Anthropologist 14(44), pt. 2, Memoir 6.

Sigstad, J. S. and J. K. Sigstad
1973 *Archaeological Field Notes of W. H. Over.* South Dakota State Archaeologist Research Bulletin 1. University of South Dakota, Vermillion.

Silverberg, R.
1968 *Moundbuilders of Ancient America: The Archaeology of a Myth.* New York Graphic Society, Greenwich.

Simmons, A. H., A. L. W. Stodder, D. D. Dykeman, and P. A. Hicks
1989 *Human Adaptations and Cultural Change in the Greater Southwest.* Arkansas Archeological Survey Research Series No. 32, Fayetteville.

Simms, S. R.
1988 Conceptualizing the Paleoindian and Archaic in the Great Basin. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface,* edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 41-52. Nevada State Museum Anthropological Papers 21. Carson City.

Simpson, R. D.
1982 The Calico Mountains Archaeological Project: A Progress Report. In *Peopling of the New World,* edited by J. E. Ericson, R. E. Taylor, and R. Berger, pp. 181-192. Ballena Press, Los Altos, CA.

Singer, M. J. and P. Fine.
1989 Pedogenic Factors Affecting Magnetic Susceptibility of North California Soils. *Soil Science Society of America Journal* 53:1119-1127.

Skaggs, R. H.
1978 Climatic Change and Persistence in Western Kansas. *Annals of the Association of American Geographers* 68(1):73-80.

Smart, T. L. and R. I. Ford
1983 Plant Remains. In *Recent Excavations at the Edwin Harness Mound, Liberty Works, Ross County, Ohio,* by N'omi Greber, pp. 54-58. Midcontinental Journal of Archaeology, Special Paper 5.

Smiley, T. L., R. A. Bryson, J. E. King, G. C. Kukla, and G. I. Smith
1991 Quaternary Paleoclimates. In *Quaternary Nonglacial Geology: Conterminous U. S.* The Geology of the North America vol. K-2, The Geological Society of America.

Smith, B.
1992 Prehistoric Plant Husbandry in Eastern North America. In *Rivers of Change: Essays on Early Agriculture in Eastern North America.* Smithsonian Institution Press, Washington D.C.

Smith, B. H.
1984 Molar Wear in Hunter Gatherers and Agriculturalists. *American Journal of Physical Anthropology* 63:39-58.

Smith, C. S. and W. H. Birkby
1962 Preliminary Report on the Archaeological Investigations in Melvern Reservoir, Osage County, Kansas, 1962. Ms. on file, National Park Service, Midwest Archaeological Center, Lincoln.
1963 Investigations in the Melvern Reservoir, Osage County, Kansas. PA 8(20).

Smith, C. S. and R. L. Jantz
1972 Skeletal Material from the Walth Bay Site, 39WW203. Ms. on file, Midwest Archaeological Center, National Park Service, Lincoln.

Smith, C. S. and L. M. McNees
1990 Rattlesnake Pass Site: A Folsom Occupation in South-Central Wyoming. *Plains Anthropologist* 35(129):273-289.

Smith, E. A. and B. Winterhalder (editors)
1992 *Evolutionary Ecology and Human Behavior.* Aldine de Gruyter. New York.

Smith, H. T. U.
1965 Dune Morphology and Chronology in Central and Western Nebraska. *Journal of Geology,* 73:557-578.
1968 Nebraska Dunes Compared with Those of North Africa and Other Regions. In *Loess and Related Eolian Deposits of the World,* edited by C. B. Schultz and J. C. Frye, pp. 29-47. University of Nebraska Press, Lincoln.

Smith, R. M., P. C. Twiss, R. K. Krauss, and M. J. Brown
1970 Dust Deposition in Relation to Site, Season, and Climatic Variables. *Soil Science Society of America Proceedings* 34:112-117.

Snortland, J. S.

1994 Northern Plains Woodland Mortuary Practices. In *Skeletal Biology in the Great plains. Migration, Warfare, Health, and Subsistence.* edited by D. W. Owsley and R. L. Jantz, pp. 51-70. Smithsonian Institution Press, Washington, D.C.

Snyder, L. M. and J. R. Bozell

1983 *Identification and Analysis of Verbetrate Faunal Remains Recovered from the Logan Creek Site (25BT3) Burt County, Nebraska.* Technical Report 83-03, Division of Archaeological Research, Department of Anthropology, University of Nebraska, Lincoln.

Soffer, O.

1985 *The Upper Paleolithic of the Central Russian Plain.* Academic Press, Orlando.

Soffer, O. and N. D. Praslov (editors)

1993 *From Kostenki to Clovis, Upper Paleolithic—Paleo-Indian Adaptations.* Plenum Press, New York.

Solecki, R.

1952a Appraisal of the Archeological Resources of the Glen Elder Reservoir, Mitchell and Osborne Counties, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1952b Appraisal of the Archeological Resources of the Kirwin Reservoir, Phillips County, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1952c Appraisal of the Archeological Resources of the Webster Reservoir, Rooks County, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1952d Appraisal of the Archeological Resources of the Wilson Reservoir, Russell County, Kansas: Supplement. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1953 Appraisal of the Archeological and Paleontological Resources of the Tuttle Creek Reservoir, Marshall, Pottawatomie, and Riley Counties, Kansas. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

Sollberger, J. B.

1977 On Fluting Folsom. *Bulletin Texas Archeological Society* 48:47-52.

1985 A Technique for Folsom Fluting. *Lithic Technology* 14(1):41-50.

Sorenson, C. J., Sallee, K. H., Mandel, R. D.

1987 Holocene and Pleistocene Soils and Geomorphic Surfaces of the Kansas River Valley. In *Quaternary Environments of Kansas,* edited by W. C. Johnson, pp. 93-102. Kansas Geological Survey, Guidebook Series 5.

Sorenson, J. H., S. J. Johnsgard, and C. Wozencraft

1989 *Bibliography of Kansas Geology, 1823-1984.* Kansas Geological Survey, Bulletin 221.

Souders, V. L. and M. S. Kuzila

1990 A Report on the Geology and Radiocarbon Ages of Four Superimposed Horizons at a Site in the Republican River Valley, Franklin County, Nebraska. *Proceedings of the Nebraska Academy of Sciences*: 65, Nebraska Academy of Sciences, Lincoln.

Spalding, H. H. and A. B. Smith

1958 *The Diaries and Letters of H. H. Spalding and A. B. Smith Relating to the Nez Perce Mission, 1838-1842,* edited by C. M. Drury. Northwest Historical Series 4. Arthur H. Clark Co., Glendale, California.

Spaudling, A. C.

1955 Prehistoric Cultural Development in the Eastern United States. In *New Interpretations of Aboriginal American Culture History,* pp. 12-26, Anthropological Society of Washington, Washington D.C.

1985 Fifty Years of Theory. *American Antiquity* 50(1): 301-308.

Speer, R. D.

1986 History of the Plainview Site. In *Guidebook to the Archaeological Geology of Classic Paleoindian Sites on the Southern High Plains, Texas and New Mexico,* edited V. T. Holliday, pp. 52-59. Geological Society of America Guidebook, Department of Geography, Texas A&M University.

Spencer, R. F. and J. D. Jennings

1965 *The Native Americans: Prehistory and Ethnology of the North American Indians.* Harper and Row, New York.

Sperry, J. E.

1965 *Cultural Relationships of the Miller and Rush Creek Archaeological Sites on the Lower Republican River of Kansas.* Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

Speth, J. D.

1983 *Bison Kills and Bone Counts: Decision Making by Ancient Hunters.* University of Chicago Press, Chicago.

Speth, J. D. and K. A. Spielmann

1983 Energy Source, Protein Metabolism, and Hunter-Gatherer Subsistence Strategies. *Journal of Anthropological Archaeology* 2:1-31.

Spielmann, K.

1983 Late Prehistoric Exchange Between the Southwest and Southern Plains. *Plains Anthropologist* 28:257-272.

1986a *Farmers, Hunters, and Colonists: Interaction Between the Southwest and Southern Plains.* University of Arizona Press, Tucson.

1986b Interdependence Among Egalitarian Societies. *Journal of Anthropological Archaeology* 5(4):279-312.

1989 Colonists, Hunters, and Farmers: Plains-Pueblo Interaction in the Seventeenth Century. In *Columbian Consequences, Volume I: Archaeological and HIstorical Perspectives on the Spanish Borderlands West,* edited by D. H. Thomas, pp. 101-114. Smithsonian Institution Press. Washington, D. C.

Squier, E. G. and E. H. Davis

1848 *Ancient Monuments of the Mississippi Valley.* Smithsonian Contributions to Knowledge, vol. 1. Washington D.C.

Stafford, M. D.

1990 *The Powars II Site (48PL330): A Paleoindian Red Ochre Mine in Eastern Wyoming.* Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Stafford, T. W. Jr.,

1990 Late Pleistocene Megafauna Extinctions and the Clovis Culture: Absolute Ages Based on Accelerator 14C Dating of Skeletal Remains. In *Megafauna and Man: Discovery of America's Heartland,* edited by L. D. Agenbroad, J. I. Mead, and L. W. Nelson, pp. 118-122. Hot Springs, South Dakota.

1994 Accelerator C-14 Dating of Human Fossil Skeletons: Assessing Accuracy and Results on New World Specimens.In *Method and Theory for Investigating the Peopling of the Americas,* edited by R. Bonnichsen and D. G. Steele, pp. 45-56. Center for the Study of the First Americans, Oregon State University, Corvallis.

Stafford, T. W., P. E. Hare, L. Currie, A. J. T. Jull, and D. J. Donahue

1990 Accuracy of North American Human Skeletal Ages. *Quaternary Research* 34:111-120.

1991 Accelerator Radiocarbon Dating at the Molecular Level. *Journal of Archaeological Science* 18:35-72.

Stafford, T. W., Jr., A. J. T. Jull, K. Brendel, R. C. Duhamel, and D. Donohue

1987 Study of Bone Radiocarbon Dating Accuracy at the University of Arizona NSF Accelerator Facility for Radioisotope Analysis. *Radiocarbon* 29: 24-44.

Stanford, D. J.

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

1975 The 1975 Excavations at the Jones-Miller Site, Yuma County, Colorado. *Southwestern Lore* 41:34-43.

1978 The Jones-Miller Site: An Example of Hell Gap Bison Procurement Strategy. In *Bison Procurement and Utilization: A Symposium,* edited by L. B. Davis and M. Wilson, pp. 90-97. Plains Anthropologist Memoir 14.

1979a The Selby and Dutton Sites: Evidence for a Possible Pre-Clovis Occupation of the High Plains. In *Pre-Llano Cultures of the Americas: Paradoxes and Possibilities*, edited R. L. Humphrey and D. J. Stanford, pp. 101-123. The Anthropological Society of Washington.

1979b Bison Kill by Ice Age Hunters. *National Geographic Magazine* 155(1):114-119.

1982 A Critical Review of Archaeological Evidence Relating to the Antiquity of Human Occupation of the New World. In *Plains Indian Studies*, edited by D. H. Ubelaker and H. J. Viola, pp. 202-218. Smithsonian Contributions to Anthropology 30.

1983 Pre-Clovis Occupation South of the Ice Sheets. In *Early Man in the New World*, edited R. Shutler, Jr. pp. 65-72. Sage Publications, Beverly Hills.

1984 The Jones-Miller Site: A Study of Hell Gap Bison Procurement and Processing. *National Geographic Society Research Reports, 1975 Projects* 16:615-635. (edited by P. H. Oehser, J. S. Lea, and N. L. Powers). National Geographic Society, Washington, D. C.

1991a Clovis Origins and Adaptations: An Introductory Perspective. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 1-13. Center for the Study of the First Americans, Department of Anthropology, Oregon State University, Corvallis.

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

Stanford, D. J. and J. Albanese

1975 Preliminary Results of the Smithsonian Institution Excavation at the Claypool Site, Washington, County, Colorado. *Southwestern Lore* 41(4):22-28.

Stanford, D. J. and F. Broilo

1981 Frank's Folsom Campsite. Essays in Honor of Mark Wimberly, edited by M. S. Foster. *The Artifact* 19(3-4):1-13.

Stanford, D. J. and J. S. Day (editors)

1992 *Ice Age Hunters of the Rockies*. University Press of Colorado, Niwot.

Stanford, D. J. and R. W. Graham

1985 Archaeological Investigations of the Selby and Dutton Mammoth Kill Sites, Yuma, Colorado. *National Geographic Society Research Reports* 19:519-541.

