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THE CROW CREEK SITE (39BF11) MASSACRE: A PRELIMINARY REPORT,(U)
FEB 81 L J ZIMMERMAN, T EMERSON, P WILLEY DACW45-78-C-0018

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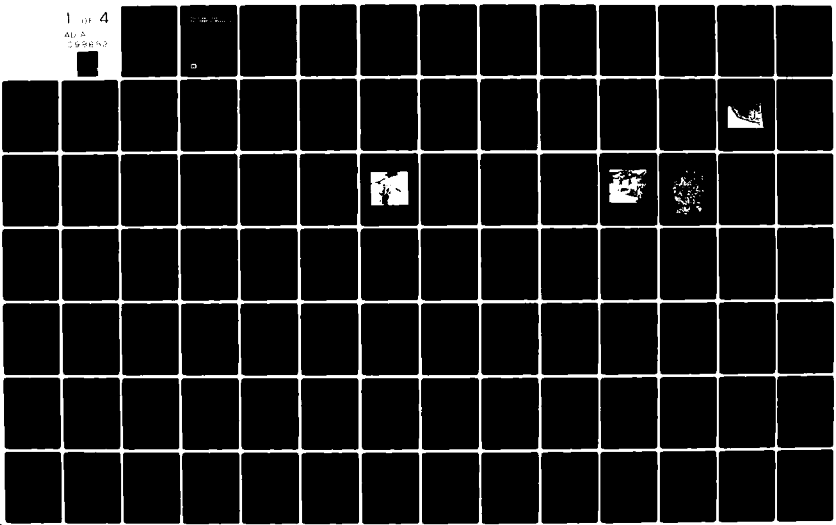

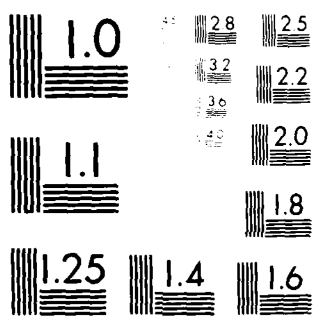

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THE CROW CREEK SITE (39BF11) MASSACRE: A Preliminary Report

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The University of South Dakota Archaeology Laboratory

Feb~~ruary,~~ 1981

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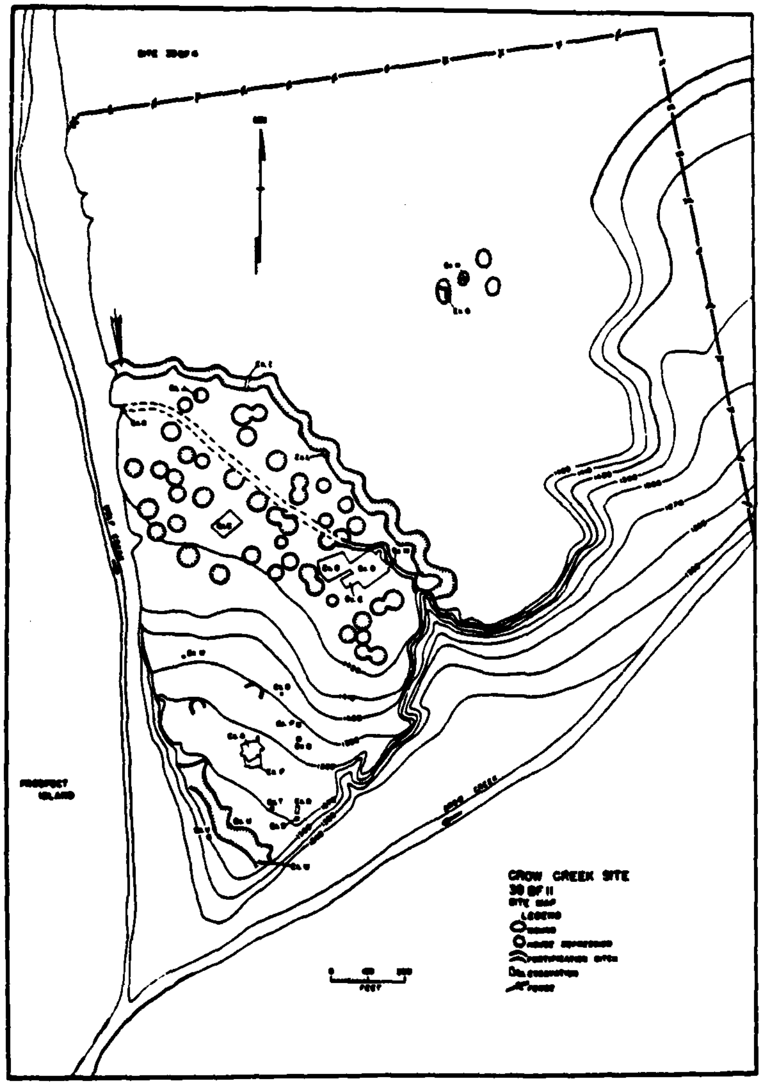
A PRELIMINARY REPORT

The Crow Creek Site (39BF11) Massacre



DACW45-78-C-0018

US Army Corps of Engineers
Omaha District

ABSTRACT

During the Summer of 1978 the skeletons of at least 486 individuals were excavated from the badly eroded and looted end of the fortification ditch of the Crow Creek site (39BF11) in Central South Dakota. The skeletal material was analyzed during the following year. This report documents the excavation and analysis of materials recovered. The site was occupied during the Initial Coalescent variant of the Coalescent tradition from the 14th Century A.D. The skeletons recovered showed evidence that the individuals had died in warfare; many showed evidence of mutilation. This document contains sections dealing with excavation, various aspects of demography, mutilation, pathology and recommendations for the site.

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THE CROW CREEK MASSACRE SITE: AN INTRODUCTION

The annual meeting of the South Dakota Archaeological Society was held in Chamberlain, South Dakota, over the Memorial Day weekend of 1978. A tour of major archeological sites in the area was arranged so that society members could gain an appreciation for the impressive prehistory of the Missouri River valley in South Dakota. The tour group stopped at the Crow Creek site (39BF11) in Buffalo County about ten miles north of Chamberlain. The site, a fortified village of the Initial Coalescent variant, provided considerable discussion for the tour participants, especially because the site, a National Historic Landmark, was (and is) facing severe problems from erosion. A staff member of the South Dakota Archaeological Research Center left the group to inspect the ends of the fortification ditch and the area between them to determine the effects of erosional damage. At the Wolf Creek end of the ditch, he noticed bone eroding from a cut bank a meter or so from the surface. Closer inspection confirmed that the bone was human.

South Dakota State Archaeologist Robert Alex notified the Corps of Engineers-Omaha District, and they acted to protect the area where erosion had exposed the bones. A University of South Dakota Archaeology Laboratory (USDAL) survey crew was in the area and was contacted to remove the skeletal remains so that the bank could be stabilized. Because the site is a National Landmark, a determination of the impact of excavation on the site had to be made and proper clearance for the excavation had to be given. The land is near Ft.

Thompson on the Crow Creek Sioux Reservation and the tribal council was notified of the impending action so that they could have input to matters of excavation and ultimate reburial of the remains. At the time, when all parties were notified and had given their consent to the operation, the number of skeletons in the ground was assumed to be small and the excavation a simple one. No one realized the true nature of the site until an act of vandalism exposed a macabre chapter in Plains prehistory.

During the time that necessary administrative procedures were being carried out so that excavation and stabilization of the site could proceed, a vandal noticed the exposed bones and damaged part of the site; using a pick-mattock in the area of the exposed bones. Whether bones or artifacts were being sought was not clear, but the result was a gaping hole in the vertical face of the site with fragmented human remains scattered down the slope.

Physical anthropologist P. Willey was on the site shortly after the looting occurred. Willey and the archeologists gathered the fragmented bone and returned to The University of South Dakota where the bones were washed and sorted. The important nature of the skeletal material soon became apparent.

Minimum element counts indicated that over 40 individuals were represented in the material from the relatively small looter's hole. In addition, many of the skull fragments suggested marks left by scalping and examination of some forearm bones showed that hands had been cut off. The victims had evidently met death by massacre and had been subsequently mutilated. The looter's hole showed that skeletal materials remained in the hole, but the extent of the remains was unknown.

The act of vandalism had seriously undercut the bank so that slumpage was inevitable. Arrangements were made to excavate the remaining materials so that the bank could be stabilized. For the sake of excavator safety, the bank was to be stepped back. As this activity was begun, the true nature of the massacre unfolded; several hundred individuals had been killed and their bodies thrown into the bottom of the fortification ditch surrounding the site. While the excavation was in progress, the site received international attention and was embroiled in controversy over the excavation and ultimate disposition of the remains.

The excavation lasted until cold weather forced a halt to operations in early December. Skeletal materials were sent to the USDAL in Vermillion and were washed. Preliminary analysis began in November and full scale analyses were begun in January. Analyses continued until the last possible minute on May 31, 1979, when the remains were returned to the reservation where they await reburial.

This report documents the excavation, the analysis and interpretation of the cultural remains and skeletal material, and the preliminary interpretations of the massacre site. The principal investigator for the project was Larry Zimmerman; Thomas Emerson acted as field supervisor. Zimmerman and Emerson wrote the majority of the archeological portions of the report. Carlyle S. Smith prepared the analysis of the ceramics and Everett White wrote the section on geomorphology and soils. Thomas Haberman analyzed all floral remains for the excavation. P. Willey and Mark Swegle analyzed the skeletal materials and prepared sections on demography and related items. John Gregg and Pauline Gregg analyzed the remains for pathologies and wrote that segment of the report. M. Pamela Bumsted prepared the section on collagen analysis.

This report must be considered preliminary. Data were gathered that will take years to analyze (a list of available data is included as Appendix A). Hypotheses have been offered in this report which must be considered very speculative and await corroboration from further study. Qualified investigators are urged to examine the information presented here and to offer criticisms and suggestions. The raw data generated by the project can also be made available by contacting either the principal investigator or the Corps of Engineers-Omaha District.

ACKNOWLEDGEMENTS

The excavations at the Crow Creek site proved to be an incredible experience for everyone involved; many people were involved in the excavations and deserve the authors' gratitude for their contributions. Audhild Schanche supervised the excavations and Ned Hanenberger acted as her crew chief. The crew varied from day to day and worked admirably under frequently miserable conditions. The crew members were: Roberta Neirison, Barb Lass, LeRoy Thompson, Roger Williams, Sid Eare, Pat Big Eagle, Dorsey Deloria, Dayton Bard, Tom Wolf,

Jim Sartain, Richard Whitten, Audrey Blackbull, and Ann Borel. A special note of thanks should go to the Crow Creek Sioux Tribe. Tribal council members Robert Philbrick, Duane Big Eagle and Ron Kirkie did much to facilitate excavations. Other members of the tribe visited the excavations, often provided the crew with welcome nourishment and drink and made the stay in the area a generally pleasant and friendly experience.

Analysis of the remains of nearly 500 people also proved to be incredible, extremely complex, and often frustrating. So many data were generated that years will be needed for complete analysis and interpretation. Many people and agencies were contributors to the project. The Eastman Kodak Company, through its Eastern South Dakota Representative, Dale Strimple, generously contributed X-ray film and special bone X-ray cassettes sufficient to complete the studies which added to the diagnostic acumen. The Grant Review Committee and the Administration of The University of South Dakota School of Medicine provided financial support which greatly assisted in the making and processing of X-rays. The USD Dental Hygiene Program also allowed the use of their equipment for dental X-rays. Helen Ferwerda and James Steele were invaluable in their assistance and advice regarding X-rays of skeletons. The USD School of Medicine and the South Dakota State Health Department generously tolerated the activities of the Visiting Professor (John Gregg) while the project was ongoing. Lent Johnson and his associates at the Armed Forces Institute of Pathology graciously analyzed and interpreted specimens submitted to them. Marvin J. Allison

conducted serological analysis of specimens suspected of treponematosis and offered advice in preparation of the manuscript. William Bass generously helped and advised in this and other projects to determine the pathology of the ancient Dakotas. Bass also encouraged the work on the materials and allowed P. Willey leave to conduct the osteological studies. Richard L. Jantz and Douglas Owsley contributed comparative data and statistical advice and direction. Robert Alex offered important assistance in making arrangements for the excavation. Steve Ruple coordinated various aspects of the operation and flew staff to meetings and on aerial photography runs. The secretarial staffs of the School of Medicine and the Anthropology Program of The University of South Dakota and the Anthropology Department of the University of Tennessee typed the manuscripts and generally assisted in manuscript preparation. Sally Wheelock typed the draft report and Gail Erickson the final copy. Lucille Stewart provided extraordinary editorial assistance to the project. The authors would also like to thank the individuals who reviewed the draft report. They provided valuable criticism and advice. It is hoped their comments or concerns have been adequately addressed in this final copy. The students in the Anthropology Program at USD displayed a great deal of interest in the project and many volunteered hours of time in cleaning, sorting, and cataloging material from the excavation. Students in Anthropology 491 (Human Osteology) helped restore the skeletons for analysis. They were: Donna Jaffer, Paul Jones, Kristy McGowen, Max Schmeling and Bruce Setlock. Other students in Lawrence Bradley's computer applications class helped organize the collected data into a more useable format. They were: Paula Mallon, John Hoffman, Max Schmeling, Bill Nelson, Gregg Arnold and Julie Sieh. Sieh also did preliminary analysis of teeth. Steve Symes, a USD graduate now at the University of Tennessee, did many of the mutilation tables. Jeff Buechler acted as lab supervisor and kept the lab operating smoothly; Roger Williams was his assistant. Literally hundreds of other individuals cooperated or worked on aspects of the excavation and analysis and, even though unnamed, also have the authors' deep appreciation. Primary funding for this project came from the Corps of Engineers, The University of South Dakota, and the University of Massachusetts-Amherst Biomedical Research Grant, #6-32502.

ARCHEOLOGICAL BACKGROUND

Archeological investigations at the Crow Creek site originated as part of a large scale program to gather data from archeological sites prior to their submergence or destruction by the impounded waters of the Missouri River behind Fort Randall Dam. This salvage excavation was a joint project between the United States National Park Service and the Nebraska State Historical Society. The work was conducted by the Society during the summer seasons of 1954 and 1955 under the supervision of Marvin F. Kivett, then Museum Director of the Nebraska State Historical Society. A report of the archeological investigations at the Crow Creek site by Marvin F. Kivett and Richard E. Jensen was published in 1976. The following summary of the procedure and findings at the Crow Creek site is based upon their report.

The multi-component Crow Creek site is located on the east bank of Francis Case Reservoir, 10.5 miles north of Chamberlain, South Dakota. The site is on the first and second terraces above the former confluence of Crow and Wolf (Elm) Creeks. Crow Creek is a perennial stream some 50 miles in length, while the latter is a shorter, seasonal stream. These two drainages used to join on the Missouri flood plain just south of the site prior to the rise of the Ft. Randall Reservoir flood pool.

The topography in the vicinity of the Crow Creek site varies from the flat, low flood plain (now submerged) of the Missouri River to steeply inclined and erosionally scarred river bluffs which rise up to meet the gently rolling prairie.

The site covers a triangular area of nearly 18 acres (FIG. 1; Plate 1). The western base is formed by a terrace edge which drops almost vertically into the reservoir basin. The southeastern border is another terrace edge that slopes steeply into the narrow and often times inundated Crow Creek flood plain. The northeastern limit is defined by a deep fortification ditch depression 1,250 feet long which links these two terrace edges. The majority of the site is situated on Federal land with the exception of the eastern-most area which is privately owned by Mr. Robert Philbrick.

The 1954 excavations by the Nebraska State Historical Society were confined to the deeply buried Crow Creek component on the lower terrace. The 1955 excavations extended to the upper terrace where some 50 house pits and two fortification ditches were visible. Limited excavations permitted the identification of the principal occupation as the Wolf Creek component. (Kivett and Jensen 1976).

The Crow Creek and Wolf Creek occupations are prehistoric. The Crow Creek component belongs to the Initial Middle Missouri variant and the Wolf Creek component to the Initial Coalescent variant as defined by Lehmer (1971). The Crow Creek component has been dated in the 12th Century A.D., the Wolf Creek component in the latter part of the 15th Century A.D. Later occupations in the immediate area are also known. Both Lewis and Clark (Thwaites 1904:165), and later Culbertson (1952), mention the tendency of the Sioux to camp there frequently. Culbertson also reported the presence of the Yankton Trading House apparently situated on the north side of Crow Creek in

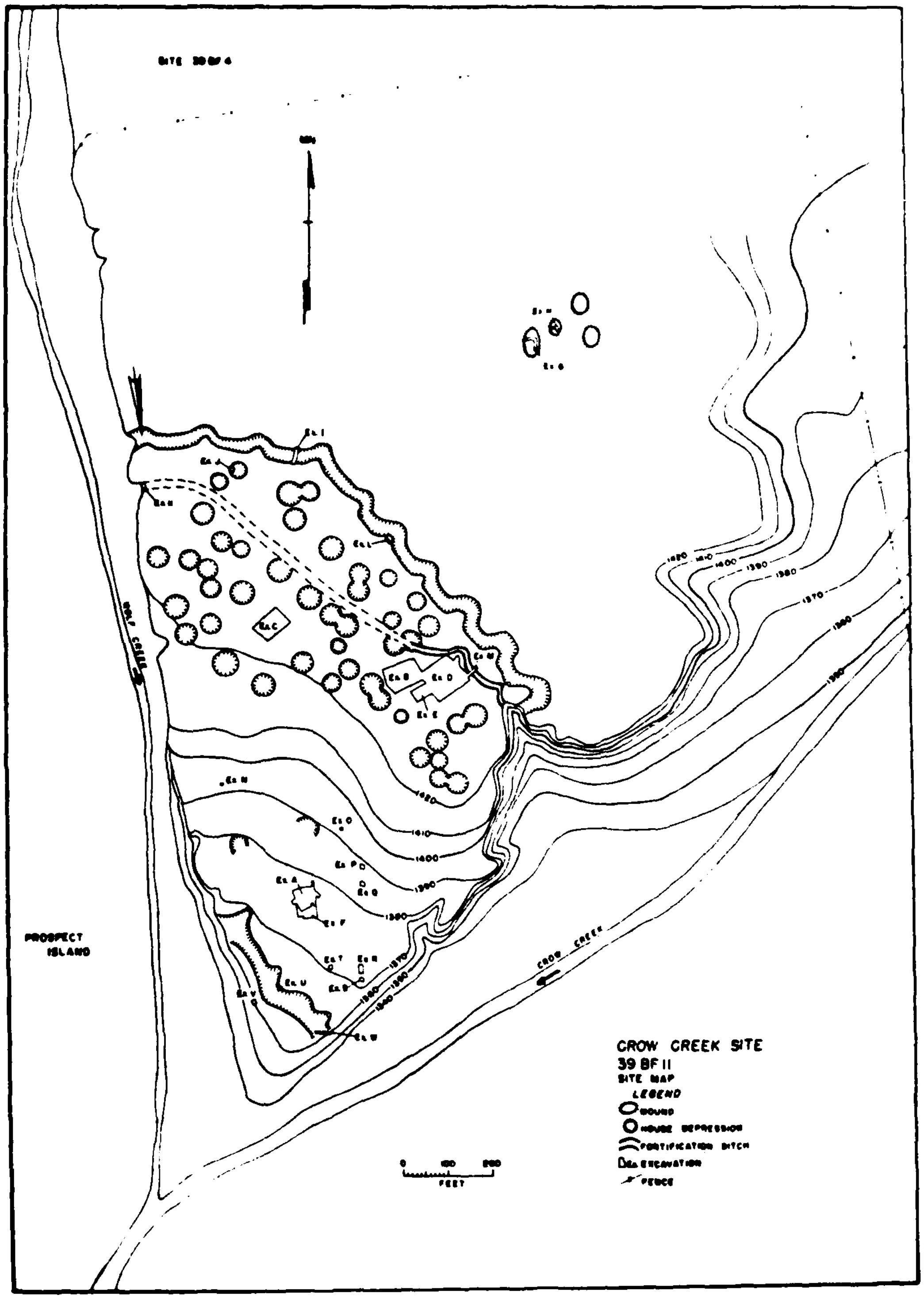
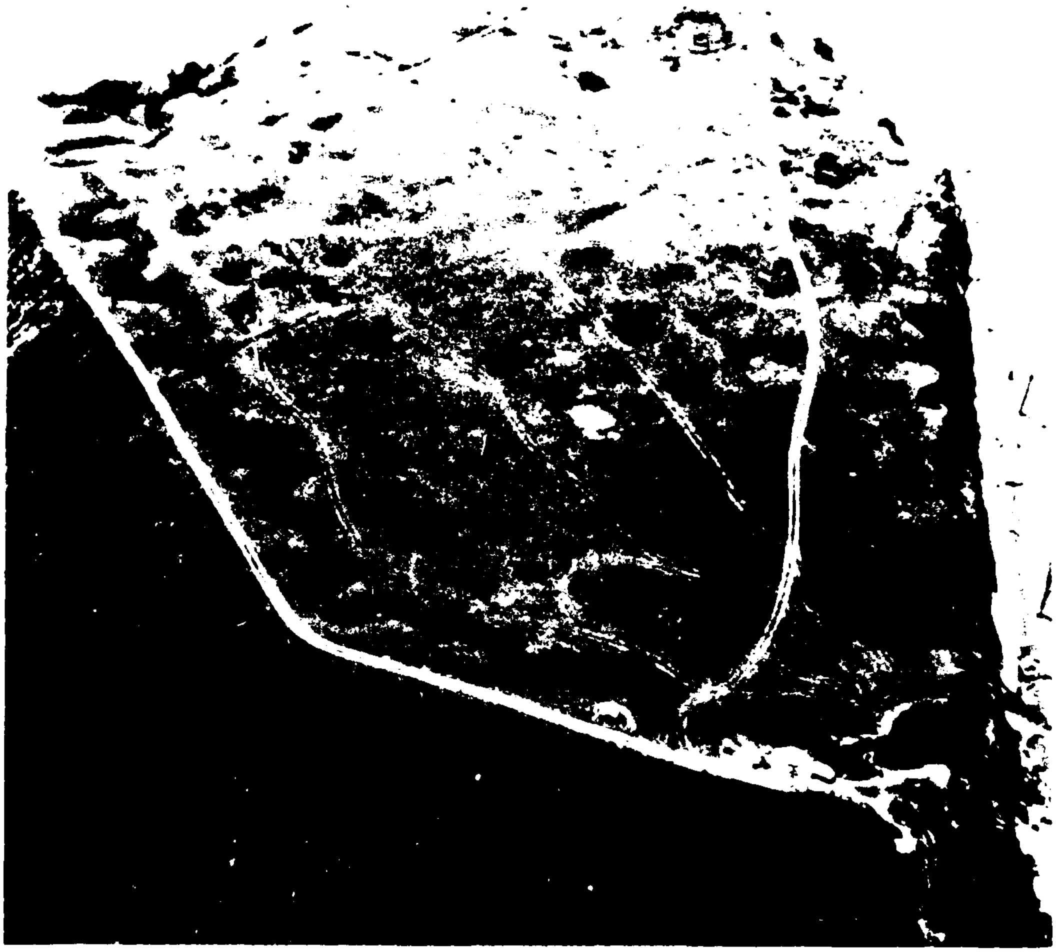


FIGURE 1. Plan of the Crow Creek Site (39BF11), Buffalo County, South Dakota. Arrow points to area of 1978 excavations. (After Figure 1, Kivett and Jensen 1976)



1850. Kivett and Jensen(1976) did recover historic material in a test of the western end of an inner fortification ditch. The upper two feet of fill contained tin cans, fragments of barbed wire, and glass sherds which may date from the 1860 to 1880 period. This material may be refuse left by the Winnebago who, according to local tradition, occupied portions of the site during that period. The more recent utilization by fisherman and looters is amply demonstrated by the profusion of beverage containers which litter the beach.

Excavations and surface features of the Wolf Creek component indicated a settlement of at least 50 dwellings clustered within a heavily fortified perimeter. The exposure of Houses I, III, IV and V revealed nearly square structures with rounded corners. Such square houses with rounded corners were indicative of the Central Plains tradition(Lehmer 1971:107). House II was atypical and the only reported counterpart is House 10 at Talking Crow site (Smith 1977: 31).

A large number of post molds were reported in the Wolf Creek houses. These were assumed to be a result of rebuilding and/or interior partitions and furniture. An abundance of post molds within houses was common to the Middle Missouri tradition but uncommon in Central Plains tradition houses (Lehmer 1971:108). The houses were built in shallow pits 12 to 24 inches deep. All the Wolf Creek component houses had exterior entrance passageways opening toward the southwest, central hearths and interior storage pits.

The Wolf Creek component village had an excellent location for defensive purposes. The view of the river valley and a majority of the surrounding uplands was unobstructed. The terrace cliffs of the Wolf and Crow Creeks prevented easy access to the village from the west and south. Fortification systems were built around the northern and eastern extremities of the village - the areas which provided the easiest access to an enemy - and enhanced the natural defenses. The depression of the outer ditch is still clearly visible and links the two terrace cliffs in a sinuous path created by the presence of 10 bastions. Test excavations in the outer ditch found a low density of material which may indicate a relocation of the Wolf Creek inhabitants shortly after construction. Excavation I failed to unearth any remnants of a palisade.

The less apparent uncompleted inner ditch was filled with refuse diagnostic of the Wolf Creek component. The construction of this fortification ditch had apparently begun during the earliest part of the Wolf Creek occupation and it was later used as a refuse dump. Bastions and a palisade were associated with the inner ditch. The 12 house depressions lying between the inner and outer fortification ditches indicate that one possible reason for the abandonment of the construction of the inner ditch and later construction of the outer ditch was expansion of the village. The danger of enemy attack may not have been imminent during the first part of the occupation but may have been a later threat so the outer ditch was then constructed.

The artifact assemblages, settlement patterns, and permanent dwellings of the two components are typical of the Plains Village pattern. This adaptation is presumed to be a hybrid resulting from the diffusion of the Northwestern Plains hunting tribes' adaptation with that of the Eastern Woodland people (Lehmer 1971:65). The subsistence pattern is based on hunting and horticulture. Stone projectile points, scrapers, stone blades, shaft smoothers, bone awls, needles, shaft wrenches, and hide tanners attest to the importance of hunting to the people of both occupations. More direct evidence is the common occurrence of bison bones and other faunal remains. Scapula knives, hoes, and diggers and the remnants of corn and squash seeds indicate a subsistence based on domestic plants. Some reliance upon gathering is also suggested by the presence of mussel shells and seeds of wild berries.

Approximately 30,000 pottery sherds, including over 4,500 rimsherds, were unearthed at Crow Creek during the two field seasons. Despite the estimated 300 years that separated the two occupations, the temper, color, and texture of the entire pottery collection were highly homogenous. Similarly, the variance in surface finishes of the bodysherds was represented in both occupations.

The superimposition of the Wolf Creek House I over the earlier component House VI, caused a mixture of ceramics. However, when surface finishes, rim forms, and rim decorative techniques were taken into account,differences between the two occupations do appear. Comparisons with pottery types already established for the Middle Missouri Valley demonstrate this.

Bodysherds from the Wolf and Crow Creek occupations exhibited examples of cord roughened, smooth, and simple stamped finishes. The simple stamped finish is a trait presumed to be initiated in the Extended Middle Missouri culture, contemporary with the Wolf Creek occupation but absent in Central Plains pottery. Cord roughening occurs in the Central Plains tradition, Middle Missouri tradition and the Initial Coalescent variant, as exemplified by the Wolf Creek component, but is absent in the Extended Coalescent horizon and the Post-contact Coalescent (Lehmer 1971). The smooth or plain finish is present in the Middle Missouri, Central Plains and Coalescent traditions. On the basis of these comparisons of bodysherd finishes, pottery of the Wolf Creek occupation is limited to the bounds of the Middle Missouri tradition and the Initial Coalescent horizon.

Kivett and Jensen(1976:38-42) based their identification of the ceramic types on the previously published work of Hurt (1951) for the Chamberlain, Mitchell, Kimball, Maxon, and Stewart types. The Foreman types were based on the descriptions set forth by Lehmer (1954). The several Campbell Creek types, the Talking Crow Straight Rim type, and the Grey Cloud Horizontal Incised type were identified from Smith's descriptions (1951, 1953). In this monograph, Smith bases his identifications on direct comparisons with the collection from the Talking Crow site (Smith 1977). Kivett and Jensen offered generalized descriptions of rims which did not fit the previously established types. With the elimination of mixed situations, types established by Hurt are limited to the Crow Creek component which belongs to the Initial Middle Missouri variant as defined by Lehmer (1971). The Wolf Creek component is characterized by the types defined by Smith for the Campbell Creek phase of the Initial Coalescent variant (Smith 1977).