Stanford, D. J. and M. A. Jodry

1988 The Drake Clovis Cache. *Current Research in the Pleistocene* 5:21-22.

Stanford, D. J. and R. Patton

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

Stanford, D. J., W. R. Wedel, and G. R. Scott

1981 Archaeological Investigations of the Lamb Springs Site. *Southwestern Lore* 47:14-27.

Stanley, K. O. and W. J. Wayne

1972 Epirogenic and Climatic Controls of Early Pleistocene Fluvial Sediment Dispersal in Nebraska. *Geological Society of America Bulletin* 83:3675-3690.

Stearn, E. W. and A. E. Stearn

1945 *The Effect of Smallpox on the Destiny of the American Indian*. B. Humphries, Boston.

Steele, D. G. and J. F. Powell

1992 Peopling of the Americas: Paleobiological Evidence. *Human Biology* 64:303-336.

1993 Paleobiology of the First Americans. *Evolutionary Anthropology* 2:138-146.

1994 Paleobiological Evidence of the Peopling of the Americas: A Morphometric View. In *Method and Theory for Investigating the Peopling of the Americas*, edited by R. Bonnichsen and D. G. Steele, pp. 141-163. Center for the Study of the First Americans, Oregon State University, Corvallis.

Steele, D. G., J. F. Powell, L. D. Martin, and W. Dort, Jr.

1991 Human Skeletal Remains Recovered from the Bonner Springs Locality, Northeastern Kansas. *Current Research in the Pleistocene* 8:57-59.

Steele, J. P., J. B. Gregg, S., Clifford, and A. M. Holzhueter

1965 Paleopathology in the Dakotas. *South Dakota Journal of Medicine* 18:17-29.

Stein, C. M.

1976 *Wolf Creek Archaeology: An Analysis of Two Sites*. Unpublished Master's thesis, Department of Anthropology, Wichita State University.

1978 Radiocarbon Dates from Coffey County. *Kansas Anthropological Association Newsletter* 24(4-5):12-13.

1984 Traces of Early Man in Kansas Tantalize Archeologists. *Kansas Preservation* 6(2):5-7. Topeka.

Steinacher, T L.

1975 The Moll Creek Site (14CY102). Ms. on file, Nebraska State Historical Society, Lincoln.

1976 *The Smoky Hill Phase and Its Role in the Central Plains Tradition*. Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

Steinacher, T. L., J. Ludwickson, G. Carlson and R. Bozell

1991 An Evaluation of the Central Plains Tradition-Pawnee Ancestry. Paper presented at the 49th Plains Anthropological Conference, Lawrence.

Steinbock, R. T.

1976 *Paleopathological Diagnosis and Interpretation: Bone Diseases*. C. C. Thomas, Springfield, Illinois.

Stephenson, R. L.

1954 Taxonomy and Chronology in the Central Plains-Middle Missouri River Area. *Plains Anthropologist* 1:15-21.

1967 *Reflections on the River Basin Survey' Program*. Reprint Series No 48. Desert Research Institute, University of Nevada.

Sterns, F. H.

1914 Ancient Lodge Sites on the Missouri in Nebraska. *American Anthropologist* 16(1): 135-137.

1915a A Stratification of Culture in Eastern Nebraska. *American Anthropologist* 17: 121-127.

1915b *The Archaeology of Eastern Nebraska, with Special Reference to the Culture of the Rectangular Earth Lodges*. Unpublished Ph.D. dissertation, Harvard University.

Steward, J. H.

1938 *Basin-Plateau Aboriginal Sociopolitical Groups*. Bureau of American Ethnology, Bulletin 120. Washington, D. C.

1955 *Theory of Culture Change*. University of Illinois Press, Urbana.

1977 *Evolution and Ecology, Essays on Social Transformation*. Edited by J. C. Steward and R. F. Murphy. University of Illinois Press, Urbana.

Stewart, J. D.

1978 Mammals of the Trapshoot Local Fauna, Late Pleistocene of Rooks County, Kansas. Proceedings of the Nebraska Academy of Science, 88th Annual Meeting Abstracts, pp. 45-46.

1984 Snowshoe Hare, *Lepus americanus*, from the Peoria Loess of Kansas. Kansas Academy of Sciences 3:39.

1987a Latitudinal Effects in Wisconsinan Mammalian Faunas of the Plains. Quaternary Environments of Kansas. *Kansas Geological Survey Guidebook Series* 5:153-158.

1987b Late Wisconsinan Biota and Artifacts from the Kansas-Nebraska Border. *Journal of Vertebrate Paleontology* 7:27A.

1989 Paleontology and Paleoecology of the 1987 Excavation of the North Cove Site, 25HN164. In *Archaeological Investigations at the North Cove Site, Harlan County Lake, Harlan County, Nebraska, An Interdisciplinary Approach*, edited by M. J. Adair, pp. 63-80. U.S. Army Corps of Engineers, Kansas City District.

Stewart, T. D.

1943 *Skeletal Material from Platte and Clay Counties, Missouri.* United States National Museum, Bulletin 138. Smithsonian Institution, Washington, D.C.

1956 Examination of the Possibility that Certain Skeletal Characters Predispose to Defects in the Lumbar Neural Arches. *Clinical Orthopaedics and Related Research* 8:44-59.

1959 Description of the Skeletal Remains from Doniphan and Scott Counties, Kansas. *Smithsonian Institution Bureau of Ethnology Bulletin* 174:669-683.

Stewart, T. D. and L. G. Quade

1969 Lesions of the Frontal Bone in American Indians. *American Journal of Physical Anthropology* 30:89-110.

Stiner, M. (editor)

1991 *Human Predators and Prey Mortality.* Westview Press, Boulder.

Story, D. A.

1990 Cultural History of the Native Americans. In *The Archeology and Bioarcheology of the Gulf Coastal Plain*, by D. A. Story et al., pp. 163-366. Arkansas Archeological Survey, Research Series 38 (2 vols.). Fayetteville.

Stout, J. D., T. A. Rafter, and J. H. Troughton

1975 The Possible Significance of Isotopic Ratios in Paleoecology. In *Quaternary Studies*, edited by R. P. Suggate and M. M. Creswell, pp. 279-286. Royal Society of New Zealand, Wellington.

Strong. W. D.

1932 An Archeological Reconnaissance in the Missouri Valley. *Explorations and Field-Work of the Smithsonian Institution in 1931,* pp. 151-158. Washington D.C.

1933 The Plains Culture Area in the Light of Archaeology. *American Anthropologist* 35(2): 271-287.

1935 *An Introduction to Nebraska Archaeology.* Smithsonian Miscellaneous Collections 93(10) Washington, D. C.

1940 From History to Prehistory in the Northern Great Plains. *Smithsonian Miscellaneous Collections* C:353-394.

1942 The Value of Archaeology in the Training of Professional Anthropologists. *American Anthropologists* 54:318-321.

Stuart-Macadam, P.

1985 Porotic Hyperostosis: Representative of a Childhood Condition. *American Journal of Physical Anthropology* 66:391-398.

1987 Porotic Hyperostosis: New Evidence to Support the Anemia Theory. *American Journal of Physical Anthropology* 74:521-526.

Struever, S.

1964 *The Hopewell Interaction Sphere in Riverine-Western Great Lakes Culture History.* Illinois State Museum Scientific Papers Vol. 12(3). Springfield.

1968 Flotation Techniques for the Recovery of Small Scale Archaeological Remains. *American Antiquity* 33(3):353-362.

Sturdevant, C.

1980 Archaeological Reconnaissance Kansas and Smoky Hill Rivers Bank Stabilization Study, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

1983 Cultural Resources Management Plan Clinton Lake, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

Sturdevant, C. and J. Carrel

1983 Cultural Resources Management Plan Hillsdale, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

Styles, B. W.

1981 *Faunal Exploitation and Resource Selection, Early Late Woodland Subsistence in the Lower Illinois Valley.* Northwestern University Archeological Program, Scientific Papers 3. Evanston.

Sundstrom, L.

1989 *Culture History of the Black Hills with Reference to Adjacent Areas of the Northern Great Plains.* J and L Reprints in Anthropology, Volume 40. Lincoln.

Swinehart, J. B,

1990 Wind-Blown Deposits. In *An Atlas of the Sand Hills*, edited by A. Bleed and Flowerday, pp. 43-57.

Swineford, A. and J. C. Frye

1951 Petrography of the Peoria Loess in Kansas. *Journal of Geology* 59:306-322.

Symes, S. A.

1983 *Harris' Lines as Indicators of Stress: An Analysis of Tibiae from the Crow Creek Massacre Victims.* Unpublished Master's thesis, Department of Anthropology, University of Tennessee, Knoxville.

Symes, S. A., H. W. Case, and S. Thurston

1985 Report on Forensic Anthropology Case No.:35-25. Ms. on file, Department of Anthropology, University of Tennessee, Knoxville.

Szathmary, E. J. E.

1994 Modelling Ancient Population Relationships from Modern Population Genetics. In *Method and Theory for Investigating the Peopling of the Americas*, edited by R. Bonnischsen and D. G. Steele, pp. 117-130. Peopling of the Americas Publication, Corvallis.

Tankersley, Kenneth B.

1994 Clovis Mastic and its Hafting Implication. *Journal of Archaeological Science* 21:117-121.

Tate, M. J.

1985 A BLM-Class III Cultural Resources Survey For Machii-Ross Petroleum Company, Milton Reservoir Black Survey in Weld County, Colorado. Ms. on file, Bureau of Land Management, Canon City District, Canon City.

Tate, M. J. and P. D. Friedman

1986 A Cultural Resources Inventory of the Proposed Senac Dam Site, Arapahoe County, Colorado. Ms. on file, Arapahoe County Planning Department, Aurora.

Taylor, J. W.

1987 Oklahoma's Oldest Arrowpoint? Salvage of an Ancient Hearth at the Canyon Road Site (34CN-46), Canadian County. *Oklahoma Anthropological Society Newsletter* 35(7):7-9.

Taylor, K. C., G. W. Lamorey, G. A. Doyle, R. P. Alley, P. M. Grootes, P. A. Mayewski, J. W. C. White, and L. K. Barlow

1993 The 'Flickering Switch' of Late Pleistocene Climate Change. *Nature* 361:432-436.

Taylor, R. E.

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

1994 Radiocarbon Dating of Bone Using Accelerator Mass Spectrometry: Current Discussions and Future Directions. In *Method and Theory for Investigating the Peopling of the Americas*, edited by R. Bonnichsen and D. G. Steele, pp. 27-44. Center for the Study of the First Americans, Oregon State University, Corvallis.

Taylor, W. W.

1948 *A Study of Archaeology.* Memoir Series of the American Anthropologist Association No 69, Menasha.

Teeri, J. A. and L. G. Stowe

1976 Climatic Patterns and the Distribution of C_4 Grasses in North America. *Oecologia* (Berlin) 23:1-12.

Teit, J. A.

1930 *The Salishyian Tribes of the Western Plateaus.* 45th Annual Report, pp. 23-396. Bureau of American Ethnology, Washington, D.C.

Teltser, P. A. (editor)

1995 *Evolutionary Archaeology, Methodological Issues.* The University of Arizona Press, Tucson.

Thies, R. M.

1981 Archaeological Investigations at John Redmond Reservoir, East Central Kansas, 1979. Ms. on file, the U.S. Army Corps of Engineers, Tulsa District.

1982a Archaeological Investigations at Big Hill Lake, Southeastern Kansas, 1980. Ms. on file, the U.S. Army Corps of Engineers, Dallas

1982b *The Archeology of the Begin Ossuary, 14JW312, Jewell County, Kansas.* Kansas State Historical Society, Contract Archeology Publication, 2.

1985 *Arrowhead Island: A Middle Woodland Village in East Central Kansas.* Kansas State Historical Society Contract Archaeology Publication No. 3, Topeka.

1990 *The Archaeology of the Stigenwalt Site 14LT351.* Kansas State Historical Society Contract Archeology Series 7. Topeka.

Thies, R. M. and T. A. Witty, Jr.

1992 The Archaic of the Central Plains. *Revista de Arqueologia Americana* 5:137-165.

Thieszen, L. L.

1994 Stable Isotopes on the Plains: Vegetation Analyses and Diet Determinations. In *Skeletal Biology in the Great Plains, Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 261-289. Smithsonian Institution. Washington, D.C.

Thomas, C.

1894 *Report of the Mound Explorations of the Bureau of Ethnology,* Bureau of American Ethnography, 12th Annual Report, Washington D.C.

Thomas, D. H.

1978 *Archaeology.* Holt, Rinehart, and Winston. New York.

1986 *Refiguring Anthropology: First Principles of Probability and Statistics.* Waveland Press, Prospect Heights.