In general, in the Plains Village tradition, non-ceramic artifacts are seldom diagnostic of specific cultural affiliation. Artifacts of bone, shell, and stone seem to be more generalized in nature and less sensitive to cultural change. A few of these tools seem to be characteristic of one or the other components at the Crow Creek site. For instance, lozenge-shaped beveled edge knives and catlinite pipes seem restricted to the Wolf Creek occupation. Lehmer (1971:114) has suggested that these items are derived from the Central Plains tradition. Grooved mauls and plate chalcedony knives are common in the Wolf Creek component and are typical of the later Middle Missouri and Coalescent variants. Busycon shell occurs only in the Crow Creek component, which may indicate closer affiliation with the Mississippi Valley cultures.

By A.D. 1400 the people responsible for the Initial Coalescent variant had entered the southern part of the Middle Missouri subarea and had begun settling in the Big Bend region. Lehmer (1971: 125) has postulated that there were two Middle Missouri village groups in the area north of the Initial Coalescent intrusion. The Modified Initial Middle Missouri villages were situated in the Big Bend and lower Bad-Cheyenne regions along with the fortified southern villages of the Extended Middle Missouri variant. The existence of modified Initial Middle Missouri has recently been seriously questioned by Johnson (1979). These groups were perhaps in conflict with the Wolf Creek people.

THE 1978 EXCAVATIONS AT THE CROW CREEK SITE

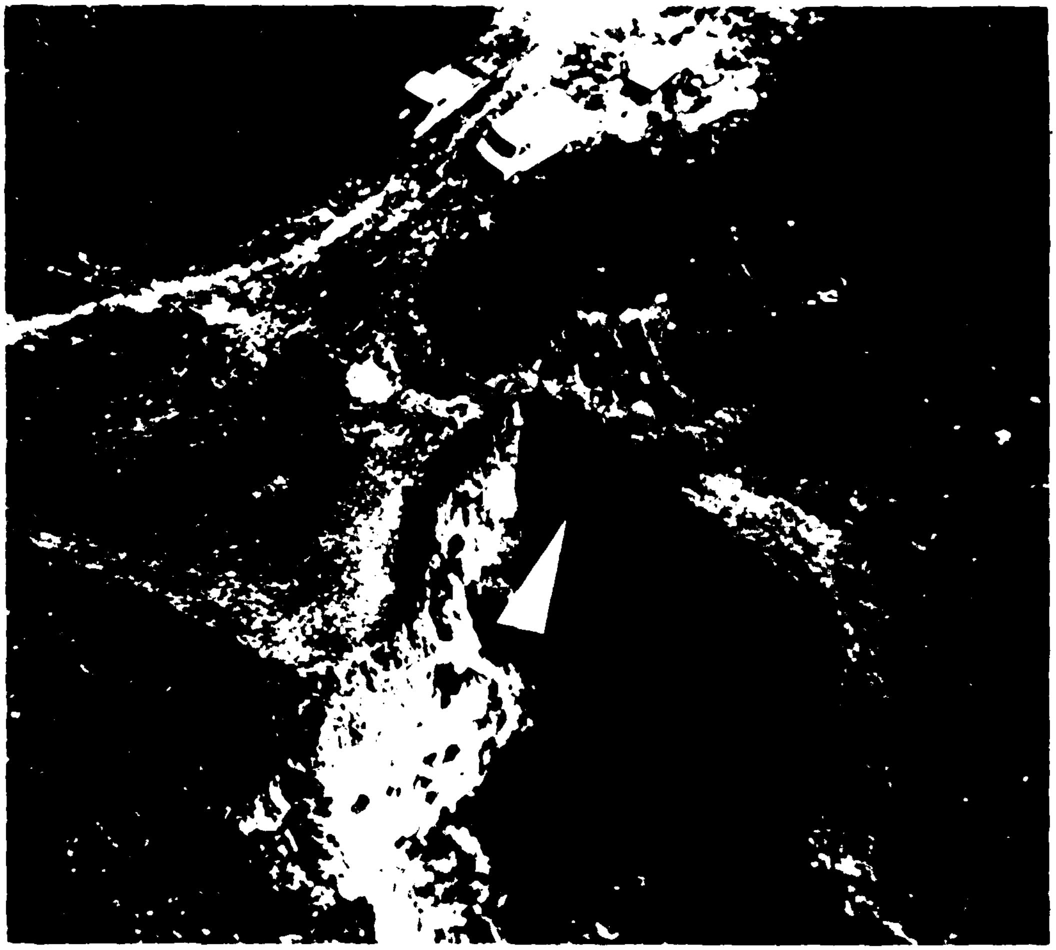
Excavations began in early August of 1978 and continued into the beginning of December when freezing conditions brought them to a halt. During this period, the remains of about 500 individuals were removed from the outer fortification ditch for examination and analysis at The University of South Dakota Archaeology Laboratory. The excavation procedures and the site stratigraphy will be discussed in this section.

EXCAVATION PROCEDURES

The skeletal material located in the outer fortification ditch was recognized to be a unique and irreplacable source of data relating to the physical anthropology of early Initial Coalescent human populations in South Dakota. That a clear and concise picture of the cultural context be provided by the excavation was considered to be critical, but other factors also had to be taken into account in planning excavation strategy. One of these was the safety of the excavators. The National Landmark status of the Crow Creek site required that disturbance be kept to a minimum and therefore the excavations needed to be confined to the minimal area required to remove the skeletal material.

The outer fortification ditch was being eroded away by water run-off (Plate 2). The result was a large, deep ravine which eroded its way into the western-most bastion. This erosion originally exposed the skeletal material. The skeletal deposit was located in the face of the bluff about 2.5 meters below the rim; below the de-

PLATE [illegible] [illegible]rial view of t[illegible] [illegible].
'[illegible]ooter' hole is directl[illegible] [illegible] figure in
t[illegible] [illegible]avation.



posit was a steeply sloping drop of 20 meters to a rocky beach. The situation was aggravated by the fact that the cliff was unstable and was constantly slumping off in massive blocks. Access to the bone deposit could only be gained from a small ledge located about a meter below. This ledge could be reached in two ways; by being lowered from above by ropes, or by making a precarious climb of about 20 meters up the slope from below. Despite the isolated position of the bone deposit, vandals had managed to gain access to it before the excavations began. The looters had removed a section of the bank 2 meters across, 1½ meters high, and 1 meter deep. This vandalism not only destroyed valuable information but increased the hazards of excavation by undercutting the already unstable cliff face.

The archeologists opened a long, narrow trench running back from the cliff edge along the fortification ditch depression in order to overcome these conditions. Originally, this trench was to be stepped down along the east end and sides. As the size of the area to be excavated increased, however, the steps were difficult to maintain. In order to obtain a clear profile, the initial phase of the excavation began by cleaning the face of the fortification ditch which had been exposed by the ravine erosion. This was accomplished by hanging a ladder over the cliff face so that one of the crew could smooth the profile wall. When this was completed and the ditch profile became visible, a grid system was placed immediately over the probable position of the buried skeletal deposit.

The grid system was laid out using numerical designations for the east-west coordinates and letter designations for north-south (FIG. 2; Plate 3). One meter squares were the basic units of excavation with all material being collected by quadrants within them. In addition, elevations were taken on all cultural material collected. Concentrations of material and material in direct association with the human bone deposits were plotted. During the later analysis such data on provenience did not materially contribute to an understanding of the situation. In part this was due to the general paucity of material and its undiagnostic nature. In the upper part of the fortification ditch, movement of materials and soil by wind and water made context questionable. A similar situation existed in the lower portion of the ditch where provenience was rendered ambiguous by soil movement.

When the human skeletal deposits were encountered, a slightly different method of recording was used. Bone Bed A, which was a thin scattering of human bone overlying the main deposit (Bone Bed B), was individually piece-plotted (Plate 4). When the massive Bone Bed B was reached, procedures were modified to deal with its much larger quantity. The upper level of Bone Bed B was mapped and photographed square by square. All articulations were given a specific "articulation number" and collected as a unit; unarticulated bone was collected by one-quarter meter square units. The lower level of Bone Bed B was dealt with in a similar manner; except it

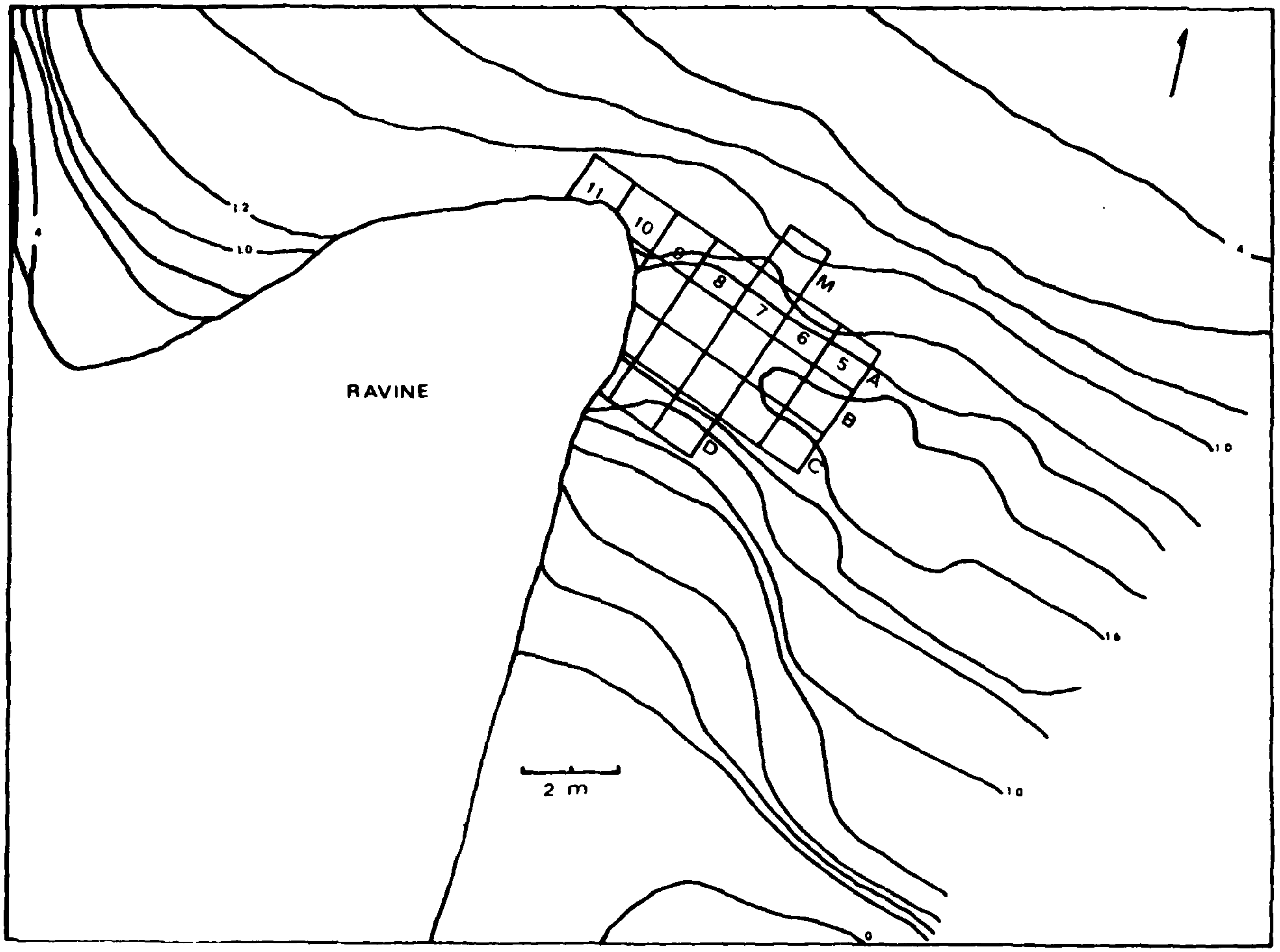
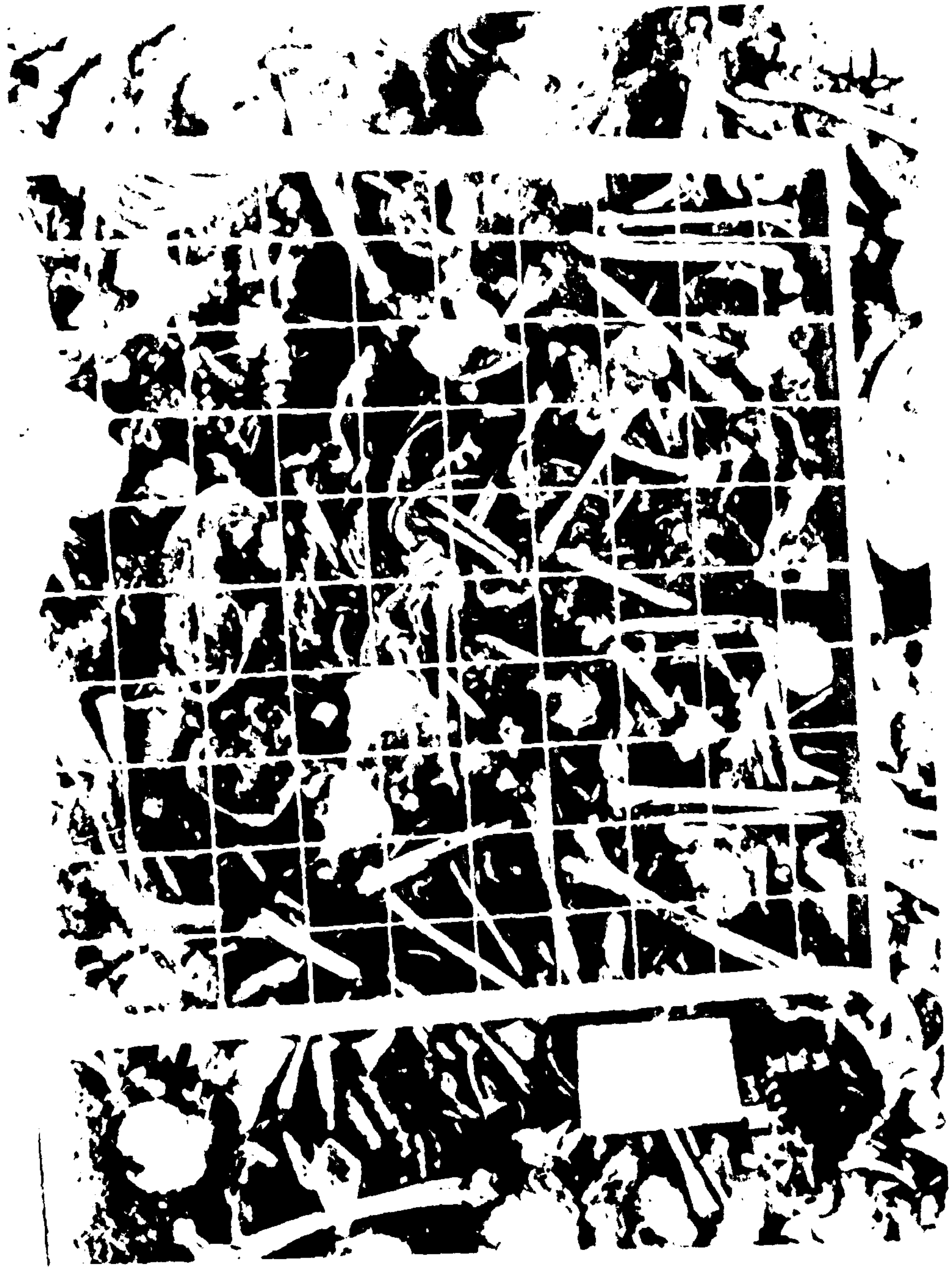


FIGURE 2. Map showing location and layout of 1978 grid system. The contour intervals are given in .20 meter intervals and represent depth below arbitrary datum of 0.



was not mapped, only photographed. By this phase of the work, conversations with the project physical anthropologist P. Willey, in conjunction with an examination of the recovered data, indicated such mapping had contributed no additional information not being obtained through other techniques.

In all, a total of 18 entire 1 meter squares and 4 partial squares were excavated to expose a roughly rectangular area 6 meters east-west and varying from 3 to 5 meters north-south. The depth of the excavations varied from about 1½ to 3 meters. In the upper portion of the ditch fill (Zone 1), the soil was removed completely from the squares even when sterile subsoil was encountered. In the lower, narrower portion of the fortification ditch, the sterile subsoil was not removed (FIG. 3). In this area the excavation followed the edges of the actual ditch. The soil from Zone 1 was removed by shovel skimming with the excavators using trowels when necessary. This soil was dry screened through a ¼ inch mesh screen. Selected samples of this zone were water screened. This effort substantiated that all the relevant information was being recovered by shovel skimming and dry screening. Portions of Zone 2 were dry screened to check on the thoroughness of the material recovery. Zone 2 was excavated using trowels and various wooden picks to avoid damage to the skeletal material. Since dry screening indicated that hand excavation was resulting in very complete material recovery, screening was no longer utilized. Extensive soil samples were taken for processing as flotation samples or for later processing as pollen samples.

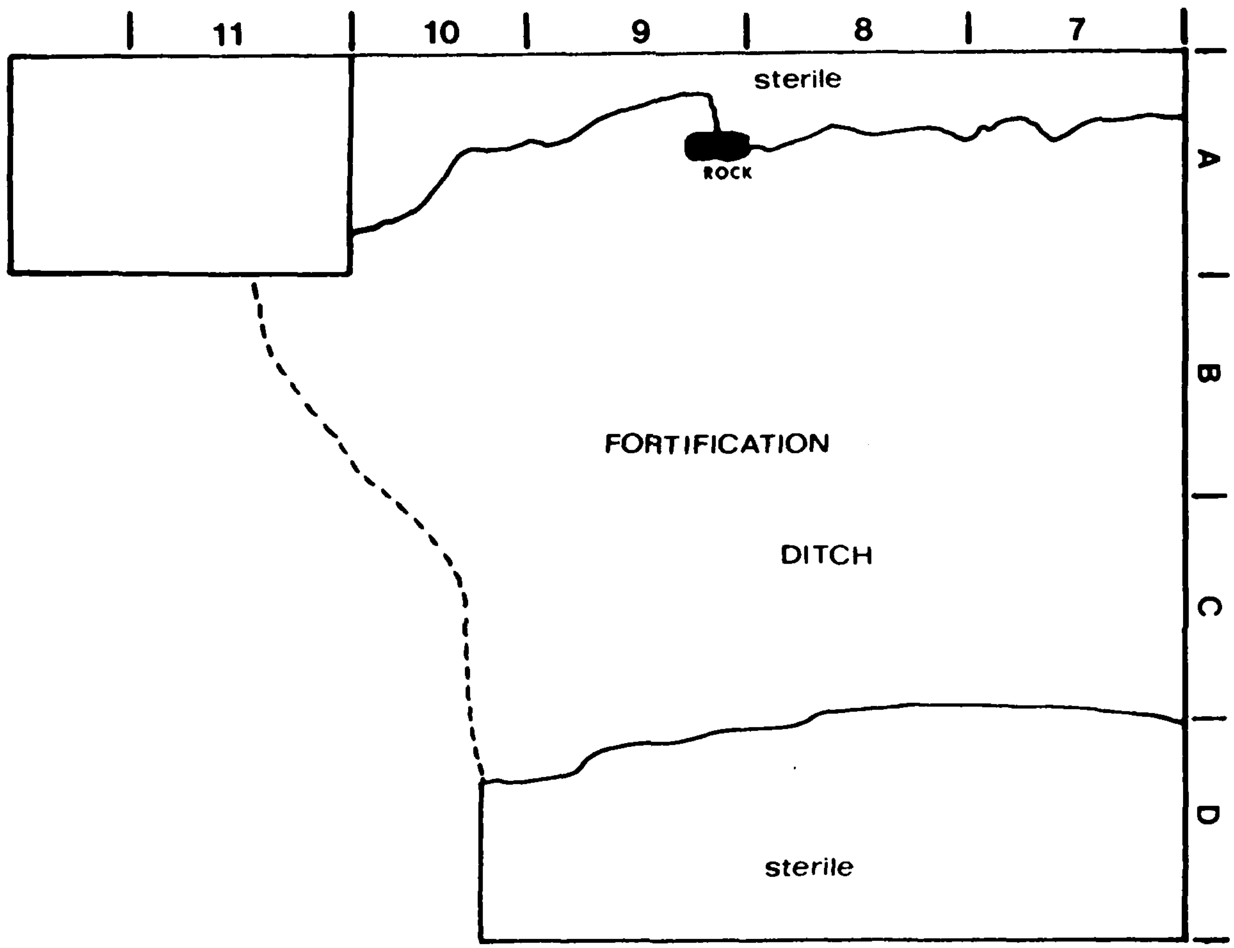


FIGURE 3. Horizontal plan map of the lower portion of the fortification ditch at 1.6 meters below southwest corner of 7B. Plan shows position of metate found at apex of Bone Bed B and width of fortification ditch at this level, i.e., at the base of Zone 1.

STRATIGRAPHY

The recent depositional history of the Crow Creek locale has been studied by Coogan and Irving (1959). In 1958, these authors carried out a detailed study of the cut-and-fill terraces on the Missouri River. One of their study sections was of the bluff on the south side of Wolf (Elm) Creek, about 100 yards north of 39BF4. This work demonstrated the presence of an upper terrace, labelled Mt-2, on the left bank of the Missouri River. The elevation of this bluff runs from about 80 to 100 feet above water level. The Crow Creek site is located in the silt cap of this terrace. The Wolf (Elm) Creek section has been described as consisting of five units which are summarized as follows (Coogan and Irving 1959: 320-321):

Unit 1 - Bedrock Pierre shale

Unit 2 - Fluvial deposits of fine grained outwash sand and gravel (29 feet thick).

Unit 3 - A well defined paleosol developed in stream deposited sand (2½ feet thick).

Unit 4 - A thick clayey humic layer of limited lateral extent (1½ feet thick).

Unit 5 - An aeolian silty sand with numerous humic horizons defining former surfaces which reach a thickness of 27 feet and is post-Cary to recent in age. This layer contains the remnants of the Plains Village components at Crow Creek.

The outer fortification ditch was excavated by the Initial Coalescent inhabitants of the Crow Creek site into the upper portion of Unit 5.

The Nebraska State Historical Society excavated a portion of the outer fortification ditch (Kivett and Jensen 1976:8). Excavation I was 40 feet long and 8 feet wide. The unit was placed at right angles to the ditch about 100 meters to the east of The University of South Dakota's 1978 excavations. Kivett and Jensen's interpretation of the profile (FIG. 4) suggested that aboriginally, the ditch had been 54 inches wide across the bottom, 12 feet wide at the top and about 6 feet deep. The authors point out that these measurements are approximate since the ditch shape and size have been affected by erosion. Little cultural material was recovered from their ditch excavations. Animal bones, charcoal, and a few rim sherds attributable to the Wolf Creek component were found.

During the 1978 excavations, examination of a number of profiles of the ditch became possible. Figure 5 represents the profile taken from the face of the eroding ravine. The location of this profile is from units 9A to 9E, and shows the western extent of the bone bed along with the vandalized section. The basic dichotomy present in all of the fortification ditch profiles between the upper and lower ditch fills is also reflected. The upper levels, which are labelled Zone 1 in this report, are composed of a large number of old humic horizons interspersed with layers of wind deposited loess. These layers reflect periods of stability and instability in the old land surfaces. The interpretation, however, is

STRATIGRAPHY

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Unit 3 - A well defined paleosol developed in stream deposited sand (2½ feet thick).

Unit 4 - A thick clayey humic layer of limited lateral extent (1½ feet thick).

Unic 5 - An aeolian silty sand with numerous humic horizons defining former surfaces which reach a thickness of 27 feet and is post-Cary to recent in age. This layer contains the remnants of the Plains Village components at Crow Creek.

The outer fortification ditch was excavated by the Initial Coalescent inhabitants of the Crow Creek site into the upper portion of Unit 5.

The Nebraska State Historical Society excavated a portion of the outer fortification ditch (Kivett and Jensen 1976:8). Excavation I was 40 feet long and 8 feet wide. The unit was placed at right angles to the ditch about 100 meters to the east of The University of South Dakota's 1978 excavations. Kivett and Jensen's interpretation of the profile (FIG. 4) suggested that aboriginally, the ditch had been 54 inches wide across the bottom, 12 feet wide at the top and about 6 feet deep. The authors point out that these measurements are approximate since the ditch shape and size have been affected by erosion. Little cultural material was recovered from their ditch excavations. Animal bones, charcoal, and a few rim sherds attributable to the Wolf Creek component were found.

During the 1978 excavations, examination of a number of profiles of the ditch became possible. Figure 5 represents the profile taken from the face of the eroding ravine. The location of this profile is from units 9A to 9E, and shows the western extent of the bone bed along with the vandalized section. The basic dichotomy present in all of the fortification ditch profiles between the upper and lower ditch fills is also reflected. The upper levels, which are labelled Zone 1 in this report, are composed of a large number of old humic horizons interspersed with layers of wind deposited loess. These layers reflect periods of stability and instability in the old land surfaces. The interpretation, however, is

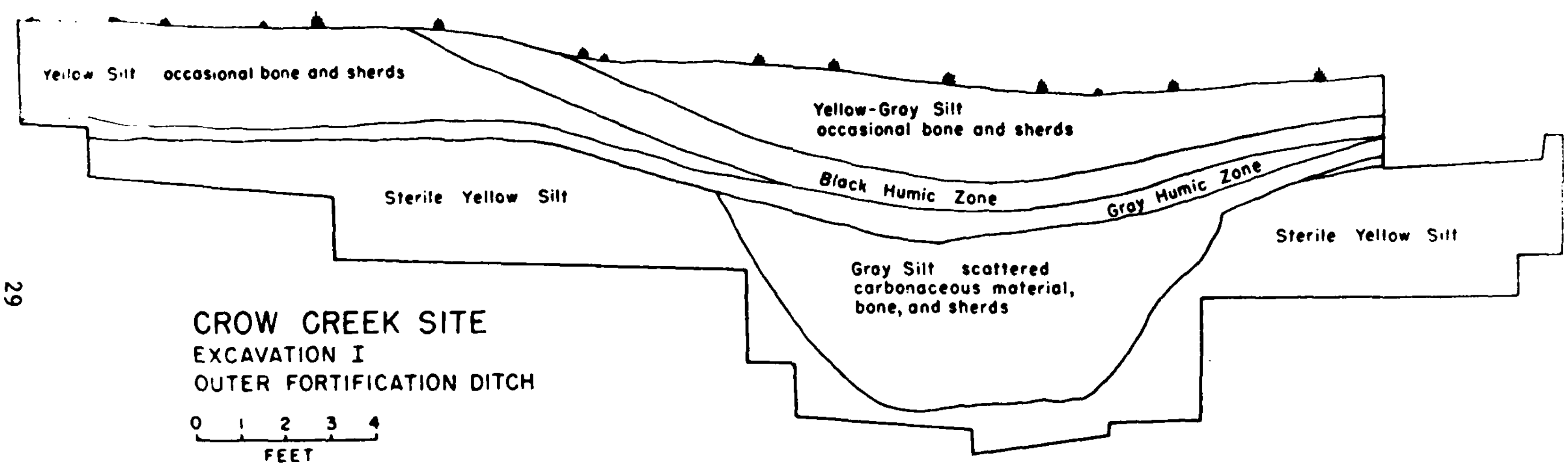

FIGURE 4. Profile of the west face of the Nebraska State Historical Society's Excavation I showing the outer fortification ditch. (After Figure 2, Kivett and Jensen).