Thompson, D.

1915 *David Thompson's Narrative.* Publications of the Champlain Society, No. 12. Champlain Society, Montreal, Quebec, Canada.

Thompson, D. M. and E. A. Bettis

1980 Archaeology and Holocene Landscape evolution in the Missouri Drainage of Iowa. *Journal of the Iowa Archaeological Society* 27:1-60.

Thompson, R. S.

1985 The Age and Environment of the Mount Moriah (Lake Mohave) Occupation at Smith Creek Cave, Nevada. In *Environments and Extinctions: Man in Late Glacial North America,* edited by J. I. Mead and D. J. Meltzer, pp. 111-119. Peopling of the Americas Publication, Orono.

Thoms, A.

1993 Knocking Sense from Old Rocks: Typologies and the Narrow Perspective of the Angostura Point Type. *Lithic Technology* 18(1-2):16-27.

Thorp, J., W. M. Johnson, and E. C. Reed

1950 Some Post-Pleistocene Buried Soils of Central United States. *Journal of Soil Sciences* 2 :1-19.

Thurmond, J. P.

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

Tiffany, J. A., S. J. Schermer, J. L. Theler, D. W. Owsley, D. C. Anderson, E. A. Bettis, III, and D. M. Thompson

1988 The Hanging Valley Site (13HR28): A Stratified Woodland Burial Locale in Western Iowa. *Plains Anthropologist* 33(120):219-259.

Timberlake, R. D.

1982 Phase III Archaeological Investigation within Cross Creek Watershed, Structure No. 15, Jackson County, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

1984 A Brief Look at Little Noxie: A Phase II Archaeological Survey of Structure #11, Cross Creek Watershed. Ms. on file, Kansas State Historical Society, Topeka.

1985 Phase I Review of Upper Delaware and Tributaries Watershed Brown, Jackson, Nemaha, and Atchison Counties, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

1986a Phase III Archaeological Testing of 14PO396 in Cross Creek Watershed, Structure No. 11, Pottawatomie County, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

1986b Phase II Survey Report of Roy's Creek Watershed, Brown County, Kansas. Ms. on file, Kansas State Historical Society, Topeka.

Titmus, G. L. and J. C. Woods

1991 Fluted Points from the Snake River Plain. In *Clovis Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 119-131. Peopling of the Americas Publication. Oregon State University, Corvallis.

Todd, L. C.

1983 *The Horner Site, Taphonomy of an Early Holocene Bison Bonebed.* Unpublished Ph.D. dissertation, University of New Mexico. Albuquerque.

1987 Analysis of Kill-Butchery Bonebeds and Interpretation of Paleoindian Hunting. In *The Evolution of Human Hunting,* edited by M. H. Nitecki and D. V. Nitecki, pp. 225-266. Plenum Press, New York.

1991 Seasonality Studies and Paleoindian Subsistence Strategies. In *Human Predators and Prey Mortality,* edited by M. C. Stiner, pp. 217-238. Westview Press, Boulder.

1995 Bone Beds, Bison Hunters, and Taphonomy: Learning to Recognize What We Don't Know. Paper presented at the 53rd Annual Plains Anthropological Conference, Laramie.

Todd, L. C. and G. C. Frison

1992 Reassembly of Bison Skeletons from the Horner Site: A Study in Anatomical Refitting. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology,* edited by J. L. Hofman and J. G. Enloe, pp. 63-82. BAR International Series 578. Oxford.

Todd, L. C. and J. L. Hofman

n.d. Variation in Folsom Age Bison Assemblages: Implications for the Interpretation of Human Action. In *Folsom Archaeology,* edited by M. A. Jodry and D. J. Stanford (in press).

Todd, L. C., J. L. Hofman, and C. B. Schultz

1990 Seasonality of the Scottsbluff and Lipscomb Bison Bonebeds: Implications for Modeling Paleoindian Subsistence. *American Antiquity* 55(4):813-827.

1992 Faunal Analysis and Paleoindian Studies: A Reexamination of the Lipscomb Bison Bonebed. *Plains Anthropologist* 37(139):137-165.

Todd, L. C., J. L. Hofman, and H. M. Wormington

n. d. Estimating Season of Death and Population Characteristics of Bison from the Frazier Agate Basin Site, Weld County, Colorado. Ms. in possession of authors (1991).

Todd, L. C. and D. J. Rapson

1991 1991 Excavations at the Hudson-Meng Bison Bonebed: Aspects of the Formational History. Paper presented at the 49th Annual Plains Anthropological Conference. Lawrence.

Todd, L. C., D. J. Rapson, and J. L. Hofman

1996 Dentition Studies of the Mill Iron and Other Early Paleoindian Bison Bonebed Sites. In *The Mill Iron Site,* edited by G. C. Frison, pp. 145-175. University of New Mexico Press, Albuquerque.

Todd, L. C. and D. J. Stanford

1992 Applications of Conjoined Bone Data to Site Structural Studies. In *Piecing Together the Past: Applications of Refitting Studies in Archaeology,* edited by J. L. Hofman and J. G. Enloe, pp. 21-35. BAR International Series 578, Oxford.

Tomanek, G. W. and G. H. Hulett
1970 Effects of Historical Droughts on Grassland Vegetation in the Central Great Plains. In *Pleistocene and Recent Environments of the Central Great Plains*, edited by W. Dort Jr. and J. K. Jones, Jr., pp. 203-211. University Press of Kansas.

Toom, D. L.
1994 Last Tango at Travis 2: A Brief Overview of the Findings of the 1989 Excavation at the Travis 2 Site (39WW15), Mobridge, South Dakota. *Newsletter of the South Dakota Archaeological Society* 24(3):1-6.

Toth, G. J. and J. K. Peterson
1992 Dental Disease Among Prehistoric and Historic Plains Populations, Dakota County, Nebraska. *Nebraska Anthropologist* 9(1&2):47-51.

Tratebas, A.
1986 *Black Hills Settlement Patterns: Based on a Functional Approach.* Unpublished Ph.D. dissertation, Indiana University.

Traub, S.
1975 Cultural Resources Survey of Project Lands, Melvern Lake, Osage County, Kansas. Ms. on file, U.S. Army Corps of Engineer, Omaha
1977 Cultural Resources Management Plan, Pomona Lake, Osage County, Kansas. Ms. on file, U.S. Army Corps of Engineer, Omaha.

Trigger, B. G.
1986 Prehistoric Archaeology and American Society. In *American Archaeology: Past and Future.* edited by D. J. Fowler, and J. A. Sabloff, pp. 187-215. Society for American Archaeology, and Smithsonian Institute Press, Washington.
1989 *A History of Archaeological Thought.* Cambridge University Press, New York.

Trimble, M. K.
1979 An Ethnohistorical Interpretation of the Spread of Smallpox in the Northern Plains Utilizing Concepts of Disease Ecology. Department of Anthropology, University of Missouri, Columbia. Submitted to National Park Service, Midwestern Archeological Center, Lincoln.
1989 Infectious Disease and the Northern Plains Horticulturists: A Human behavior Model. *Plains Anthropologist Memoir* 23 (Part 2) 34:41-148.
1992 The 1832 Inoculation Program on the Missouri River. In *Disease and Demography in the Americas*, edited by J. W. Verano and D. H. Ubelaker, pp. 257-264. Smithsonian Institution Press, Washington, D.C.
1994 The 1837-1838 Smallpox Epidemic on the Upper Missouri. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 81-89. Smithsonian Institution Press, Washington, D.C.

Troughton, J. H., J. D. Stout and T. A. Rafter
1974 Long-Term Stability of Plant Communities. *Carnegie Institute Washington Yearbook* 73: 838-845.

Trudeau, J. B.
1952 Trudeau's Journal, 1794-1795. In *Before Lewis and Clark,* edited by A. P. Nasatir, pp. 259-311. St. Louis Historical Documents Foundation, St. Louis.

Tunnell, C.
1977 Fluted Projectile Point Production as Revealed by Lithic Specimens from the Adair-Steadman Site in Northwest Texas. In *Paleoindian Lifeways,* edited by E. Johnson, pp. 140-168. The Museum Journal 17. Lubbock.

Tunnell, C. D. and L. Johnson
1991 Folsom Knapping Uniformity at the Adair-Steadman Site. Paper presented at the 56th Annual Meeting of the Society for American Archaeology. New Orleans. In *Folsom Archaeology,* edited by M. A. Jodry and D. J. Stanford, Smithsonian Institution Press, in press.

Turner, C. G., II
1979 Dental Anthropological Indications of Agriculture Among Jomon People of Central Japan. *American Journal of Physical Anthropology* 51:619-636.
1985 The Dental Search for Native American Origins. In *Out of Asia: Peopling the Americas and the Pacific,* edited by R. Kirk and E. Szathmary. Journal of Pacific History, Canberra, Australia.
1992 New World Origins: New Research from the Americas and the Soviet Union. In *Ice Age Hunters of the Rockies,* edited by D. J. Stanford and J. S. Day, pp. 7-50. University Press of Colorado, Niwot.

Turner, E. S. and T. R. Hester
1993 *A Field Guide to Stone Artifacts of Texas Indian* (second edition). Texas Monthly Fieldguide Series. Gulf Publishing, Houston.

Turner, K. R. and W. M. Bass
1972 A Human Skeleton from the Infinity Site, 14MY305. In *The Archeology of the Elk City Reservoir,* by J. O. Marshall, pp. 265-269. Kansas State Historical Society, Anthropological Series 6. Topeka.

Tuross, N. and M. L. Fogel
1994 Stable Isotope Analysis and Subsistence Patterns at the Sully Site. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 283-289. Smithsonian Institution Press, Washington, D.C.

Twiss, P. C.
1983 Dust Deposition and Opal Phytoliths in the Great Plains. In *Man and the Changing Environments in the Great Plains*, edited by W. H. Caldwell, C. B. Schultz, and T. M. Stout, pp. 73-82. Nebraska Academy of Sciences, Transactions, 11.
1987 Grass-Opal Phytoliths as Climatic Indicators of the Great Plains Pleistocene. In *Quaternary Environments of Kansas,* edited by W. C. Johnson, pp. 179-188. Kansas Geological Survey, Guidebook Series 5.

Ubelaker, D,
1971 Dentition. In *The Leavenworth Site Cemetery: Archaeology and Physical Anthropology.* Publications in Anthropology No. 2, Appendix A. University of Kansas, Lawrence.

Ubelaker, D. H. and R. L. Jantz
1979 Plains Caddoan Relationships: The View from Craniometry and Mortuary Analysis. *Nebraska History Magazine* 60(2):249-259.

Ubelaker, D., T. W. Phenice, and W. M. Bass
1969 Artificial Interproximal Grooving of the Teeth in American Indians. *American Journal of Physical Anthropology* 30:(1):145-150.

Ubelaker, D. and P. S. Willey
1978 Complexity in Arikara Mortuary Practice. *Plains Anthropologist* 23(79):69-74.

Udden, J. A.
1900 *An Old Indian Village.* Augustana Library Publication No 2, Rock Island.

Ungar, C. A.
1977 Wilson Lake, A Cultural Resource Management Plan. Ms. on file, U.S. Army Corps of Engineer, Omaha.

Unrau, W. E. and M. E. Wood
1972 Historical Sites of the Verdigris Basin, Kansas and Oklahoma. Ms. on file, Kansas State Historical Society, Topeka.

Upham, W.
1902 Glacial Man in Kansas. *American Anthropologist* 4: 566-568.

U.S. Department of Commerce
1983 *Climatic Atlas of the United States.* Washington, D.C.

Van Zant, K. L.
1979 Late Glacial and Postglacial Pollen and Plant Macrofossils from Lake West Okoboji, Northwestern Iowa. *Quaternary Research* 12:358-380.

Vaughan, S. J.
1975 Archaeological Investigations for the Copan Reservoir, Northeastern Oklahoma and Southeast Kansas. Ms. on file, U.S. Army Corps of Engineer, Tulsa.

1976 Second Season Archaeological Investigations for the Copan Reservoir, Northeastern Oklahoma and Southeastern Kansas. Ms. on file, National Parks Service, Interagency Archaeological Services, Denver.

Vehik, R.

1978 *An Analysis of Cultural Variability during the Late Woodland Period in the Ozark Highland of Southwest Missouri.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Missouri, Columbia.

Vehik, S. C.

1983 Middle Woodland Mortuary Practices along the Northeastern Periphery of the Great Plains: A Consideration of Hopewellian Interaction. *Mid-Continental Journal of Archaeology* 8(2):211-256.

1984 Cultural Continuity and Discontinuity in the Southern Prairies and Cross Timbers. In *Plains Indians, A.D. 500-1500, The Archaeological Past of Historic Groups,* edited by K. H. Schlesier, pp. 239-263. University of Oklahoma Press.

1993 Dhegiha Origins and Plains Archaeology. *Plains Anthropologist* 38(146):231-252.

Vehik, S. C. and R. A. Pailes

1979 Excavations in the Copan Reservoir, Northeastern Oklahoma and Southeastern Kansas (1974). Ms. on file, National Technical Information Service, Springfield.

Vogel, J. C.

1980 *Fractionation of the Carbon Isotopes During Photo-synthesis.* Springer Verlag, Berlin.

Voorhies, M. R.

1969 *Taphonomy and Population Dynamics of an early Pliocene Vertebrate Fauna, Knox County, Nebraska.* University of Wyoming Contributions to Geology Special Paper 1. Laramie.

Voorhies, M. R. and R. G. Corner.

1984 The Crappie Hole Site: A Concentration of Spirally-Fractured Rancholabrean Mammal Bones in Western Nebraska. *Current Research* 1:53-54.

1985 Small Mammals with Boreal Affinities. In *Late Pleistocene (Rancholabrean) Deposits of Eastern and Central Nebraska,* edited by W. Dort, pp. 125-142. Institute for Tertiary-Quaternary Studies, TER-QUA Symposium Series 1. Nebraska Academy of Science, Lincoln.

Wagner, M. J., B. Koldehoff, T. Martin, and K. Parker

1989 Archaeological Investigation of the McPherson Site (14LV357). In *Phase I, II, and III Archaeological Investigations at Fort Leavenworth, Kansas,* pp. 159-198. American Resources Group, Ltd. Carbondale, Illinois. Submitted to the US Army Corps of Engineers, Kansas City District.

Wagner, M. J., M. R. McCorvie, T. J. Martin, and K. E. Parker

1988 *Draft Report, Phase I, II, and III Archeological Investigations at Fort Leavenworth, Kansas.* Cultural Resources Management Report No. 132, American Resources Group, Ltd., Carbondale, Illinois.

Walker, D. N.

1975 *Cultural and Ecological Analysis of the Vertebrate Fauna of the Medicine Lodge Creek Site (48BH499).* Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

1982 Early Holocene Vertebrate Fauna. In *The Agate Basin Site: A Record of Paleoindian Occupation of the Northwestern High Plains,* edited G. C. Frison and D. J. Stanford, pp. 274-308. Academic Press, New York.

Walker, D. N. and G. C. Frison

1986 The Late Pleistocene Mammalian Fauna from the Colby Mammoth Kill Site, Wyoming. In *The Colby Mammoth Site, Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming,* by G. C. Frison and L. C. Todd, pp. 191-205. University of New Mexico Press, Albuquerque.

Walker, E. G.

1988 The Graham Site: A McKean Cremation from Southern Saskatchewan. *Plains Anthropologist* 29(104):139-150.

Wanner, J. and R. H. Brunswig, Jr.

1992 A Late Archaic Skeleton from the Northeastern Colorado High Plains. *Plains Anthropologist* 37(141):367-383.

Ward, R. H., B. L. Frazier, K. Dew-Jager, and S. Paabo

1991 Extensive Mitchrondrial Diversity within a Single Amerindian Tribe. *Proceedings of the National Academy of Science, USA* 88:8720-8724.

Waters, M. R.

1985 Early Man in the New World: An Evaluation of the Radiocarbon Dated Pre-Clovis Sites in the Americas. In *Environments and Extinctions: Man in Late Glacial North America,* edited by J. I. Mead and D. J. Meltzer, pp. 125-144. Center for the Study of Early Man, University of Maine, Orono.

Watson, D. R. and S. R. Holen

1994 Dating the Skidi, Part II: Further Thoughts on Euroamerican Trade Goods at Site 25HW16. Paper presented at the 16th Annual Flint Hills Archaeological Conference, Topeka, Kansas.

Watson, P. J.

1976 In Pursuit of Prehistoric Subsistence: A Comparative Account of Some Contemporary Flotation Techniques. *Midcontinental Journal of Archaeology* 1(1):77-100.

Watson, P. J., S. A. LeBlanc, and C. L. Redman

1971 *Explanations in Archaeology. An Explicitly Scientific Approach.* Columbia University Press, New York

Watson, R. A. and Wright H. E., Jr.

1980 The End of the Pleistocene: A General Critique of Chronostratigraphic Clarification. *Boreas.* 9: 153-163.

Watts, W. A.

1980 The Late Quaternary Vegetation History of the Southern Unites States. *Annual Review of Ecology and Systematics* 11:387-409.

Watts, W. A. and R. C. Bright

1968 Pollen, Seed, and Mollusk Analysis of a Sediment Core from Pickerel Lake, Northeastern South Dakota. *Geological Society of America Bulletin* 79:855-876.

Watts, W. A. and H. E. Wright, Jr.

1966 Late-Wisconsin Pollen and Seed Analysis from the Nebraska Sandhills. *Ecology* 47(2):202-210.

Wauchope, R.

1962 *Lost Tribes and Sunken Continents.* The University of Chicago Press.

Wayne W. J., R. B. Morrison, J. S. Aber, S. S. Agard, R. N. Bergantino, J. P. Bluemle, D. A. Coates, M. E. Cooley, R. F. Madole, J. E. Martin, B. Mears, Jr., R. B. Morrison, and W. M. Sutherland

1991 Quaternary Geology of the Northern Great Plains. In *Quaternary Nonglacial Geology; Conterminous U.S.*, edited by R. B. Morrison. Geological Society of America, The Geology of North America V. K-2.

Weakley, H. E.

1943 A Tree-Ring Record of Precipitation in Western Nebraska. *Journal of Forestry* 41:816-819.

1946 A Preliminary Report on the Ash Hollow Charcoal. In *Ash Hollow Cave,* by J. L. Champe, pp. 105-110. University of Nebraska Studies 1. Lincoln.

1962 History of Drought in Nebraska. *Journal of Soil and water Conservation,* 17:271-275.

Weakly, W. F.

1965 1964 Archeological Salvage in the Elk City Reservoir. *Plains Anthropologist* 10(27).

1971 Tree-ring Dating and Archaeology in South Dakota. *Plains Anthropologist Memoir* 8 (Part 2) 16(54).

Webb, T., III, P. J. Bartlein, S. P. Harrison, and R. H. Anderson

1993 Vegetation, Lake Levels, and Climate in Eastern North America for the Past 18,000 Years. In *Global Climates Since the Last Glacial Maximum*, edited H. E. Wright, Jr. et al. University of Minnesota Press, Minneapolis.

Webb, T., III, and Bryson, R. A.

1972 Late- and Postglacial Climatic Change in the Northern Midwest, U.S.A. *Quaternary Research* 2(1):70-115.

Webb, T. III, E. J. Cushing, and H. E. Wright, Jr.

1983 Holocene Changes in the Vegetation of the Midwest. In *Late Quaternary Environments of the United States, v.2, The Holocene*, edited by H. E. Wright. University of Minnesota Press, Minneapolis.

Webb, W. S.

1946 *Indian Knoll*. University of Kentucky Press. (Reprinted 1974, University of Tennessee Press)

Webb, W. S., D. L. Dejarnette

1942 *An Archaeological Survey of Pickwick Basin in the Adjacent Portions of the State of Alabama, Mississippi, and Tennessee*. Bureau of American Ethnology, Bulletin No. 129.

Weber, D. and C. J. Anderson

1977 Archaeological Reconnaissance of the Loveland Dam, Pipeline, and Power Plant Site. Ms. on file, U.S. Forest Service, Arapahoe-Roosevelt National Forest Headquarters, Fort Collins.

Wedel, M.

1959 Oneota Sites on the Upper Iowa River. *Missouri Archaeologist* 21(2-4):1-181.

Wedel, M. M. and R. J. DeMallie

1980 The Ethnohistoric Approach in Plains Area Studies. In *Anthropology on the Great Plains*, edited by W. R. Wood, and M. Liberty, pp. 110-128. University of Nebraska Press, Lincoln.

Wedel, W. R.

1933 Preliminary Notes on the Archaeology of Medicine Valley in Southwestern Nebraska. *Nebraska History Magazine* 14(3):144-166.

1934a Contributions to the Archaeology of the Upper Republican Valley, Nebraska. *Nebraska History Magazine* 25(3): 133-209.

1934b Minneapolis 1. *Nebraska History Magazine* 15(3):210-237.

1934c Preliminary Classification for Nebraska and Kansas Cultures. *Nebraska History Magazine* 15(3):251-255.

1936 *An Introduction to Pawnee Archeology*. Smithsonian Institution, Bureau of American Ethnology, Bulletin 112. Washington, D.C.

1938a *The Direct-Historical Approach in Pawnee Archaeology*. Smithsonian Miscellaneous Collections 97(7). Washington, DC.

1938b Some Problems and Prospects in Kansas Prehistory. *Kansas Historical Quarterly* 7(2):115-132.

1938c Inaugurating an Archaeological Survey in Kansas. *Explorations and Fieldwork of the Smithsonian Institution in 1937*, pp. 103-106.

1940 Cultural Sequence in the Central Great Plains. *Smithsonian Miscellaneous Collections* 100:291-352. Washington, D.C.

1941 Environment and Native Subsistence Economies in the Central Great Plains. *Smithsonian Miscellaneous Collections* 101(3):1-29. Washington, D.C.

1943 *Archaeological Investigations in Clay and Platte Counties, Missouri*. U.S. Natural History Bulletin 183, Washington D.C.

1947 Preliminary Appraisal of the Archeological and Paleontological Resources of Certain Proposed Reservoir Areas in the Lower Platte Sub-Basin, Nebraska. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1953 Some Aspects of Human Ecology in the Central Plains. *American Anthropologist* 55(4):499-514.

1955 *Archeological Materials from the Vicinity of Mobridge, South Dakota*. Smithsonian Institution Bureau of American Ethnology, Bulletin 157. Smithsonian Institution Press, Washington, D.C.

1959 *An Introduction to Kansas Archeology*. Bureau of American Ethnology Bulletin 174, Smithsonian Institution, Washington.

1961a *Prehistoric Man on the Great Plains*. University of Oklahoma Press, Norman.

1961b Plains Archeology, 1935-1960. *American Antiquity* 27(1): 24-32.

1963 The High Plains and Their Utilization by the Indians. *American Antiquity* 29(1):1-16.

1964 The Great Plains. In *Prehistoric Man in the New World*, edited by J. D. Jennings and E. Norbeck, pp. 193-222. University of Chicago Press, Chicago.

1967 Salvage Archaeology in the Missouri River Basin. *Science* 156(3775): 589-597.

1970 Some Observations on "Two House Sites in the Central Plains: An Experiment in Archaeology." *Nebraska History Magazine* 51(2):225-252.

1978a Notes on the Prairie Turnip (*Psoralea esculenta*) Among the Plains Indians. *Nebraska History Magazine* 59:1-25.

1978b Plains Archaeology in 1977. *Great Plains Journal* 17:25-40.

1978c Symposium Commentary. Presented at Plains Conference, Denver.

1978 The Prehistoric Plains. In *Ancient Native Americans*, edited by J. D. Jennings, pp. 183-219. W. H. Freeman, San Francisco.

1979a Introduction. In *Toward Plains Caddoan Origins*, edited by W. R. Wedel, pp. 131-133. Nebraska History 60(2).

1979b House Floors and Native Settlement Populations in the Central Plains. *Plains Anthropologist* 24(84):85-98.

1982 *Towards a History of Plains Archaeology*. J & L Reprints in Anthropology 24, Lincoln.

1983 Native Subsistence Adaptations in the Great Plains. In *Man and the Changing Environments in the Great Plains*, edited by W. W. Caldwell, C. B. Schultz, and T. M. Stout, pp. 93-110. Transactions of the Nebraska Academy of Sciences 11, Special Issue.

1986 *Central Plains Prehistory: Holocene Environments and Culture Change in the Republican River Basin*. University of Nebraska Press, Lincoln.

Wedel, W. R., W. Husted, and J. Moss

1968 Mummy Cave: Prehistoric Record from the Rocky Mountains of Wyoming. *Science* 160(3824):184-186.

Wedel, W. R. and T. E. White

1947 Memorandum Concerning Certain Recently Reported Sites on Lime Creek, in Medicine Creek Reservoir Area, Frontier County, Lincoln. Ms. on file, University of Nebraska State Museum, Lincoln.