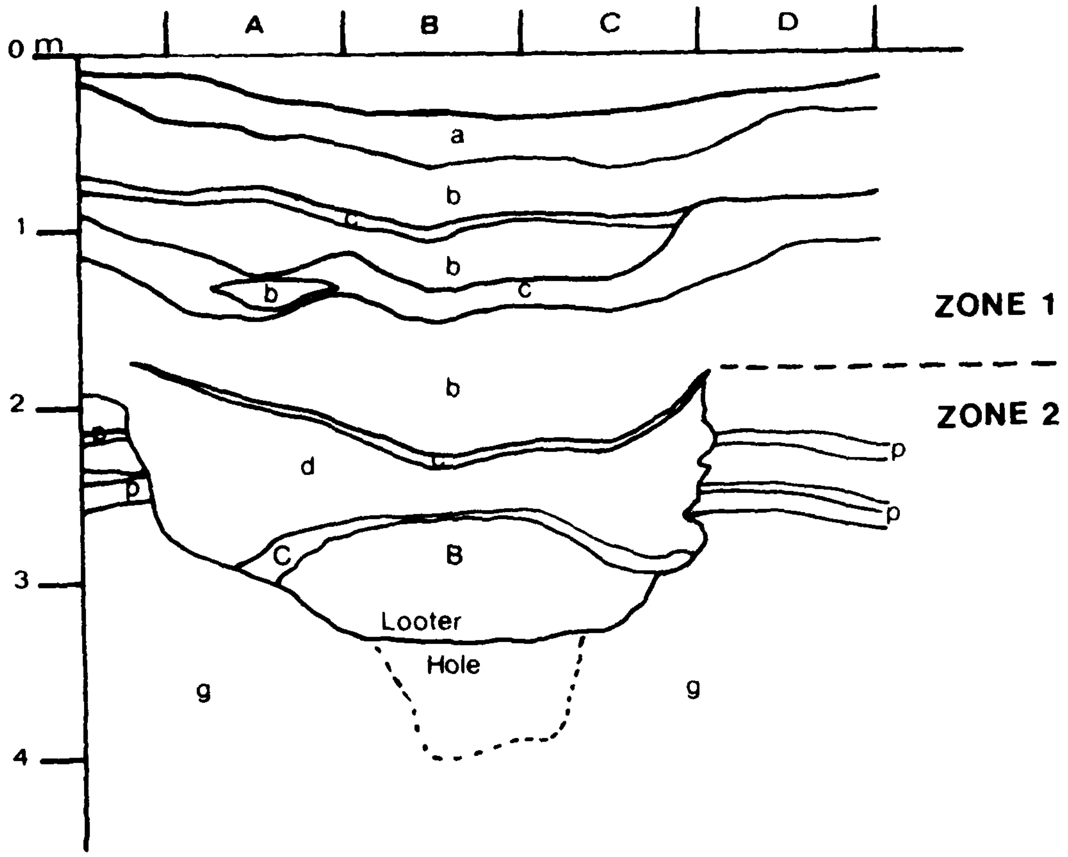

FIGURE 5. Profile of east wall of 9A-D. Key: a - dark gray silt (10YR 4/1); b - pale brown silt (10YR 7/4); c - dark gray silt (10YR 3/1); d - light gray silt (10YR 6.5/1); C - clay layer (10YR 3/z); B - Bone Bed; p - buried paleosols; g - sterile subsoil.

not that simple in this zone. The neat layering of loess and humic levels has been much disturbed by wind and water erosion and redeposition. This movement of sediments has caused concern over the context of the material recovered in Zone 1. Underlying Zone 1 is the fill of the lower portion of the fortification ditch which has been designated Zone 2. In all the profiles, this fill is very homogenous. The deposition of this zone appears to have been very rapid.

A very similar profile was found on the east wall of units 7M through 7D. This profile, shown in Figure 6, was exceptional in that the lower zone representing the fortification ditch was sharp and clear with little evidence of deformation by erosion. The clay layer which covered Bone Bed B is present in this profile. A small portion of the eastern fringe of Bone Bed A is also visible.

During the course of the excavations,Everett M. White examined the exposed profile. Figure 7 represents a schematic of the sediments present in the east wall of 5A - 5C. Layer 1 correlates with Zone 2 in the previously discussed profiles while Layers 2-4 equate with Zone 1.

Sediment Mantling

The sediment exposed on the east face of the excavation is predominantly loess or derived from loess. Loess characteristically is deposited as thin layers lodged in vegetation, transported slightly by runoff water on slopes, and mixed by soil fauna and flora. Because of this mixing, the depositional laminae are destroyed

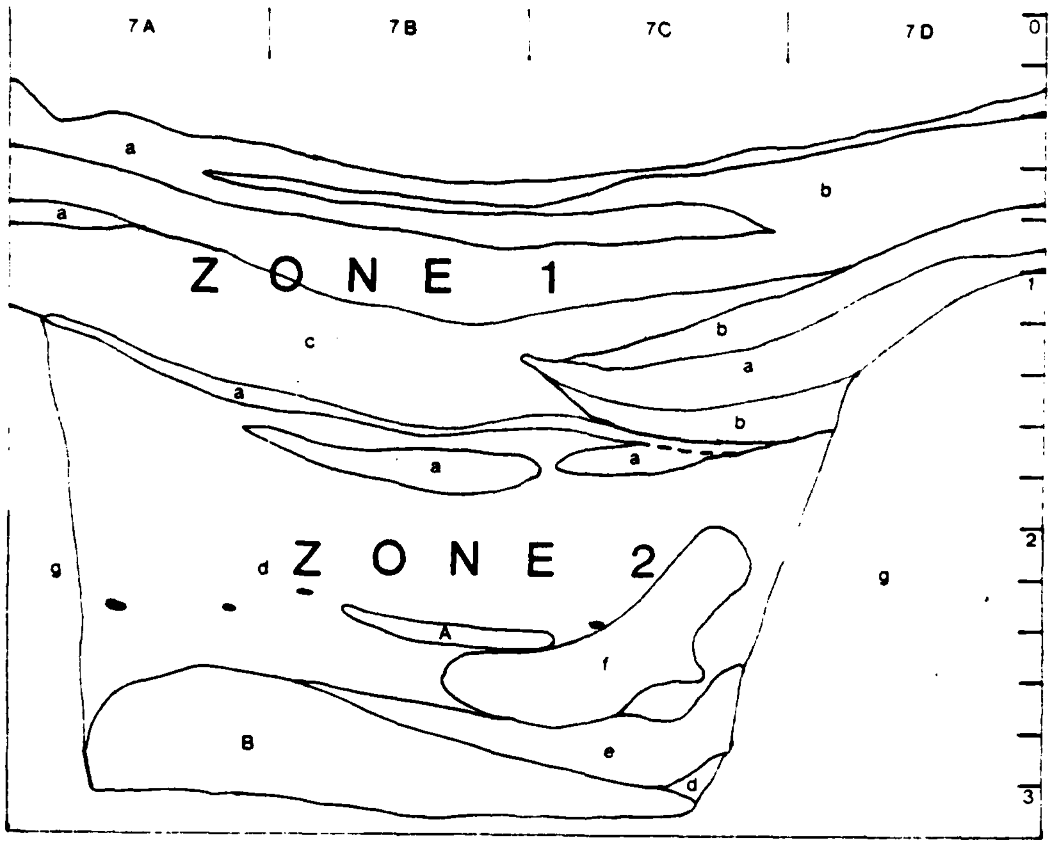

FIGURE 6. Profile of east wall of 7A-7D. Key: a - dark gray silt (10YR 4/1); b - pale brown silt (10YR 7/4); c - dark gray silt (10YR 3/1); d - light gray silt (10YR 6.5/1); e - dark gray-black (10YR 2.5/1) clay layer; f - layer is identical to e but with the inclusion of large fragments of burned clay; g - sterile subsoil; A - Bone Bed A; B - Bone Bed B; - human bone fragments.

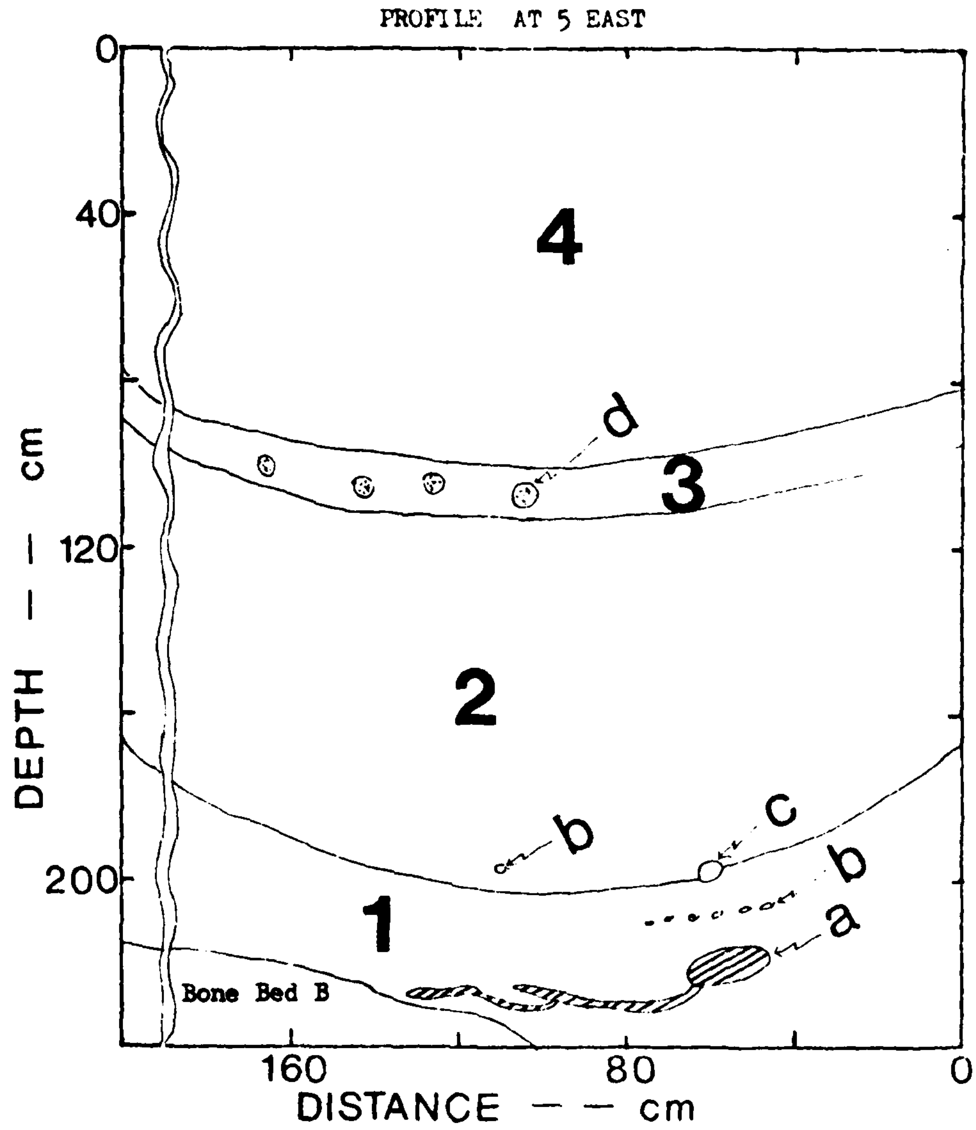

FIGURE 7. Soil layers in east face of the excavation pit at the Crow Creek Burial Site. Layer 1 overlies the burial deposit or fortification ditch bottom, contains carbonates, clay masses (a), and bones (b) oriented parallel to the upper contact with a cobble (c). Layers 2,3, and 4 are loessial and contain a few thin dark-colored humic laminae in the lower part, thin soil zones in the middle with light-colored filled animal burrows (d), and an upper part where soil formation is most active today.

unless the loess accumulates sporadically at a rate greater than the mixing.

Layer 1 above the burial zone at the base of the face (FIG. 7) lacks: 1) alternate laminae of very thin dark-colored humic soil surfaces and lighter-colored loessial material, 2) evidence that water had disturbed or sorted the silt or, 3) evidence that the carbonates in the sediment were not those present in the material when it was deposited. The layer contains masses and contorted seams of soft clay (about 50-65 percent $< 2\underline{u}$ size) which have distinct boundaries with the silt except where earthworms have transported material across the interface. The clay masses could not be transported intact by wind or water from a source 50 to 100 feet below the site. No known soil weathering process could create and deposit the clay, especially where soil formation has been very weak. At the same level adjacent to the pit face, another clay-rich mass contained a fragment of fissile shale which was unweathered. Thus, the clay must have been originally slack-water sediment from the adjacent creek and river flood plain or shale ground by humans. If the clay masses had not been deposited contemporaneously with the silt, rains would wash the clay over the silt to cause layering of clay with silt as loess increments were added. Thus the clay and silt must have been deposited together by humans. The upper part of Layer 1 contains a cobble and some bones that were arranged in a form approximating the layering in the overlying loessial sediment. Loess was possibly being deposited at the time these extraneous materials were deposited.

Layer 2 contained numerous light- and dark-colored laminae which are leached of carbonate except for small calcareous fragments, presumably deposited by wind. Layer 2 was formed by the accumulation of loess at relatively rapid rates because the thin dark-colored laminae are in the minority. The reverse is true for Layer 3 which contains humic layers a few centimeters wide. Layer 3 also contains rodent burrows filled with light-colored loessial material. Presumably aeolian deposition was minimal when soil formation was dominant in Layer 3. Layer 4 is a continuation of Layers 2 and 3 except the laminae are essentially destroyed by mixing and soil formation. A weakly developed soil occurs at the surface.

Definite slump structures cannot be proposed from the material visible on the east face of the excavation. Compaction and settling of the skeletal material could be expected. If one assumes the initial surface of the burial mass below Layer 1 was a meter or so higher north of the 160 cm distance (FIG.7), and a clay layer was placed over it, the clay would slope steeply to the south where skeletal material apparently was absent. Settling would shorten the length of the clay layer by folding, flowing, or shearing. The juxtaposition of the one clay layer below the other one at the 100 cm distance (FIG. 7) may result from settling. As the layer at 120 cm settled at a more rapid rate than the one at 80 cm, a shear crack could have developed placing the layer below its original alignment and connection with the 80 cm distance layer. Gradually, as settling occurred, the 120 cm layer would slide below the 80 cm layer as silt settled to the north.

Loess and Loess Deposition

The relationship of the fortification ditch to loess deposition is of interest but not relevant to the archeological interpretation of the site. Loess normally accumulates most rapidly where the site is protected either by wind shielding or by a cover of vegetation. At this ditch, about two meters of loess have been deposited uniformly across the area and the ditch has not been obliterated. The ditch should have a more mesic environment and more vegetation than the contiguous surface. Wild animals concentrated near the river water may have grazed the area so intensely that only short-grasses could survive. An additional factor is that the ditch may be oriented enough NW-SE in the prevailing wind direction so that it was not sheltered from the wind and collected loess rapidly if the vegetation were short.