Welch, J. R. and J. M. Hale

1987 Pleistocene Loess in Kansas—Status, Present Problems, and Future Considerations. In *Quaternary Environments of Kansas*, edited by W. C. Johnson, pp. 67-84. Kansas Geological Survey, Guidebook Series 5.

Wells, C.

1967 A New Approach to Paleopathology: Harris's Lines. In *Diseases in Antiquity*, edited by D. Brothwell and A. T. Sandison, pp. 390-404. C. C. Thomas, Springfield, Illinois.

Wells, G. L.

1983 Late-Glacial Circulation over Central North America Revealed by Eolian Features. In *Variations in the Global Water Budget*, edited by A. Stree-Perrott et al., pp. 317-330. D. Reidel, Dordrecht, Netherlands.

Wells P. V. and J. D. Stewart

1987a Cordilleran-Boreal Taiga and Fauna on the Central Great Plains of North America, 14,000-18,000 Years Ago. *The American Midland Naturalist* 118:94-106.

1987b Spruce Charcoal, Conifer Macrofossils, and Landsnail and Small-Vertebrate Faunas in Wisconsinan Sediments on the High Plains of Kansas. In *Quaternary Environments of Kansas*, edited by W. C. Johnson, pp. 129-140. Kansas Geological Survey, Guidebook Series 5.

Wendland, W. M.
1978 Holocene Man in the Plains—The Ecological Setting and Climatic Background. *Plains Anthropologist* 23:273-287.
1982 Geomorphic Responses to Climatic Forcing During the Holocene. In *Space and Time in Geomorphology*, edited by C. E. Thorn, pp. 355-371. Allen and Unwin Ltd., London, England.

Wendland, W. M. and R. A. Bryson
1974 Dating Climatic Episodes of the Holocene. *Quaternary Research* 4:9-24.

Wendorf, F. and A. D. Krieger
1959 New Light on the Midland Discovery. *American Antiquity* 25:66-78.

Wendorf, F., A. D. Krieger, C. C. Albritton, and T. D. Stewart
1955 *The Midland Discovery*. University of Texas Press, Austin.

West, D. L.
1991 The Sutter Site Revisited: The Faunal Analysis. Paper presented at the 49th Annual Plains Anthropological Conference, Lawrence.

West, F. H.
1983 The Antiquity of Man in America. In *Late Quaternary Environments of the United States, Volume 1. The Late Pleistocene*, edited by S. C. Porter, pp. 364-382. University of Minnesota Press, Minneapolis.

Wetherill, R. B.
1995 *A Comparative Study of Paleoindian Evidence at the Bonner Springs Locality, Lower Kansas River Basin, Kansas*. Unpublished Master's thesis, Department of Anthropology, University of Kansas. Lawrence.

Whallon, R.
1989 Elements of Cultural Change in the Later Palaeolithic. In *The Human Revolution, Behavioral and Biological Perspectives on the Origins of Modern Humans*, edited by P. Mellars and C. Stringer, pp. 433-454. Edinburgh University Press.

Wheat, J. B.
1971 Lifeways of Early Man in North America. *Arctic Anthropology* 8(2):22-31.
1972 *The Olsen-Chubbuck Site: A Paleoindian Bison Kill*. Society for American Archaeology, Memoir 26.
1976 Artifact Life Histories: Cultural Templates, Typology, Evidence, and Inference. In *Primitive Technology and Art*, edited by J. S. Raymond et al. pp. 7-15. The University of Calgary Archaeological Association. Calgary.
1979 *The Jurgens Site*. Plains Anthropologist Memoir 15.

Wheeler, R. P.
1952 A Note on the "McKean Lanceolate Point." *Plains Archeological Conference Newsletter* 4(4):39-44.
1954a Selected Projectile Point Types of the United States. *Bulletin of the Oklahoma Anthropological Society* 2:1-6.
1954b Two New Projectile Point Types: Duncan and Hanna Points. *Plains Anthropologist* 1:7-14.
1985 The Middle Prehistoric Period in the Central and Northern Plains. In *McKean/Middle Plains Archaic: Current Research*, edited by M. Kornfeld and L. C. Todd, pp. 5-10. Occasional Papers on Wyoming Archaeology 4. University of Wyoming, Department of Anthropology, Laramie.
1957 Archaeological Remains in Three Reservoir Areas in South Dakota and Wyoming. Ms. on File at the Midwest Archaeological Center, Lincoln, NE.
1995 *Archeological Investigations in Three Reservoir Areas in South Dakota and Wyoming, Part I Angostura Reservoir*. J and L Reprints Volume 46. Lincoln.

Wheeler, R. P. and G. H. Smith
1953 The Prehistory and Early History of the Niobrara River Basin. Missouri River Basin Project, Niobrara River Basin Development Plan. National Parks Service-R on file, SI-RBS, Lincoln.

White, R. G.
1980 Historical and Architectural Reconnaissance, Kansas and Smoky Hill Rivers Bank Stabilization Study. Ms. on file, U.S. Army Corps of Engineers, Omaha.

White, T. E.
1947 Preliminary Appraisal of the Paleontological Resources of the Smoky Hill River Sub-Basin, Kansas and Colorado. SI-RBS-MBP-A on file, SI-RBS, Washington, DC.
1951 Appraisal of the Archeological and Paleontological Resources of the Niobrara River Basin, Nebraska. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

Whitney, J. D.
1880 *Auriferous Gravels of the Sierra Nevada of California*. Museum of Comparative Zoology, Harvard College 6(1): 288-321.

Wickland, J. A.
n.d. An Analysis of Human Skeletal Material from Oneota Sites in or near Iowa. Ms. on file, University of Kansas, Lawrence.

Wiessner, P.
1982 Risk, Reciprocity and Social Influences on !Kung San Economics. In *Politics and History in Band Societies*, edited by E. Leacock and R. B. Lee, pp. 61-84. Cambridge University Press, Cambridge.
1983 Style and Social Information in Kalahari San Projectile Points. *American Antiquity* 48(2):253-276.

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

Will, G. F. and Hyde, G. E.
1917 *Corn Among the Indians of the Upper Missouri*. University of Nebraska, Lincoln.

Wille, M. B.
1958 *A Comparative Study of Ceramic Traits within the Central Plains Tradition*. Unpublished Master's thesis, University of Kansas, Lawrence.

Willey, G. R.
1966 *An Introduction to American Archaeology: North and Middle America*, Vol.1. Prentice Hall, Englewood Cliffs.

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

Willey, G. R. and J. A. Sabloff
1980 *A History of American Archaeology* (2nd edition). W. H. Freeman, New York
1993 *A History of American Archaeology* (2nd edition). W. H. Freeman, New York.

Willey, P.
1990 *Prehistoric Warfare on the Great Plains. Skeletal Analysis of the Crow Creek Massacre Victims*. Garland Publishing, New York.

Willey, P. and W. M. Bass
1969 A Study of a Kansa Child from the Doniphan Site, 14DP2, Doniphan County, Kansas. *Kansas Anthropological Association Newsletter* 15(1):1-7.
1978 A Scalped Skull from Pawnee County. *Kansas Anthropological Association Newsletter* 24(1):1-11.

Willey, P. and T. E. Emerson
1993 The Osteology and Archaeology of the Crow Creek Massacre. *Plains Anthropologist*, Memoir 27, 38:(145):227-269.

Willey, P., B. R. Harrison, and J. T. Hughes
1978 The Rex Rodgers Site. In *Archaeology at MacKenzie Reservoir*, edited J. T. Hughes and P. S. Willey, pp. 51-114.. Texas Historical Commission, Office of the State Archaeologist, Archaeological Survey Report 24.

Willey, P. and J. L. Hofman

1994 Interproximal Grooves, Toothaches, and Purple Coneflowers. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 147-157. Smithsonian Institution Press, Washington, D.C.

Willey, P. and R. W. Mann

1986 The Skeleton of an Elderly Woman from the Crow Creek Site and Its Implications for Paleodemography. *Plains Anthropologist* 31(112):141-152.

Willey, P., R. W. Mann, P. H. Moore-Jansen, R. L. Jantz, M. Guilbeau, and L. Meadows

1987 *Human Skeletal Material from the South Dakota Archaeological Research Center.* Anthropology Department, University of Tennessee, Knoxville.

Willey, P. and M. Swegle

1980 A Sioux Child with Notched Teeth from South Dakota. *South Dakota Archaeology* 4:33-44.

Williams, B. G.

1986 *Early and Middle Ceramic Remains at 14AT2.* Kansas State Historical Society, Contract Archaeology Publication 4.

Williams, J. A.

1988 Analysis of Miscellaneous Human Osteological Remains Recovered from Multi-County Areas of South Dakota. Contract No. DACW45-87-M-0274. Omaha District Corps of Engineers, U.S. Department of the Army, Omaha, Nebraska.

1991 Possible Evidence of Scurvy in a Prehistoric Skeleton from the Northeastern Plains. *Proceedings of the North Dakota Academy of Science* 45:29.

1993 *Analysis of Miscellaneous Human Osteological Remains Recovered from Multi-County Areas of South Dakota.* Contribution Number 275. University of North Dakota, Grand Forks, and South Dakota State Historical Society, Rapid City.

1994 Disease Profiles of Archaic and Woodland Populations in the Northern Plains. In *Skeletal Biology in the Great Plains. Migration, Warfare, Health, and Subsistence,* edited by D. W. Owsley and R. L. Jantz, pp. 91-108. Smithsonian Institution Press, Washington, D.C.

Williams, S.

1991 *Fantastic Archaeology: The Wild Side of North American Prehistory.* University of Pennsylvania Press, Philadelphia.

Williston, S. W.

1897 The Pleistocene of Kansas. *University Geological Survey of Kansas* 2:297-308.

1899 Some Prehistoric Ruins in Scott County, Kansas. *Kansas University Quarterly,* 7(4):109-114.

1902a An Arrowhead found with Bones of *Bison Occidentalis* Lucas, in Western Kansas. *American Geologist* 30:313-315.

1902b A Fossil Man in Kansas. *Science* 16: 195-196.

Williston, S. W. and H. T. Martin

1900 Some Pueblo Ruins in Scott County, Kansas. *Kansas Historic Collection* 6: 124-130.

Willman, H. B. and J. C. Frye

1970 *Pleistocene Stratigraphy of Illinois.* Illinois State Geological Survey, Bulletin 94.

Wilmeth, R.

1952 Appraisal of the Archeological Resources of the Pomona and Melvern Reservoir, Osage County, Kansas. KSHS-A. on file, SI-RBS, Lincoln.

1960 Excavations in the Pomona Reservoir. Ms. on file, Kansas State Historical Society, Topeka.

1968 A Fossilized Bone Artifact from Southern Saskatchewan. *American Antiquity* 33(1):100-101.

1970 *Excavations in the Pomona Reservoir.* Kansas State Historical Society, Anthropological Series No. 5.

Wilmsen, E. N.

1965 An Outline of Early Man Studies in the United States. *American Antiquity* 31(2):172-192.

1973 Interaction, Spacing Behavior, and the Organization of Hunting Bands. *Journal of Anthropological Research* 29:1-31.

1974 *Lindenmeier: A Pleistocene Hunting Society.* Harper and Row, New York.

Wilmsen, E. N. and F. H. H. Roberts, Jr.

1978 *Lindenmeier, 1934-1974, Concluding Report on Investigations.* Smithsonian Contributions to Anthropology 24. Washington, D.C.

Wilson, G. L.

1917 *Agriculture of the Hidatsa Indians, An Indian Interpretation.* Bulletin of the University of Minnesota, Studies in the Social Sciences, No. 9, Minneapolis.

Wilson, M.

1974 The Casper Local Fauna and its Fossil Bison. In *The Casper Site: A Hell Gap Bison Kill on the High Plains,* by George C. Frison, pp. 125-171. Academic Press, New York.

Winchell, N. H.

1902 The Lansing Skeleton. *American Geologist* 30:189-194.

1903 The Pleistocene Geology of the Concannon Farm, Near Lansing, Kansas. *American Geology* 31:263-308.

1913 *The Weathering of Aboriginal Stone Artifacts.* Minnesota. Historical Society 16(1).

Windmiller, R.

1974 Archaeological Investigations in the Two Forks Reservoir Area, Colorado: First Quarterly Progress Report (and Appendum). Ms. on file, National Parks Service, Rocky Mountain Region, Denver.

1975 Archaeological Investigations for the Two Forks Dam and Reservoir Alternatives, Colorado. Ms. on file, U.S. Army Corps of Engineer, Omaha.

Winfrey, J. V.

1991 *Spatial Distribution of Cultural Material and Post-Depositional Disturbances at the Wallace Site (25GO2): A Plains Woodland Occupation Site in South Central Nebraska.* Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

Wininger, D. and B. Logan

1995 Ceramic Assemblage. In *Phasing in White Rock: Archaeological Investigation of the White Rock and Warne Sites, Lovewell Reservoir, Jewell County, Kansas—1994,* by B. Logan. Project Report Series No. 90. University of Kansas, Museum of Anthropology, Lawrence.

Winship, G. P.

1896 The Coronado Expedition. 1540-1542. *Bureau of American Ethnology, 14th Annual Report for the Years 1892-1893,* Part 1:329-613.

Winterhalder, B. and E. A. Smith (editors)

1981 *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses.* University of Chicago Press, Chicago.

Wishart, D. J.

1975 Images of the Northern Great Plains from the Fur Trade, 1807-1843. In *Images of the Plains: The Role of Human Nature in Settlement,* edited by B. W. Blouet and M. P. Lawson, pp. 45-55. University of Nebraska Press, Lincoln.

Wissler, C.

1914 Material Cultures of the North American Indians. *American Anthropologist* 16(3): 447-505.

1922 *The American Indian* (2nd edition). New York.

1942 The American Indian and the American Philosophical Society. *Proceedings of the American Philosophical Society* 86: 189-204.

Withers, A. M.

1949a Preliminary Survey of the Archaeological Resources of the Blue River-South Platte Project, Colorado. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

1949b Preliminary Survey of the Archeological Resources in the Gunnison-Arkansas project, Colorado: East of the Mountains. SI-RBS-MBP-A on file, SI-RBS, Lincoln.

Withers, A.

1972 Archaeological Survey of the Chatfield Reservoir, Colorado, 1968. Ms. on file, National Parks Service, Midwest Archaeological Center, Lincoln.

Witty, T. A. Jr.

1957 The Logan Creek Site (25BT3). Ms. on File, Nebraska State Historical Society, Lincoln.

1961a Appraisal of the Archeological Resources of the Council Grove Reservoir, Morris County, Kansas. KSHS-A on file, SI-RBS, Lincoln.

1961b Appraisal of the Archaeological Resources of the John Redmond Reservoir, Coffey and Lyon Counties, Kansas. KSHS-A on file, SI-RBS, Lincoln.

1961c Excavations in the Wilson Reservoir Area, Russell County, Kansas. *Plains Anthropologist* 6(12):64.

1961d Archaeological Investigations on the Milford Reservoir, Clay County, Kansas. Ms. on file, National Park Service, Midwest Archaeological Center, Lincoln.

1962a Archeological Investigations of the Hell Creek Valley in Wilson Reservoir, Russell and Lincoln Counties, Kansas. KSHS-AS 1 on file, SI-RBS, Lincoln.

1962b Archeological Salvage in the Milford and Council Grove Reservoir. *Plains Anthropologist* 7(16).

1962c Archeological Survey of the Elk City Reservoir. *Kansas Anthropological Association Newsletter* 7(6-8).

1963a Appraisal of the Archeological Resources of the Cheney Reservoir, Reno, Kingman and Sedwick Counties, Kansas. *Kansas Anthropological Association Newsletter* 8 (5).

1963b Appraisal of the Archeological Resources of the Marion Reservoir, Marion County, Kansas. *Kansas Anthropological Association Newsletter* 9 (1).

1963c Archeology of the Council Grove Reservoir, Kansas. *Plains Anthropologist* 8(20):117.

1963d 1963 Excavations in the John Redmond Reservoir. *Kansas Anthropological Association Newsletter* 9(2).

1963e *The Woods, Avery, and Streeter Archeological Sites, Milford Reservoir, Kansas.* Anthropological Series No. 2. Kansas State Historical Society, Topeka.

1964a *Appraisal of the Archaeological Resources of the Perry Reservoir, Jefferson County, Kansas.* Kansas Anthropological Association Newsletter 10(1).

1964b *Radiocarbon Dates from the John Redmond Reservoir Area.* Kansas Anthropological Association Newsletter 9(9).

1965a *Archeological Survey of the Upper Verdigris Watershed.* Kansas Anthropological Association Newsletter 11(3).

1965b 1964 Excavations in the Council Grove Reservoir, Morris County, Kansas. *Plains Anthropologist* 10(27):51.

1966a 1965 Archeological Excavations in the Perry Reservoir and the Kansas Monument Site. *Plains Anthropologist* 11(32):165.

1966b The West Island Site, 14PH10, A Keith Focus Plains Woodland Site in Kirwin Reservoir, Phillips County, Kansas. *Plains Anthropologist* 11(32):127-135.

1967 The Pomona Focus. *Kansas Anthropological Association, Newsletter* 12(9):1-5.

1968 KAA Fall Dig, 1968. *Kansas Anthropological Association Newsletter* 14(2):1-2.

1969 The Caldwell Dig. *Kansas Anthropological Association Newsletter* 15(2):1-3.

1970 The Lovewell Mammoth. *Kansas Anthropological Association Newsletter* 15(5):3-4.

1975 Preliminary Report of Salvage Archaeological Investigations at Site 14OS347, Melvern Lake, Kansas. Ms. on file, U.S. Army Corps of Engineers, Omaha.

1978 Along the Southern Edge: The Central Plains Tradition in Kansas. In *The Central Plains Tradition: Internal Development and External Relationships*, edited by D. J. Blakeslee. Office of the State Archaeologist, University of Iowa, Report 11:56-66. Iowa City.

1981 The Pomona Focus, Known and Unknown. *The Missouri Archaeologist* 42:77-84.

1982a *The Slough Creek, Two Dog and William Young Sites, Council Grove Lake, Kansas.* Kansas State Historical Society, Anthropological Series 10, Topeka.

1982b Cultural Resources Sample Survey of Shoreline Areas, Perry Lake, Delaware River, Kansas. Ms. on file, U.S. Army Corps of Engineers, Omaha.

1983 Four Archaeological Sites of the Perry Lake, Kansas. Ms. on file, NPS, Interagency Archaeological Services, Denver.

n.d. Appraisal of the Archeological Resources of the Elk City Reservoir, Montgomery County, Kansas. Ms. on file, SI-RBS, Lincoln.

Witty, T. A., W. M. Bass, and P. A. Grubbs

1964 The West Island Site, 14PH10, A Keith Focus Plains Woodland Site in Kirwin Reservoir, Phillips County, Kansas. Ms. on file, National Park Service, Midwest Archeological Center, Lincoln.

Wolbach, J. B.

1947 Vitamin A Deficiency and Excess in Relation to Skeletal Growth. *Journal of Bone and Joint Surgery* 29:171-192.

Wolley, A. M.

1988 *Prehistoric Zinc Nutrition: Archaeological, Ethnographic, Skeletal and Chemical Evidence.* Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

1992 Abnormal Frequencies of Spina Bifida Occulta in Several Prehistoric Populations from Northeastern Nebraska. *Nebraska Anthropologist* 9(1&2):53-68.

Wolley, A. M. and A. J. Osborn

1991 *Adaptive Storage and Caching Behavior in the Prehistoric Southwest: An Isolated Storage Vessel at Site 42SA20779 in Glen Canyon National Recreation Area.* National Park Service, Midwest Archaeological Center Occasional Studies in Anthropology 25. Lincoln.

Wood, C. E.

1976 *Trinchera Cave: A Rockshelter in Southeastern Colorado.* Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Wood, J. J.

1967 *Archeological Investigations in Northeastern Colorado.* Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Wood, W. R.

1956a *The Redbird Focus.* Unpublished Master's thesis, Department of Anthropology, University of Nebraska, Lincoln.

1956b Settlement Patterns of the Redbird Focus. *Plains Anthropologist* 7:3-9.

1957 The Redbird Focus, North Central Nebraska. *Missouri Archaeological Society News Letter* 115:6-8.

1959 Notes on Ponca Ethnohistory, 1785-1804. *Ethnohistory* 6(1):1-27.

1965 *The Redbird Focus and the Problem of Ponca Prehistory.* Plains Anthropologist 10(28), Memoir 2.

1967 Preliminary Report on Archaeological Work in the Medicine Creek Valley, Nebraska. Ms. on file, the Bureau of Reclamation., Lower Missouri Region, Denver.

1968 Mississippian Hunting and Butchering Patterns: Bone from the Vista Shelter, 23SR20, Missouri. *American Antiquity* 332):170-179.

1969 Conclusions. In *Two House Sites in the Central Plains: An Experiment in Archaeology.* Plains Anthropologist 14(44), Memoir 6.

1971 Pottery Sites near Limon, Colorado. *Southwestern Lore* 37(3):53-85.
1990 A Query on Upper Republican Archaeology in Colorado. *Southwestern Lore* 56(3):3-7.
1993 *Nanza, The Ponca Fort.* J & L Reprints in Anthropology 44. Lincoln.

Wood, W. R. (editor)
1969 *Two House Sites in the Central Plains Tradition.* Plains Anthropologist 14(44), pt. 2, Memoir 6.
1977 *Trends in Middle Missouri Prehistory: A Festschrift Honoring the Contributions of Donald J. Lehmer.* Memoir 13. Plains Anthropologist 22 (78, Part 2).
1993 *Na'"za, the Ponca Fort.* Reprints in Anthropology, 44. J & L Reprint Co., Lincoln.

Wood, W. R. and D. L. Johnson
1978 A Survey of Disturbance Processes in Archaeological Site Formation. In *Advances in Archaeological Method and Theory 1*, edited by M. B. Schiffer, pp. 315-383. Academic Press, New York.

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

Wood, W. R. and T. D. Thiessen (editors)
1985 *Early Fur Trade on the Northern Plains: Canadian Traders Among the Mandan and Hidatsa Indians, 1738-1818.* University of Oklahoma Press, Norman.

Woodall, J. N.
1968 Growth Arrest Lines in Long Bones of the Casas Grandes Population. *Plains Anthropologist* 13:152-160.

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

Wormington, H. M.
1948 Report of a Survey Conducted by the Denver Museum of Natural History in the Cherry Creek Reservoir Area. Arapahoe County, Colorado. Ms. on file, SI-RBS, Lincoln.
1957 *Ancient Man in North America.* Fourth edition. Denver Museum of Natural History, Popular Series 4. Denver.
1988 The Frazier Site, Colorado. In *Guidebook to the Archaeological Geology of the Colorado Piedmont and High Plains of Southeastern Wyoming,* edited by V. T. Holliday, pp. 82-84. Geological Society of America. Department of Geography, University of Wisconsin-Madison.

Wormington, H. M. and D. Ellis (editors)
1967 *Pleistocene Studies in Southern Nevada.* Nevada State Museum Anthropological Papers 13. Carson City, Nevada.

Wormington, H. M. and R. G. Forbis
1965 *An Introduction to the Archaeology of Alberta, Canada.* Denver Museum of Natural History Proceedings 11. Denver.

Wright, C. A.
1980 Archaeological Investigations in the Proposed Blue Springs Lake Area, Jackson County, Missouri: The Early Woodland Period. Ms. on file, Burns and McDonnell Engineers, Kansas City.

Wright, C. M.
1985 The Complex Aspects of the "Smokey Hill Jasper" Now Known as Niobrarite. *Journal of the Kansas Anthropological Association* 5(3):87-90.

Wright, G. F.
1892 *Man in the Glacial Period.* D. Appleton, New York.

Wright, H. E., Jr.
1970 Vegetational History of the Central Plains. In Dort, W. Jr. and Jones, J. K. Jr. (eds.), *Pleistocene and Recent Environments of the Great Plains,* edited by W. Dort, Jr. and J. K. Jones, Jr., pp. 157-172. Special Publication of the Department of Geology, University of Kansas, 3.
1976 The Dynamic Nature of Holocene Vegetation—A Problem in Paleoclimatology, Biogeography, and Stratigraphic Nomenclature. *Quaternary Research* 6:581-596.
1984 Sensitivity and Response Time of Natural Systems to Climatic Change in the Late Quaternary. *Quaternary Science Reviews* 3:91-131.
1989 The Amphi-Atlantic Distribution of the Younger Dryas Paleoclimatic Oscillation. *Quaternary Science Reviews* 8:295-306.
1991 Environmental Conditions for Paleoindian Immigration. In *The First Americans: Search and Research,* edited by T. D. Dillehay and D. J. Meltzer, pp. 113-135. CRC Press, Boca Raton.

Wright, H. E., Jr., J. C. Almendidinger, and J. Grüger
1985 Pollen Diagram from the Nebraska Sandhills and the Age of the Dunes. *Quaternary Research*, 24:115-120.