Loess mantling the fortification ditch is very weakly calcareous, apparently has accumulated in about 500 years, and has a logical source area to the Northwest on the Missouri River flood plain. However, the silty sediment on the flood plain is characteristically very calcareous. If very calcareous loess were gradually leached, increment by increment, as it is deposited, a zone of carbonate accumulation should occur in the lower part of the fill. Subsoils are normally dry in the 46 cm annual precipitation zone of South Dakota so that calcium leaching entirely out of the fill seems unlikely. Possibly, the source of the surficial loess is not the flood plain but has been the partially leached loessial material exposed by the erosion of the steep slope to the west of the site. As the slope erodes and advances eastward, the loess may be derived from partially leached loess exposed, moved, redeposited, re-exposed, removed, etc., for many cycles. Each time it is re-exposed the lower more calcareous part could be removed by water erosion down the slope.

In summary, then, field observation substantiates that a portion of the fill of the lower fortification ditch Zone 2 was brought in by human agents. Specifically, the clay and some village midden appear to have been deliberately packed in a layer about 30 cm thick over the Bone Bed B skeletal material. As noted by White, the clay is only available from the sediments associated with the creek bottoms and had to be physically transported up the bluff to the village area. During excavation, this packed clay was noted to form an almost continuous layer over the bone. Bone Bed B, therefore, was deliberately placed in the fortification ditch and thinly covered with fill.

Bone Beds A and B

Bone Bed B was deposited in a large mass which was cone-shaped with its apex in squares 8A and 9A. From this apex it fanned out to cover the remainder of the exposed fortification ditch bottom. The bed reached a thickness of about 1½ meters at the apex and then thinned rapidly to the east, south, and west. The distribution of the bones suggested that they had been carried to the outer edge of the forification ditch and continually dumped in the same spot, gradually developing their fan-shaped distribution.

The apex of this deposit was "marked" by the presence of a large granitic metate jammed along the north face of the ditch (FIG. 3). Whether the presence of this item was fortuitous or deliberate is impossible to determine. The clay layer covered Bone Bed B to within about one-half meter of the apex where it feathered out and disappeared. This clay layer thickened toward the bottom slopes of the bone deposit suggesting to some extent that it may have been eroded off the apex. There was also some evidence to indicate that there had been some disturbance of the upper portions of Bone Bed B. When excavations reached the top of the clay layer, it was found to have a scattered deposit of human bone on it. This deposit was designated as Bone Bed A; it appeared to consist only of scattered, disarticulated, human remains along with a number of bison scapula hoes. The presence of these items on top of the clay layer in conjunction with the absence of clay on the apex of Bone Bed B may indicate that Bed A represents material dug out of Bed B by scavengers soon after interment.

The depositional and post-depositional history of Zone 2 has a strong bearing on the analysis of the recovered artifactual material. Much of the fill of this zone appears to be derived from the surrounding village midden. While this material would be roughly contemporaneous with the massacre, its provenience within the ditch would have little meaning. This problem is accentuated by the movement of the clay layer due to erosional and animal disturbance and as a result of settling of the bone deposit due to the decomposition of the human remains. The net result renders the present provenience of the cultural material meaningless except in general terms. The material can, however, be treated meaningfully as a unit. The fact that Zone 2 seems to represent a very rapid deposition supports this latter view. This material is extremely important because it does corroborate the Initial Coalescent dating of the skeletal material.

CULTURAL MATERIAL

The 1978 excavations support Kivett and Jensen's (1976:8) results that there was very little cultural material present in the outer fortification ditch. Despite the almost 50 m^3 of earth removed from the ditch, only a moderate amount of pottery, lithics, bone, and fire-cracked rock was recovered. In the following sections this cultural material will be discussed using the basic fill units, Zone 1 and Zone 2, as the units of analysis.

CERAMICS

There were 436 sherds recovered from the fortification ditch in 1978. Of these there are 407 body sherds and 29 rim sherds. Sherds which could be glued together were counted as one specimen. Most of the similar sherds, not fitting together, appear to belong to separate vessels. In general the pottery conforms with Campbell Creek Ware, defined on the basis of the pottery from the Talking Crow site (Smith 1977:63-67) and is characteristic of the Campbell Creek phase of the Initial Coalescent variant of the Coalescent tradition. The Talking Crow Straight Rim type (Smith 1977:58-59) lasts from Initial into post-Contact Coalescent times.

The temper consists of particles of grit, seemingly derived from crushed granite and metamorphic rocks which occur in glacial deposits in the region. These body sherds are relatively thin, usually ranging from 6 to 9 mm in thickness. The texture is best described as medium-fine. They range in color from gray to brown with some showing reddish surfaces attributable to secondary firing in an oxidizing atmosphere. Vessels with globular bodies, constricted necks, and straight to slightly flaring rims with thin lips are represented. Surface finish is predominately cord marking subjected to partial erasure by the wet hand of the potter. Simple stamping, partially erased, is less prevalent. Plain body sherds really seem to represent surface smoothed areas on otherwise cord marked (roughened) or simple stamped vessels. In sorting the sherds, the mere trace of cord marking or simple stamping was sufficient to place a specimen in one or the other category. At first glance, the majority of the sherds might be thought of as "plain" under inadequate light, or without experimental knowledge of the kinds of negative impressions made by cord wrapped or grooved paddles. A few small sherds indicate that the shoulders were sometimes decorated with incised lines forming indeterminate designs. Twenty-six sherds were so eroded that they were relegated to the indeterminate category and not used in computing percentages. Several small sherds were so disintegrated that they were discarded. A total of 381 sherds are listed in Table 1 showing the similarity in percentages in the two Zones.

Descriptions of Types

Talking Crow Straight Rim, 3 sherds

Rims are straight to slightly flaring. All measure 6 mm in thickness at the lips. One large sherd measures 8 mm at the shoulder and has a height of 32 mm. One with a plain neck has hollow reed,

TABLE 1. Surface treatment on body sherds.

	Zone 2		Zone 1		Both Zones	
	Number	Percent	Number	Percent	Number	Percent
Simple stamped	29	15.10	36	19.05	65	17.06
Cordmarked	105	54.69	118	62.43	223	58.53
Plain	56	29.20	29	15.34	85	22.31
Decorated shoulder	2	1.10	6	3.17	8	2.10
Totals	192		189		381	

or grass stem, punctates on the flattened lip. Two with simple stamped necks display diagonally oriented notches on flattened lips. Pressure from decoration resulted in thickening of the lips.

Campbell Creek Pinched, 1 sherd

One straight rim, 31 mm high, has a rounded lip which was thickened by the addition of a thin fillet. It bears a clear example of thumb and forefingernail pinching. The lip measures 9 mm and the neck below 8 mm in thickness.

Campbell Creek Plain, 6 sherds

The rims range from 10 to 26 mm in height with a mean of 22 mm. The lips range from 5 to 7 mm in thickness with a mean of 5.6 mm. Lower rims range from 7 to 8 mm in thickness with a mean of 7 mm. Two rounded lips and one flattened lip are plain. Two rounded lips bear vertical notches on the interior, invisible from the exterior of the vessel.

Cambell Creek Cordmarked, 13 sherds

Rims range from 19 to 48 mm in height with a mean of 36 mm. Lips range from 5 to 8 mm in thickness with a mean of 6 mm. Lower rims range from 4 to 9 mm in thickness with a mean of 7 mm. The thickening is due to lips flattened by decoration and, in one instance, by the addition of a thin fillet, or the folding over of surplus paste on the one plain lip. Eleven rims are straight and two are flaring. All of the other 12 lips are decorated by a stab-and-drag punctating technique following the orifice. The end of a roughly broken stick may have been used as a tool. All lower rims bear traces of smoothed over cordmarking.

Campbell Creek Indented, 6 sherds

Most of the sherds are too small to indicate form except one which appears to be straight. Some of the sherds grade into Campbell Creek Pinched. The lips are always indented on the exterior and there may be indenting on the interior of the lip as well. One rim is 22 mm high. Lips range in thickness from 4 to 7 mm with a mean of 5.6 mm. Lower rims range from 6 to 9 mm in thickness with a mean of 7 mm. Perhaps one sherd belongs to Campbell Creek Plain with interior indentation which is so deep that an indented effect occurs on the exterior. Campbell Creek Indented is at the extreme range of variability in regard to its definition at Talking Crow site (Smith 1977:67, Pl. XI f-j) where it is not well represented quantitatively and may not represent a significant grouping at any site. In Table 2 it is evident that the small sample of 29 rims does not lend itself to interpretations based on stratigraphic distribution.

Percentages derived from the small sample of 29 rims (Table 2) preclude valid comparisons with tabulations from find spots of similar cultural affiliation at the Talking Crow site, such as Zone I and Feature 20 in Mound 1, the 18"-30" level in Mound 2, House 10 floor,

TABLE 2. Ceramic types based on rim sherds.

	Zone 2 Number	Zone 1 Number	Both Zones Total	Both Zones Percent
Talking Crow Straight Rim		3	3	10.34
Campbell Creek Pinched	1		1	3.45
Campbell Creek Plain	1	5	6	20.69
Campbell Creek Cordmarked	12	1	13	44.83
Campbell Creek Indented	5	1	6	20.69
Totals	19	10	29	

and Fortification (Smith 1977: Tables 28-30, 32). In each instance Grey Cloud Horizontal Incised is represented by from 7.7 to 16.0 percent of samples ranging in size from 49 to 181 specimens. Perhaps one might expect to find in a sample of 29 sherds only a minimum of two or a maximum of five sherds of Grey Cloud Horizontal Incised if the type were as popular as it was in the Campbell Creek phase at the Talking Crow site.

Kivett and Jensen (1976: Table 4) report percentages ranging from 7.89 through 11.25 to an atypical popularity of 27.27 for the type of Houses I and V in the Wolf Creek component. Sample sizes range from 38 to 179 specimens. Only 63 sherds of Grey Cloud Horizontal Incised, out of a total of 548, are reported from the houses. The 63/548 ratio from Kivett and Jensen represents an average of 11.5 percent. If this percentage can be assumed similar to this new sample, about three Grey Cloud Horizontal Incised sherds would be expected in a sample of 29.

It seems evident that the absence of Grey Cloud Horizontal Incised in the sample associated with the victims of the massacre is of no statistical significance and that the pottery sample is similar in age and cultural affiliation to that found in the Campbell Creek phase at the Talking Crow site.

LITHIC ARTIFACTS

Zone 1

Three projectile points were located in the upper zone. Two of these are straight based triangular points while one is triangular with a concave base and side notches. Only one plain straight based triangular is complete enough to measure and is 24.5 mm in length, 17.5 mm in width and 5.0 mm in thickness.

Lithics were not plentiful in this zone. Fragments of two thumbnail scrapers, one small piece of scoria, one broken piece of a plate chalcedony knife, and 23 pieces of debitage completed the recovered lithic assemblage. Fire-cracked cobbles were plentiful but have not been quantified.

Zone 2

In spite of the overwhelming skeletal evidence for violent death displayed in the bone deposits of this zone, only four projectile points were recovered. Two of the points are triangular with straight bases. Both are made of white chert. One point is 26 mm long, 16.2 mm wide, and 3.6 mm thick while the other is 29.3 mm long, 14.4 mm wide and 3.7 mm thick. The remaining two points are side notched triangular points with flat bases. One is of white chert while the other is made from a yellow-brown chert. Only one is complete and is 16.3 mm long, 9.2 mm wide and 2.1 mm thick.

As in the case of Zone 1, the rest of the lithic assemblage was very limited. Twenty-one pieces of chert and quartzite debitage were recovered, along with one small fragment of a plate chalcedony knife. Fire-cracked rock was plentiful throughout the fill.

Lithic typology has never been adequately developed for the Plains Village tradition. Smith (1977:82) has noted that in terms of proportions, the Campbell Creek phase is characterized by plain triangular points with straight bases and by side-notched triangular points, but chronological significance of point typology is tenuous at best.

WORKED BONE

Zone 1

Zone 1 was completely lacking in worked bone.

Zone 2

Polished Bone

In Zone 2 a number of polished bone fragments and bone tools were recovered from the bone bed areas. Six fragments of polished bone were found during the course of excavation. Three of these were longbone fragments from Bone Bed A. The main concentration of worked bone was found in Bone Bed B. Three fragments of polished scapula were found in the upper levels of the bone deposit.

Awls

A single awl made from a large mammal ulna was recovered from Bone Bed A. The distal end of the ulna had been ground down and rounded off. The proximal end had been split lengthwise. This split surface shows polish from use. The total length of the awl is 120 mm.

Bone Projectile Point

A single socketed bone projectile point was found with the human bone. The point is conical with the socket-end diameter of 15 mm and a length of 47 mm. Such projectile points have been recorded from Initial Coalescent sites.

Ulna Pick

A single bison ulna pick was recovered from the fill between Bone Beds A and B. This pick was snapped off at the distal end. A hole approximately 20 mm in diameter had been made through the proximal end, presumably as an aid in hafting. Slightly above the perforation is a single polished groove suggesting the presence of a thong to aid in holding the handle in place.

Bison Scapula Hoes

Five bison scapula hoes were found in Zone 2. Four of these were mixed in Bone Bed A and were lying atop the clay layer covering Bone Bed B. These four all show a number of modifications. In each case, one edge of the lip running about the glenoid fossa has been worn down. This may have been deliberately done to aid in hafting or it may have worn down through use. All of these hoes have had the spines removed. The other hoe was found on top of Bone Bed B. Although the spine was removed, the articular end (i.e., the glenoid fossa) had not been modified. All of the hoes are broken.

Comments

Diagnostically and chronologically these bone tools contribute little information. No items were recovered that would not conform with the Initial Coalescent affiliation suggested by the ceramic assemblage. The prevalence of hoes with basically unmodified articular ends would tentatively indicate a Campbell Creek phase correlation according to Smith (1977:107). This is further supported by the evidence from the previous excavation. Kivett and Jensen (1976:62) report that all of the bison scapula hoes recovered from a Wolf Creek context had retained their articular ends, many of which show wear along the posterior and/or anterior edges. Only the spines had been removed.