Wyckoff, D. G.
1964 *The Cultural Sequence at the Packard Site, Mayes County, Oklahoma.* Oklahoma River Basin Survey, Archaeological Site Report 2. Norman.
1985 The Packard Complex: Early Archaic, Pre-Dalton Occupations on the Prairie-Woodlands Border. *Southeastern Archaeology* 4(1):1-26.
1989a *The Burnham Site and Pleistocene Human Occupations on the Southern Plains of the United States.* Papers of the World Summit Conference on the Peopling of the Americas. Center for the Study of the First Americans, University of Maine, Orono.
1989b Accelerator Dates and Chronology at the Packard Site, Oklahoma. *Current Research in the Pleistocene* 6:24-26.
1992 The Cody Complex in Eastern Oklahoma's Arkansas Basin. *Current Research in the Pleistocene* 9:

Wyckoff, D. G. and R. Bartlett
1995 Living on the Edge, Late Pleistocene-Early Holocene Cultural Interaction along the Southeastern Woodlands-Plains Border. In *Native American Interactions, Multiscalar Analyses and Interpretations in the Eastern Woodlands,* edited by M. S. Nassaney and K. E. Sassaman, pp. 27-72. University of Tennessee Press, Knoxville.

Wyckoff, D. G. and B. J. Carter
1994 *Geoarchaeology at the Burnham Site: 1992 Investigations at a "Pre-Clovis Site" in Northwestern Oklahoma.* Special Publication of the Oklahoma Archeological Survey, University of Oklahoma, Norman.

Wyckoff, D. G., B. J. Carter, W. Dort, Jr., G. R. Brakenridge, L. D. Martin, J. L. Theler, and L. C. Todd
1990 Northwestern Oklahoma's Burnham Site: Glimpses Beyond Clovis? *Current Research in the Pleistocene* 7:60-63.

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

Yapp, C. J. and S. Epstein
1977 Climatic Implications of D/H Ratios of Meteoric Water over North America (9500-22000 BP) as Inferred from Ancient Wood Cellulose C-H Hydrology. *Earth Planet Science Letters* 34:33-50.

Yarnell, R. A.
1972 *Iva Annua Var Macrocarpa:* Extinct American Cultigen? *American Anthropologist* 74:335-341.
1977 Native Plant Husbandry North of Mexico. In *Origins of Agriculture*, edited by C. A. Reed, pp. 861-878. Mouton Publishers, The Hague, Paris.
1978 Domestication of Sunflower and Sumpweed in Eastern North America. In *The Nature and Status of Ethnobotany,* edited by R. I. Ford, pp. 289- 299. Anthropological Papers 67. Museum of Anthropology, University of Michigan, Ann Arbor.

Yellen, J. E.
1977 *Archaeological Approaches to the Present.* Academic Press, New York.

Young, B. and M. B. Collins

1989 A Cache of Blades with Clovis Affinities from Northeastern Texas. *Current Research in the Pleistocene* 6:26-28.

Young, D. E.

1988 The Double Burial at Horn Shelter: An Osteological Analysis. *Central Texas Archaeologist* 11:11-115.

Yuhas, R. H.

1993 Using TM Data to Detect Global Climate Change. *Eosat Notes* 8 (3/4):7,11.

Zakrzewski, R. J. and J. L. Maxfield.

1971 Occurrence of *Clethrionomys* in the Late Pleistocene of Kansas. *Journal Mammalia* 52:620-621.

Zegura, S.

1985 The Initial Peopling of the Americas: An Overview. In *Out of Asia: Peopling the Americas and the Pacific*, edited by R. Kirk and E. Szathmary, pp. 1-18. The Journal of Pacific History, Canberra.

Ziegler, R. J.

1976 A Cultural Resources Management Plan for Tuttle Creek Lake for the Years 1978-1983. Ms. on file, U.S. Army Corps of Engineers, Omaha.

1981a Excavations at 23JA40. In *Prehistoric Cultural Resources Within the Right- of-Way of the Proposed Little Blue River Channel, Jackson County, Missouri*, assembled by K. L. Brown and R. J. Ziegler. Museum of Anthropology, University of Kansas, Lawrence. Submitted to the U.S. Army Corps of Engineers, Kansas City District.

1981b Sites Tested. In *Prehistoric Cultural Resources within the Right-of-Way of the Proposed Little Blue River Channel, Jackson County, Missouri*, assembled by K. L. Brown and R. J. Ziegler. Museum of Anthropology, University of Kansas, Lawrence. Submitted to the U.S. Army Corps of Engineers, Kansas City District.

Zier, C. J., D. A. Jepson, M. McFaul, and W. Doering

1993 Archaeology and Geomorphology of the Clovis-Age Klein Site Near Kersey, Colorado. *Plains Anthropologist* 38(143):203-209.

Zimmerman, L. J.

1971 *The Glenwood Taxonomic Problem*. Unpublished Master's thesis, Department of Anthropology, University of Iowa, Iowa City.

1976 Archaeological Research in the Glenwood Locality: Changing Perspectives. *Proceedings of the Iowa Academy of Science* 83:121-124.

1977a *Prehistoric Locational Behavior: A Computer Simulation*. Office of the State Archaeologist, University of Iowa, Report 10.

1977b The Glenwood Local Sequence: A Re-examination. *Journal of the Iowa Archeological Society* 24:62-83.

1985 *Peoples of Prehistoric South Dakota*. University of Nebraska Press.

Zimmerman, L. J. and L. E. Bradley

1978 *Test Excavations at the Gavins Point Site, 39YK203, South Dakota*. University of South Dakota Archaeological Laboratory, Contract Completion Study 76.

Zimmerman, L. J., T. Emerson, P. Willey, M. Swegle, J. Gregg, P. Gregg, E. White, C. Smith, T. Haberman, and M. P. Bumsted

1981 The Crow Creek Site (39BF11) Massacre: A Preliminary Report. Ms. on file, U.S. Army Corps of Engineers, Omaha District.

Zimmerman, L. J., J. B. Gregg, and P. S. Gregg

1980 Osteopathology in the Crow Creek Massacre victims. Paper presented at Annual Meeting of the American Association of Physical Anthropologists, Niagara Falls, New York.

Zitt, J. O.

1992 *Prehistoric and Early Historic Subsistence Patterns and Dental Pathology on the Northern Great Plains*. Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Index

accelerator mass spectrometer (AMS) 22, 77, 110
adaptation types
concept of 203–204
historic 142–149
prehistoric 204-220
Ade site 19
Agate Basin complex 65
Agate Bluff site 121
Aker site 111
Albion Boardinghouse site 87, 90, 91
Alibates agatized dolomite 53, 130
Alibates flint 51, 62, 65, 66, 71, 74
Allen site 65–66, 98
amber 46
American Museum of Natural History 56
Anderson site 119, 219
Andrews site 118, 120
Angostura complex 67
Angus site 53
Annie's site 133
antiquarianism 29
Anzick site 46, 51
Apex complex 91
Apple Creek flotation method 104
Apple Valley phase 125
Archaic, see Mesoindian 79
architectural features
Historic 143, 144, 146, 149
Mesoindian 81, 82, 96, 97, 100
Paleoindian 69, 73
Plains Village
123, 125, 126, 127, 129, 130, 133
Protohistoric 134, 135, 137, 139
Woodland 111, 112, 114, 115, 117, 119, 120
Arp site 120
Arpan site 150
Ash Hollow Cave 121
Ash Hollow focus, complex 121
Ash Hollow site 27
Ashland site 134
Aubrey site 47, 209
Avoca site 117, 118

Barton County landfill site 16, 20–21, 27
Beacher's Island battle site 66
beads, mentioned 56, 59, 60, 84, 89, 90,
94, 95, 96, 97, 116, 120, 121, 130, 135, 139
Beisel-Steinle site 16, 20–21, 27
Big Village site 144, 156, 160, 163, 167
Bignell Hill site 8, 16, 21
bioarcheology
data coding of 152
demography 162–166
history of 150–152
sources for 154–156
bison 87, 90, 93, 94, 95, 96, 97, 221
as meat in diets 41, 46, 59–60
bonebed/kill site 31, 56, 60, 61, 62, 63, 65,
66, 69, 70, 71, 72, 73, 74, 84, 86, 207
density 206, 211, 213, 214
dominance 59, 80, 87, 104, 114, 155
in Plains Village times 130
in protohistoric times 137, 139
in Woodland sites 116, 117, 119, 121
products of 52, 214
Black Mountain site 62
Black Ranch site 146
Black Vermillion phase 91
Black Widow Ridge site 150
Blackman, Elmer E. 32
Blackwater Draw site 46, 57
Blue Stone site 134
bone objects, mentioned 44, 46, 49, 58, 58–
59, 89, 90, 97, 98, 113, 114, 116, 119,
120, 121, 126, 130, 131, 138, 139, 207, 219
Bonner Spring site 23, 44
Boundary site 150
Bowlin Bridge site 106
Bowlin phase 106
Budenbender site 130, 131
Buffalo Pasture site 150
Bureau of American Ethnology (BAE) 30
burial sites
characteristics of 153–154
contexts 157
distribution 153–154
in cemeteries 150, 153, 157, 159, 160, 162,
164, 165, 168, 169, 179, 181, 186, 219
in mounds 95, 150, 153, 156, 157, 162,
165, 201, 216, 219
ritual 67, 216
time periods of 157–160
with evidence of warfare 183–184
Burkett site 136, 137, 138
Burnham site 44
Busse site 51–52

Caddoan speakers 138
Calovich Mound site 153, 197, 219
Casper site 66
Cattle Guard site 61, 209
Central Plains tradition 116, 118, 126–
133, 217, 218, 219, 220
charcoal records 9, 10, 19
Charles Abbott farm site 30
Chelsea phase 95, 96
Cherokee Sewer site 84
Cheyenne River site 150, 162
Clary Ranch site 74
clay pipe 135
Claypool site 50, 51, 70
Clinton phase 124
Clovis complex 46–54, 204
Coal Oil Canyon site 115
Cochran Mound site 111
Cody complex 68–69
Coffey site 91, 93–94, 97
Cogan Mounds site 111
Colby site 47
Colvin phase 97
Colvin site 97
Cooper site 115, 208
copper 109, 129, 130, 135, 215
Cordero Mine site 91
Council Grove Lake 94
Cow-Killer site 91, 93, 116
Coyote Canyon site 9
Crow Creek village site 151, 165
Cuesta phase 108, 112–113
cultural resource management (CRM) 39, 39–
40, 78, 106
Curry site 116

Dalton complex 75
DB site 27, 125
Deer Creek phase 119
Deluge Shelter 72, 91, 93
Dent site 46, 49, 50, 54
Denver Museum of Natural History 56
Dhegihan speakers 134, 138
Dinosaur National Monument 72, 91
Dipper Gap site 87, 88, 88–89, 91
Diskau site 53
Dismal River complex 139, 144, 213
Dittmar site 219
dog
in bonebeds 67, 72, 208
in burial mound 95
in burial site 95
in Mesoindian sites 83, 86, 89, 94, 99
in Paleoindian sites 70
in Woodland sites 113
Doniphan site 125, 134
Doyle site 114, 115
Drake site 51, 54
Dreier-Frasca or Frasca site 72
Dry Lake site 98
Dutton site 19, 44, 51

Eckles site 52
Edwards chert 51, 74
"El Cuartelejo" or Kansas Pueblo 31, 139, 213
El Dorado phase 95–97
Elliott site 94
epidemics 166–168
Euro-American trade goods
135, 138, 139, 144, 159
Eustis ash pit sites 8, 14, 16, 20, 27

Fanning site 125, 134
Faulconer site 96
Fenn cache 46, 51
Feye site 120
Fincher site 146
First Americans 43, 204, 205
Flattop chalcedony 53, 61, 62, 65, 66,
72, 74, 89
Flint Hills chert 53, 92
Florence chert
see Flint Hills chert 93
Folsom complex 55–62
technological system 57–59
Folsom site 31, 56
Fort Atkinson 145
Fort Hood military installation 26
Fort Leavenworth military reservation 146

Fort Riley military reservation 10, 17, 21
Fort Scott 145
Fort Zarah Road site 145
Four Bear site 150, 162, 163
Fowke, Gerard 32
Fowler-Parrish site 61
Frazier site 65
Frederick/Allen complex 72–73
Frontier complex 98

Garcia site 156
Gavins Point site 133
Geiger site 94
Gering site 98
Glen Elder site 134
Gordon Creek site 67, 208
Goshen complex 54–55
radiocarbon dates 55
Graham site 130, 220
Grasshopper Falls phase 117–118, 215
Gray (Schuyler-Gray) site 138
Green Plum site 134
Greenwood phase 93, 116–117
Griffing site 130, 218
Grover Hand site 150