Of more interest is the fact that hoes and a pick were found only in Zone 2, and in all cases in direct association with the bone deposits. Four hoes came directly from the packed surface of the clay layer while the other hoe was found lying on the top of Bone Bed B just under the clay layer. One could suggest that these hoes were the very ones used to spread the clay over the human remains interred in Bone Bed B.

What evidence is available from the meager cultural inventory is compatible with an Initial Coalescent affiliation for the outer fortification ditch. If the socketed bone projectile point was not simply picked up from the surface of the site and deposited with the bone, it may be an indication that the massacre was carried out by other Coalescent peoples. Given all the possible intervening variables, this assessment must be considered extremely tenuous.

FAUNAL REMAINS

A number of faunal remains were recovered from the fill of the outer fortification ditch. The nature of the deposition suggests that these remains will contribute little to the understanding of the Plains Village way of life, to specific knowledge of the events of which these excavations investigated. The discussion of the faunal remains has been divided into two units; those in Zone 1 and those in Zone 2.

Zone 1

The predominant remains from the fill are those of bison (Table 3). The remainder of the faunal material consisted primarily of a small amount of deer bones i.e., either the white-tailed or the mule deer (Table 4). Both are common in the area today. The upper level fill of Zone 1 also includes a medial long bone fragment of a bird which is unidentifiable as to species. Two probable duck bones came from the fill; a small cranial fragment and a gnawed and cut left distal humerus.

Zone 2

Faunal remains were more plentiful in this zone than in the overlying one. This is probably the result of there being faunal remains in the village refuse which formed the major portion of the fill of the lower ditch zone. Again, bison was the predominant species (Table 5). A few deer remains were also recovered (Table 6).

Zone 2 also contained a number of small mammal bones and possible amphibian and bird bones (Table 7). For the most part these are not identifiable to a species level because of their fragmentary nature.

CANID REMAINS

A number of elements of the genus Canis were recovered from the matrix of Bone Bed B. Whether they are the remains of dog,

TABLE 3. Bison remains from Zone 1.

Element	Frequency
Phalanges	18
Radii	3
Astragali	1
Ulnae	3
Vertebrae Fragments	30
Femora	2
Scapulae	1
Ribs	16
Naviculars and Cuboids	2
Other Carpals	3
Mandibles	1
Calcanei	1
Sesamoids	3
Magnum carpals	2
Metatarsals	2
Ilia	2
Sacra	1
Patellae	1
Unidentifiable but probably bison	900

TABLE 4. Deer remains from Zone 1.

Element	Frequency
Pelvises	3
Vertabrae	3
Ulnae	1
Ribs	1
Cranial Fragments	2
Mandibles	1
Unidentifiable but probably deer	8

TABLE 5. Bison remains from Zone 2.

Element	Frequency
Phalanges	51
Radii	1
Astragali	2
Vertabrae Fragments	24
Scapulae	5
Ribs	9
Naviculars and Cuboids	6
Other Carpals	15
Mandibles	2
Calcanei	3
Sesamoids	25
Metatarsals	5
Metacarpals	14
Innominates	41
Patellae	2
Unidentifiable but probably bison	788

TABLE 6. Deer remains from Zone 2.

Element	Frequency
Pelvises	1
Vertabrae Fragments	3
Ribs	1
Cranial Fragments	2
Scapulae	1
Atlases	1
Calcanei	1
Radii	1

TABLE 7. Small animal remains from Zone 2.

Element	Frequency
Small Mammal	
Marmota sp. - left pelvis fragment	1
Reithrodontomys sp. (?) - left tibia	1
Amphibian	
Unidentifiable long bone fragments	2
Bird	
Probably Duck	
Right proximal humerus	1
Sternum fragment	1
Proximal radius	1
Proximal humerus	1
Left distal humerus	1
Distal bone from foot	1
Unidentifiable long bone fragments	3
Unidentifiable large bird	
Left proximal ulna fragment	1
Second digit tip	1

coyote, or wolf cannot be determined. On the basis of size, the bones are considered to most likely be dog. These are listed below, by square, with brief phrases describing each element:

1. Sq. 9A, SE

   Ulna - left, complete, mature; butcher marks on lateral, medio-distal portion of shaft.

   Radius - left, mature; butcher marks on posterior surface of the proximal end and lateral surface of proximal end.

   Tibia - left mature; polished on shaft, diseased on proximal end.

2. Sq. 7A, SE

   Two cranial fragments.

   Four long bone fragments.

3. Sq. 8B, SE

   Sacrum - complete, broken aboriginally across the second vertebra (percussion fracture); butcher marks on the anterior face of the first vertebra on both "wings."

4. Sq. 7B, SW

   Femur - right, mature; butcher marks at right angles to length of shaft near distal end on anterior surface; also cuts at right angles to length of shaft near distal ends on posterior surface and in notch directly beneath ball joint (head) on interior side; missing lateral side of distal articular end; aboriginal fracture.

5. Sq. 8B, NE

Innominate - left, distal end of pubis broken aboriginally; butcher marks on lateral surface of ilium at right angles to length of bone, also a few at right angles to shaft of ischium lateral surface; cut marks on outside lip of femur articulation in the sciatic notch; distal ends of ilium appear to have been chopped off.

Innominate - right, cut marks along lateral edge of dorsal (upper) edge of wing of ilium; percussion breaks at fossa and distal end of ilium; breaks aboriginal.

Two vertebrae - possibly caudal.

One vertebrae spine.

Ischium - right; cut marks along ridge of narrowest part of lateral surface at right angles to length of bone.

Femur - distal left; aboriginal percussion breaks at lateral side of distal end; butchering cuts on shaft of bone parallel with length of shaft, also cuts on sides near distal end and on distal articular surface.

6. Sq. 9B, NW

Tibia - left, mature, complete but with gnawing on anterior edges of proximal end; cuts in bone lengthwise on shaft on lateral surface; tooth marks with perforations on lateral surface of distal end of bone.

7. <u>Sq. 5A, SW</u>

Sacrum - complete, mature, but edges broken off, bone gnawed, with tooth perforations in the second vertebra.

8. <u>Sq. 9A, SE</u>

Calcaneus - left, mature, complete.

9. <u>Sq. 7B, NW</u>

Cranial bone - aboriginal percussion and butchering marks around the foramen magnum and occipital condyles.

10. <u>Sq. 7A, SW</u>

Rib - medial fragment; aboriginal percussion.

Scapula - right, proximal; body of scapula broken off aboriginally, with butcher marks on lateral surface, along upper edge, and just under spine on lower portion.

Based on the counts of left tibiae, the remains of two dogs are present in the Bone Bed B deposit. These bones were probably part of the general village midden which were gathered up by those who performed the burial. The dog skeletal material (as indicated by butchering marks) suggest that dogs were eaten regularly. The presence of gnawing marks on the dog bones indicates that no special treatment was performed on the bones and that they were gnawed by predatory scavengers. The fragmentary nature of the bones seems to indicate that their inclusion in the midden was accidental rather than intentional.

The close association of the dog bone with the human burial deposits had at first been thought to have some significance in terms of ritual connotations. The presence of gnawing by scavengers on the elements, however, suggests that they were from the general village debris.

Summary of Faunal Material

Due to the depositional history of the fill in the outer fortification, the value of the faunal remains is minimal. At best, they represent a "checklist" of possible species utilized by the prehistoric inhabitants of the Crow Creek village site. The faunal remains demonstrate that bison, deer, dog and birds were being taken for consumption. The fragmentary nature of much of the bone makes the species unidentifiable in the vast majority of cases. The bison long bone fragments, ribs and vertebrae were separated from the deer elements on the basis of size. This means that there is some overlap in the cases of small bison and large deer for these undiagnostic elements. Difficulties in distinguishing between dog and coyote or wolf were also encountered. As stated earlier, on the basis of size, the canid remains appear to represent dog.

FLORAL REMAINS

Samples from the Crow Creek site were sent to Thomas Haberman for the sorting and analysis of floral remains. All samples were from strata encountered during the excavation of a portion of what is assumed to be the most recent fortification ditch (the outer ditch) at the site assignable to the Initial Coalescent occupation of the site. The samples had been processed by personnel of The University of South Dakota Archaeology Laboratory using a floatation technique. Three liters of matrix were processed for each of eight sample proveniences.

Both the light and heavy fractions of the samples were inspected. The light fractions were sorted using a binocular microscope at 10X. The heavy fractions were checked under a lighted magnifying glass. All samples were completely sorted for identifiable plant fruit remains except the sample designated as being from "2X2 M Sq. Dark Horizon below Vegetable Material." This sample was observed to contain numerous uncarbonized seeds and only a portion of these were sorted for identification; seeds representative of all different species present in the sample were sorted. No identifiable seeds were observed in the sample from "Clay Layer Covering Bone Bed B Sq. 7C Elev. 233 cm below 7BSE." All other samples were found to contain identifiable seeds. Most of the seeds are in an uncarbonized condition.

Seeds sorted from the samples for identification were placed in plastic vials. Following sorting, seeds were identified and these data recorded. The primary source used in identifying the seeds from Crow Creek was Seed Identification Manual by Martin and Barkley (1961). Taxonomy follows Gleason and Cronquist (1963).

Following sorting, the light and heavy fractions were weighed and volumes measured. Weights were obtained with the use of Ohaus Triple Beam Balance and volumes were measured with the use of a series of graduated cylinders and a liquid measuring cup. These measurements are presented in Table 8. Due to the presence of soil in incompletely washed heavy fractions and numerous root fragments and leaf litter in some light fraction samples, none of the measurements of weight and volume can be regarded as very accurate. They do, however, provide some idea of the amount of material on which this study is based.

Results

This section of the report provides comments on the samples and lists of identified vegetal remains. Some impressions on the composition of the samples were noted as the material was sorted. Comments are provided for the light and heavy fractions of each sample in the following:

Comments on Samples - Light Fractions

2 X 2 M Sq. - Dark Horizon below Vegetable Material: Numerous roots and a large wood fragment present in sample, apparently most of the sample is partially decayed organic matter, very little or no charcoal present, few gastropod shells present in sample. Numerous modern, uncarbonized seeds (especially *Chenopodium* sp.) are present in sample, only a portion of those present were sorted.

2 X 2 M Sq. - Yellow Loess Below 1st Dark Horizon: Few charcoal fragments present in sample, numerous gastropod shells, numerous fine roots.

2 X 2 M Sq. - Yellow Loess Above Bed A: Small sample containing numerous fine roots.

TABLE 8. Weight and volume of heavy and light fraction samples.

	HEAVY FRACTION		LIGHT FRACTION	
	Weight	Volume	Weight	Volume
2 X 2 M Sq. - Dark Horizon below Vegetable Material	102.5	150	44.8	200
2 X 2 M Sq. - Yellow Loess below 1st Dark Horizon	8.5	11	5.0	20
2 X 2 M Sq. - Yellow Loess above Bone Bed A	10.0	13	1.9	10
Sample from Bone Bed B - Upper Level 7B	285.6	275	15.6	ca. 50
Bone Bed B - below Upper Level 9A	61.8	85	16.8	ca. 50
2 X 2 M Sq. - Immediately above Bed A	53.9	68	2.6	15
2 X 2 M Sq. - Dark Matrix	72.2	72	5.9	25
Clay Layer covering Bone Bed B - Sq. 7C at Elev. 233 cm below 7BSE	176.9	175	1.1	5

Weights in grams.

Volumes in milliliters.

Sample from Bone Bed B - Upper Level 7B: Few pieces of charcoal present, few gastropod shells present, some bone fragments present in light fraction, most of sample is partially decomposed organic matter and stem and root fragments, leaf litter, and grass fragments, sample similar to that from Bone Bed B - below Upper Level 9A.

Bone Bed B - below Upper Level 9A: Few pieces of charcoal present, few gastropod shells present, some bone fragments present, modern insect parts present, much of the light fraction sample is leaf litter, stem and root fragments, grass stems, and partially decomposed vegetal matter. The composition of the light fraction suggests that the sample, or a portion of it, was collected very near the modern ground surface, in an area of recent bank slumpage, or from an area that had recently been disturbed by rodents.

2 X 2 M Sq. - immediately Above Bed A: Small sample containing numerous fine roots, few charcoal fragments present, few gastropod shells present.

2 X 2 M Sq. - Dark Matrix: Charcoal fragments present, numerous gastropod shells, numerous root fragments varying in size from quite large to very small.

Clay Layer Covering Bone Bed B - Sq. 7C at Elev. 233 cm below 7BSE: Small sample containing numerous small root fragments, some small pieces of charcoal present, few gastropod shells present, no identifiable seeds found in sample.

Comments on Samples - Heavy Fractions

2 X 2 M Sq. - Dark Horizon below Vegetable Material: Sample incompletely washed, much soil remains in heavy fraction, a few very small, unidentifiable bone fragments and a few gastropod shell fragments present in sample.

2 X 2 M Sq. - Yellow Loess below 1st Dark Horizon: Small heavy fraction sample, incompletely washed, some soil remains in sample, numerous gastropod shell fragments present.

2 X 2 M Sq. - Yellow Loess above Bed A: Small heavy fraction sample. Incompletely washed, some soil remains in sample.

Sample from Bone Bed B - Upper Level 7B: Sample incompletely washed, some soil remains in heavy fraction, numerous unidentifiable bone fragments in heavy fraction.

Bone Bed B - below Upper Level 9A: Sample well washed, very little soil remains in heavy fraction. Numerous unidentifiable bone fragments present in heavy fraction.

2 X 2 M Sq. - immediately above Bed A: Sample incompletely washed, much soil remains in heavy fraction. Bit of charcoal and some cultural material, including a pot sherd, and a few small unidentifiable bone fragments are present in the sample.

2 X 2 M Sq. - Dark Matrix: Sample incompletely washed, some soil remains in heavy fraction, some gastropod shell fragments present.

Clay Layer covering Bone Bed B - Sq. 7C at Elev. 233 cm below 7BSE: Sample incompletely washed, much soil remains in the heavy fraction. A few small, unidentifiable bone fragments are present in the sample, a few gastropod shells present.

A variety of identifiable plant fruit remains was found in the samples. Most of the material identified is uncarbonized, although several species are present in carbonized form. Uncarbonized remains (Table 9) are assumed to be relatively recent and to post-date the prehistoric occupation of the site. Carbonized specimens (Table 10) are considered to represent plant products which were utilized by the prehistoric occupants.