Hackberry Lake site 26
Hanson site 209
Harahey (land of Pawnee) 31
Hell Gap complex 66–67
Hell Gap site 54–55, 66, 207
Hertha phase 119
Hill, Asa T. 32
Hill site 32, 84
Hiscock cache 53
Holbert Bridge Mound 94
Hollenberg Pony Express Station 145
Holocene 22–28
climate 27–28
fauna 221
soil formation 22–25
vegetation 25–27
Hopewell Interaction Sphere 109
Horner site 68
horticulture vs. agriculture 104–106, 122
Hudson-Meng site 19, 68, 70
Hulme site 218
Hungry Whistler site 86
hunting technology 59, 77–78, 99
Huse corncrib site 147
Hutton-Pinkham site 87, 88, 90
Hyde site 94

Indian Burial Pit site 153
Indian School site 151
Indian tribes
Apache 139, 213
Arikara 136, 137, 138, 150-169 passim, 177, 183, 187, 189-198 passim, 219
Assiniboine 167
Blackfeet 167
Caddoan 219
Cheyenne 161
Cree 208
Hidatsa 166, 167
Kansa 125, 134, 135, 144
Kitsai 136
Lipan 139
Llanero Band 139
Mandan 160, 166, 167
Omaha 139, 160
Oto 125, 134
Pawnee 126, 128, 136, 137, 138, 143, 160, 161, 166, 167, 220
Ponca 138–139, 139
Pottawatomie 144
Sac 144
Sioux 138, 161, 161–162, 167, 219
Skidi 138
Wichita 31, 136, 143
Infinity site 112, 113
Inter-Agency Archeological Salvage Program 33, 37
Intermill site 134
ivory objects 46

jasper 51, 52, 53, 61, 62, 65, 66, 67, 70, 72, 74, 130, 135
Jim Chase site 61
Jim Pitts site 55
John Redman Lake 95
John Redmond Lake 94
Johnson site 61
Jones-Miller site 66, 208
Jotham Meeker's site 144–145
Jurgens site 71–72

Kampschroeder site 119
Kansas City Hopewell complex 108–111
Keen site 125
Keith focus/variant 115–116
Kelley site 109
Kelso site 121
Kinney Spring site 91
Koehn-Schneider site 53
Kremmling chert 61

La Sena site 44, 221
Lake Theo site 60
Lamb Spring site 44, 72
Lange-Ferguson site 53
Lansing site 32
Larson site 150, 150–151, 163, 168
Last Glacial Maximum 10, 15, 16, 18, 19, 48
Late Paleoindian complex 63–79
Lawson site 120
Leary site 134, 220
Leavenworth site 150, 163, 167
Leavitt site 163
Lehn Farm site 128
Lewis and Clark expedition 29, 30
Lightning Spring site 91
Lime Creek site 63, 70–71
Lincoln Pottery Works site 149
Lindenmeier site 57, 60–61, 207
Linger site 61
Linwood site 162
LoDaisKa Rockshelter 87, 91, 121
LoDaiska Rockshelter 88
Logan Creek complex 83, 84–86
Logan Creek site 84
Lone Wolf Creek site 31
Long's Hill site 32
Loseke Creek variant 120
Lovewell site 52
Lower Loup complex 136
Lungren site 84

MAD site 114
Magic Mountain complex 87
Magic Mountain site 87, 91
Mahaffie Farmstead site 145
maize 101-139 passim, 213, 219
mammoth 19, 46, 48, 49, 50, 52, 53, 54, 55, 59, 60, 64, 76, 206, 207
Mammoth Meadows site 69
Manhattan Airport site 17, 27
Martin Farmstead site 147
Marvin Colson site 128
Massacre Canyon site 114, 115
Matter Mound 95
May Brook phase 124
McEndree Ranch site 211
McKean complex 81, 87–91
McKean site 87
McLemore site 162
McPherson site 106, 110
Medicine Lake site 12
Meserve complex 74–75
Meserve site 31
Midland complex 62–63
Midwestern Taxonomic System 33, 126, 138
Milankovitch radiation curves 48
Mill Iron site 46, 55
Miller site 110
Mine Creek site 146
Minneapolis site 130, 219
Missouri River Basin project 37
Mobridge site 150, 162, 168, 168–169
Monte Verde site, Chile 41
Mount Albion Complex 86
Mountain complex 90
Mowry Bluff site 128, 129
Mugler site 220
Mummy Cave 88
Munkers Creek knives 211
Munkers Creek phase 91–94
Murray Springs site 47, 209

Nanza Fort site 138
Native American Graves Protection and Repatriation Act (NAGPRA) 219
Nebo Hill complex 97, 211
Nebo Hill phase 94, 97
Nebo Hill site 97
Nebraska Loess Man 156
Nebraska phase 126–128, 220
Nebraska State Museum 36
New Chelsea site 149
Nolan site 62
North Cove site 11, 44
North Park, Colorado site 87
Norton site 73–74

Old Marmaton town site 148
Olsen-Chubbuck site 69, 71
Oneota complex 134, 220
Ottawa Baptist Mission 144

Pack Rat Rockshelter 91
Paint Creek village site 31
Paleoamericans 153, 154
Paleolithic finds 30
pathologies
  alveolar abscessing 196–197
  craniosynostosis 174
  cribra orbitalia 173–174
  dental caries 192–194
  dislocations 181
  enamel hypoplasia 191–192
  enthesophytes 180–181
  fracture 177–180
  Harris lines 189–191
  macrocephaly 174
  malnutrition 187–188
  mastoiditis 171
  osteomyelitis 171
  periodontal diseases 200–201
  periostitis 171
  porotic hyperostosis 173–174
  spina bifida 175–177
  spondylolysis 181–183
  treponematosis 169
  tuberculosis 168–169
Patterson site 118
pemmican 87, 100
Phillips Springs site 94
Phoebe Rockshelter 91
Pickerel Lake site 12
Pike Pawnee Village site 156, 167
pipestone pipes 135
Plainview complex 63
Plano, see Late Paleoindian complex
Pleistocene/Holocene transition 18–28, 206
  climate 21–22
  fauna 221
  soil formation 18–19
  vegetation 20
pollen records 9, 12, 12–13, 20, 21, 25–26
Pomona variant 123–124
pottery
  Ash Hollow Cord-Roughened 120
  Beckman 128
  Black Sand-Incised 106
  Burkett 137
  Cambridge 129
  Colfax 137
  Crockett Curvilinear Incised 220
  Cuesta Decorated 113
  Cuesta Plain 113
  Evans 138
  Feye Cord Impressed 120
  Frontier 129
  Grasshopper Falls 117
  Greenwood 116
  Harlan Cord-Roughened 116, 120
  Havana 113
  Mackay 138
  McVey 128
  Missouri Bluffs Cord Impressed 120
  Montgomery cord-roughened 113
  Nance Flared Plain 137
  Naples Stamped 113
  Nebraska 125
  Neteler Stamped 113
  Ocate Micaceous 139, 213
  Platte Valley Plain 125
  Pomona 123
  Riley Cord-roughened 126, 131
  Smoky Hill 131
  Spring Hollow-Incised 106
  Stanley Braced Rim 138
  Steed-Kisker Incised 125
  Sterns Creek Plain 120
  Sterns Creek Tool-Impressed 120
  Swaboda 128
  Tewa Red-on-Buff 139, 213
  Valley Cord Roughened 120
  Verdigris 116
  Walnut Decorated Lip 135
  Webster 137
  Wright 137
Powars site 61
Prairie Dog Bay site 11
processual archeology 37, 37–38, 38
projectile points
  Agate Basin 65
  Alberta 68
  Angostura 67
  Apex 91
  Dalton 75
  Dickson 109
  Duncan 91
  Duncan-Hanna 90
  Dustin 95, 97
  Eden 68
  Ensor 113
  Firstview 68
  Folsom 59, 62
  Frederick 67, 73, 74
  Gary 109
  Goshen 55
  Hanna 87, 91
  Kersey 68
  Lamoka 95
  Mallory 87, 90, 91
  Mason Contracting Stem 106
  McKean 87, 90, 91
  Meserve 74, 75
  Midland 62
  Motley 95
  Mt. Albion 86
  Munkers Creek knives 92, 93
  Pinto 87
  Plainview 46, 55, 65
  Pryor Stemmed 74
  San Jon 68
  San Rafael Side-Notched 87
  Scallorn 110, 113, 119
  Scottbluff 68, 90
  Sedalia Lanceolate 94, 95
  Snyders 109, 113, 114
  Steuben 109
  Table Rock 95, 97
  Walnut Valley 97

Quarry Creek site 110, 112
Quindaro town site 147–148
Quivira (land of Wichita) 31

Rainbow site 108, 114
Rainy site 135
Rancholabrean fauna 205, 206, 221
Range Mound site 95
Ray Long site 67
Reagan site 44
Red Fox site 91
red ochre 46, 47, 51, 52, 56, 60, 62, 67, 69, 83, 84, 86, 94, 208
Red Smoke site 63, 64
Red Willow site 44
Redbird "focus" 138–139
Reddin site 61
Reichart site 117
Renner site 110, 111
Richland site 119
Riggs house site 148
rituals 208, 216
  Agate Basin complex 67
  Folsom complex 60
  Mesoindian period 100
River Basin Surveys (RBS) 150–151
Rock Creek Station 145
Rodgers Shelter 94
Rosebud site 12
Ruben site 135

Sailor-Helton cache 53
Sargent site 26
Saunders site 219
scanning electron microscope (SEM) 199
Scharbaurer site 62
Schultz site 114
Schuyler-Gray site 137
Scoggin site 90, 91
Scott County Pueblo 143
Scottsbluff site 69
Sedalia Diggers 94
Sedalia phase 94
Selby site 19, 44, 51
Seminoe Beach site 66
settlement pattern
  Gatherer-Hunter-Trader 213
  Hunter-Gatherer-Forager 211
  Incipient Horticulturists 215
  Specialized Hunters 207–208
  Village Horticulturists 218
Shadow Glen site 123
Shawnee Mill site 149
Sheaman site 46, 52
Shifting Sands site, Texas 60
Signal Butte site 37, 87, 88, 89, 90
silver ornaments 160
Simon site 46
Simonsen site 84

Siouan speakers 135
Smithsonian Institution 32, 143
Smoky Hill phase 130–131
Snyder site 95, 96–97, 106, 154
South Platte phase 120–121
Southeastern Ceremonial Complex 130, 219
Southeastern Ceremonial complex 128, 220
Spillway site 135
Spring Creek site 84–86
Spring Gulch site 90, 91
St. Helena complex 132–133
Stanton site 134
steamboats 145, 167
Steed-Kisker complex/phase 125
Steed-Kisker phase 125
Steed-Kisker site 125, 219
Sterns Creek complex 119–120
Sterns, Frederick 32
Stigenwalt complex 98
Stigenwalt site 98
Stiles site 116
stone circles 61, 88
Strong, Duncan 36, 37
Sugar Creek site 219
Sully site 150, 167
Sumner Hill site 21, 27
Sungir site, Ukraine 60
Sunrise Mine site 47
Swan Creek site 150, 167, 198, 199
Sweetwater site 128
Swift Bird site 150, 169

Taylor Mound site 114
The Crying Woman site 61
Tim Adrian site 67
tobacco 108
Tobias site 143
Topeka cemetery site 147
Traff site 106, 107
tree ring data 27
Trowbridge site 109, 110, 111
Turin site 84
12 Mile Creek site 31, 32, 62
Two Deer site 118
Two Dog site 116

Upper Republican variant 128
Upper Twin Mountain site 55

Vaccination Act of 1832 166, 167
Valley focus/variant 108, 114
Vohs site 115

Wakarusa phase 119
Walker-Gilmore site 32, 120
Wallace site 114
Walnut phase 96, 97
Warne site 134
Wedel, Waldo 36, 143
West Island site 115
Whalen site 115
White Cat Village site 139
White Rock complex 134–136
White Rock site 134–135
Whiteford cemetery site 219
Wilber Thomas Rockshelter 72, 87, 88, 90
Wiley site 219
William Sherwood site 119
William Young site 91, 92, 92–93, 94, 95
Williamson site 95
Wisconsinan Stage 6–18
  climate 17–18
  soil formation 8–11
  vegetation 12–16
Witt site 131, 220
Wolf Creek phase 124
Woodruff site 115
Works Progress Administration (WPA) 32, 133, 144

Yeo site 110
Young site 110, 111, 115

Zacharias site 125, 126
Zapata site 61
zinc deficiency 177