The uncarbonized seeds identified from the flotation samples are assumed to be relatively recent which reflect the current vegetation at the site. In fact, the identified uncarbonized seeds seem to be a direct and representative reflection of the modern vegetation in the fortification ditch at Crow Creek. All of the samples investigated were collected from the fortification ditch. Choke-cherry (*Prunus virginiana* L.) and what is believed to be wolfberry (*Symphoricarpos occidentalis* Hook.) were frequent in the samples and were observed as a part of the modern flora at the site in 1978. The distribution of these shrubs closely conforms to the modern surface feature depressions at the site, especially those in the fortification ditch. Most of the herbaceous species identified, including ragweed (*Ambrosia* sp.),goosefoot (*Chenopodium* sp.), marsh-elder (*Iva xanthifolia* Nutt.), and dock (*Rumex* sp.), would also be expected to occur in moisture collecting depressions such as the fortification ditch. Some of the samples may have been collected near the present surface which would account for the presence of modern seeds. Some of the light

TABLE 9. Uncarbonized floral remains.

2 X 2 M Sq. - Dark Horizon below Vegetable Material:

Prunus virginiana L. Choke-cherry
Ambrosia sp. Ragweed
cf. *Symphoricarpos occidentalis* Hook. Wolfberry
Chenopodium sp. Goosefoot - numerous
Iva xanthifolia Nutt. Marsh-elder
Physalis sp. Ground-cherry or *Solanum* sp.
Rumex spp. Dock (2 species are suggested by differences in seed size)
Unidentified - three additional species represented by unidentified seeds.

2 X 2 M Sq. - Yellow Loess below 1st Dark Horizon:

Ambrosia sp. Ragweed - 9
Chenopodium sp. Goosefoot - 2
Iva xanthifolia Nutt. Marsh-elder - 1

2 X 2 M Sq. - Yellow Loess above Bed A:

Chenopodium sp. Goosefoot - 1

Sample from Bone Bed B - Upper Level 7B:

Prunus virginiana L. Choke-cherry - 10 pits, 5 half pits, and 10 fragments
Ambrosia sp. Ragweed - 3
Rumex spp. Dock - 10 (two species appear to be represented on the basis of seed size, 8 are large and 2 are small)
cf. *Symphoricarpos occidentalis* Hook. Wolfberry - 59
Iva xanthifolia Nutt. Marsh-elder - 2
cf. *Panicum* sp. Panic Grass - 2
Chenopodium sp. Goosefoot - 25
Unidentified - one additional species represented by one unidentified seed.

Bone Bed B - below Upper Level 9A:

Prunus virginiana L. Choke-cherry - 3 pits, 7 half pits, and 9 fragments
cf. *Symphoricarpos occidentalis* Hook. Wolfberry - 75
Chenopodium sp. Goosefoot -39
Ambrosia sp. Ragweed - 3
Iva xanthifolia Nutt. Marsh-elder - 1
Physalis sp. Ground-cherry or *Solanum* sp. - 1
Cenchrus longispinus (Hack.) Fern. Sandbur - 1

TABLE 9. Uncarbonized floral remains (continued).

Bone Bed B - below Upper Level 9A (continued):

cf. Bromus sp. Brome Grass - 6

cf. Panicum sp. Panic Grass - 1

Unidentified - three additional species represented by unidentified seeds - 2,2, and 1.

2 X 2 M Sq. - Dark Matrix:

Chenopodium sp. Goosefoot - 3 (possibly carbonized?)

TABLE 10. Carbonized floral remains.

Sample from Bone Bed B - Upper Level 7B:
Chenopodium sp. Goosefoot - 6

Bone Bed B - below Upper Level 9A:
Zea mays L. Maize, corn - 1 cupule

2 X 2 M Sq. - immediately above Bed A:
Chenopodium sp. Goosefoot - 5
cf. *Helianthus annuus* L. Common Sunflower - 1 (seed coat fragment - appears to be wild variety on basis of size)

2 X 2 M Sq. - Dark Matrix:
Prunus americana Marsh. Wild Plum - 20 pit fragments
Prunus virginiana L. Choke-cherry - 1 pit fragment

fractions seemed to include "leaf litter" which suggests that this may be the case (see sample descriptions). Recent disturbances such as burrowing rodents may explain the presence of modern seeds in older soil horizons.

Carbonized plant remains found in the samples include maize or corn (Zea mays L.), common sunflower (Helianthus annuus L.), goosefoot (Chenopodium sp.), choke-cherry (Prunus virginiana L.), and wild plum (Prunus americana Marsh.). These charred plant materials are assumed to date to the prehistoric occupation of the Crow Creek site. These materials are probably all assignable to the Initial Coalescent component on the basis of provenience.

Most of the plants represented by the carbonized specimens are species which were utilized in the subsistence economies of village populations. Corn was extensively cultivated in flood plain gardens (Gilmore 1977; Wilson 1917). Wild sunflowers were frequently gathered and larger seeded domesticated varieties were raised in gardens (Wilson 1917). Choke-cherry and wild plum were frequently gathered wild food resources and were prepared for use in a variety of ways (Gilmore 1977). The use of species of Chenopodium, goosefoot, as a food resource in Plains Village tradition subsistence economies is more indefinite. Goosefoot may have been utilized but certainly was never so important as other plant resources.

All of the plant fruits identified from carbonized specimens would have matured and been available for harvest in the late summer or fall. However, all of those used in the subsistence pattern could have been stored for a considerable period of time. In the case of *Chenopodium*, which is a very prolific seed producer, such seeds may have been incidentally charred at any season of the year (late summer and fall admittedly being the most likely or frequent). It is also probable that the scant charcoal and carbonized seed remains found in the fortification ditch were secondarily deposited by erosion from the adjacent village occupation surface. For these reasons, any inferences as to seasonality on the basis of presently available floral remains are speculative.

Previous work at the Crow Creek site resulted in the identification of corn, squash, wild plum, and goosefoot from the site (Cutler 1976). The samples studied in conjunction with this project add choke-cherry and common sunflower, probably a wild variety, to the list of plants utilized by the Initial Coalescent occupants of the site. All of the plants previously reported from the site, except squash, were replicated in the sample from the outer fortification ditch obtained by the USDAL. Charcoal and other cultural refuse was not abundant in the samples reviewed in this study.

SITE DEFENSE AND THE MASSACRE

One of the important issues which this study must address is how the massacre might have occurred at such a highly fortified site. The low density of cultural refuse seems unusual in that fortification ditches often contain substantial refuse accumulations. Although the samples are small, three liters each, this observation is reinforced by field observations during visits to the site and by the report of previous investigations at the site. Kivett and Jensen (1976:9) write that, "In contrast to the ditch fill in Excavation I [the outer ditch], which contained relatively little refuse, this ditch [the inner ditch] was packed with cultural debris." Both the outer ditch and the inner ditch are Initial Coalescent fortification systems at the Crow Creek site.

The observation, plus a few additional facts, lead to a speculative suggestion as to what may have happened at the Crow Creek village. In the report of previous investigations at the site with respect to the outer ditch, Kivett and Jensen (1976:8) write, "Although a careful limited search was made for the remains of a stockade, no post molds or other evidence were found." On the other hand, investigation of the inner ditch revealed that "Along the northern side of Excavation D and near the inner edge of the ditch was a well-defined post pattern designated Feature 120, which represented the remains of an extensive stockade"(Kivett and Jensen 1976:9). Further, "Six of the post holes [along the inner ditch] also contained human skull fragments" (Kivett and Jensen 1976:9)

This suggests that some of the post holes along the inner ditch were open at the time the village was raided; perhaps the stockade posts having been recently pulled for replacement along the outer, or new, fortification ditch.

These observations suggest that future excavations at the site may demonstrate that a portion of the outer fortification ditch was stockaded. This may support the idea advanced in this paper that a new fortification system was under construction, perhaps to protect an expanding village and replace an older system which had lost some effectiveness due to refuse accumulation, but that the village was successfully raided before this new fortification system was completed. This line of reasoning justifies the hypothesis that the village at Crow Creek was under some pressure and rather close scrutiny by a neighboring population and that the village was successfully attacked while the Crow Creek Initial Coalescent occupants were in the process of refortifying the village, a time at which the village was vulnerable to such a move by an alert enemy.

DATING THE MASSACRE

The items of material culture recovered from the fortification ditch securely associate the death and deposition of the human remains with the Initial Coalescent occupation of the Crow Creek site. The excavation and subsequent filling of the inner fortification ditch with midden in conjunction with the latter village expansion indicates that the village had been occupied for some period of time before the massacre occurred. On the other hand, the presence of Coalescent ceramics in Zone 1 does suggest some minor post-massacre habitation on the site.

Kivett and Jensen (1976:64) submitted charcoal from a post-mold found in the basin of House IV. A date of A.D. 1390±150 (M-1079a) was obtained from this sample. In addition, a series of dendrochronology dates on wood from the site have been given by Weakley (1971:30-31). Unfortunately, almost none of the specimens can be assigned to a component. Weakley was able to get dates on 12 juniper specimens which had a range of from A.D. 1385-1508. All but two of these dates fell prior to A.D. 1440. The one juniper specimen which can be securely correlated with Initial Coalescent material ranges from A.D. 1340 to A.D. 1435.

During the course of the 1978 excavations in the fortification ditch, sufficient carbonized wood to run a C14 sample date was collected. The carbonized wood used in this sample included only those specimens which came directly from the soil matrix in the lower level of the Bone Bed B deposit. The University of Wisconsin Radiocarbon Laboratory processed the sample and provided a date of 610±55 B.P. (WIS-1074). Based on the correction tables provided by Damon, et al. (1974) it is possible to present more accurate versions of both the Michigan and Wisconsin dates. Sample M-1079a corrects to A.D. 1368+196 while WIS-1074 corrects to A.D. 1325±62. The radiocarbon dates, then, provide a mid-fourteenth century date for the construction, occupation and probable demise of the fortified Initial Coalescent Crow Creek village. This is rather early in terms of the accepted dates for the beginnings of the Initial Coalescent in South Dakota. Lehmer (1971:114) favors a beginning date of A.D. 1400 while Smith (1977:152) places his early Campbell Creek phase of the Initial Coalescent at between A.D. 1425-1500.

Although the data gathered in this limited excavation can in no way solve the problems relating to the dating of the Initial Coalescent, some suggestions can be made. The date on Bone Bed B seems acceptable. Very limited work at Initial Coalescent component sites suggests that the dating problems are much more complex than has been indicated in the past. The Wolf Creek component at Crow Creek has often simply been lumped into a single occupational event. Considering the long range of dates, the stratigraphy in the outer fortification ditch, and the large scale massacre of the village inhabitants, the Coalescent occupation of Crow Creek has a much more complex history than has been indicated by previous work. Unfortunately, the only way this problem will be solved is by new excavations in the habitation areas of the site.

Construction of large fortified villages in the Middle Missouri area as early as A.D. 1300 by people of the Initial Coalescent culture seems to be indicated. Furthermore, based on the skeletal evidence, on the presence of the fortifications, and on the evidence of large scale burning of structures, it can also be suggested that the intrusion was not peaceful and it was strongly resisted. Apparently, such resistance at times had been successful but in this instance it failed to stop the spread of Initial Coalescent peoples.

CULTURAL AFFILIATION OF THE VICTIMS

The problem of the cultural affiliation of the massacre victims as evidenced by archeological remains is critical to the understanding of the physical anthropology and ethnic background of the early Plains Village groups in South Dakota. During the course of the excavations, several visiting colleagues raised the issue of whether the massacre victims were associated with the Middle Missouri or Initial Coalescent component at the site. Those favoring a Middle Missouri association envisioned the possibility of the Crow Creek component villagers being overwhelmed and killed by the invading Initial Coalescent peoples.

Several lines of evidence suggest that the victims were in fact the Initial Coalescent occupants of the Wolf Creek village. The skeletal remains were found in the outer fortification ditch. This ditch appears to represent an expansion of the village, indicating an already lengthy occupation by Initial Coalescent peoples. This occupation was long enough to entail the construction of the inner fortification ditch, to fill it with Wolf Creek component midden, and to construct the outer houses and ditch. The cultural material found in association with the bone deposit is all identifiable with the Initial Coalescent variant.

There is also evidence from the 1954-1955 excavations (Kivett and Jensen 1976) that the Wolf Creek village may have been destroyed by hostile groups. Every Wolf Creek component structure excavated or tested showed some signs of having been burned. Some human bone was also recovered from the Wolf Creek component. A human mandible and cranium came from the inner ditch fill. Skull fragments were found in six of the post holes from the inner ditch palisade. Various human remains were noted in refuse pits. Two bell-shaped pits near House V contained a human skull and pelvis. Another pit near House IV held a human femur and several phalanges. Testing of a depression adjacent to the west end of the outer foritifcation ditch revealed a house floor and associated bell-shaped pit. Near the bottom of the pit were the semi-flexed, partially articulated remains of an individual. The skull, right arm and hand, the left forearm and hand, and the feet were missing. This pattern of mutilation was often repeated in the material from the outer fortification ditch which indicates that the villagers may have come to an untimely death.

In other words, a good case can be made for the massacre occurring during the Initial Coalescent occupation of the village. Judging from the evidence, the event probably happened in the middle or later part of the period. Again, all the collected information tends to support the belief that it was the actual villagers who died. This is reinforced by the analysis of the skeletal material which shows that the victims were men, women, and children. This is hardly the composition of an enemy raiding party. One can perhaps safely conclude that the victims were the occupants of the Wolf Creek village. The very fact that the bones were buried indicates they were villagers. If the villagers had killed previous inhabitants or a visiting group it would have been far easier to heave the bodies over the bluff than to have buried them. The midden fill in the ditch and the burial of the dead seem to indicate that in spite of the massive decimation of the village, Initial Coalescent peoples continued to occupy the area, although probably at a much reduced level.

ELEMENT COUNT

Elements were counted in two ways. First, an inventory of each bag was made which listed the minimum number of elements present. Because parts of the same bone may have been in two or more bags, a summation of these inventory counts would overestimate the number of bones present. Additionally, a minimum count was made of the long bones and the petrous portion of the temporals. Bones from the right and left sides were counted separately. Both the inventory and minimum counts were made by Mark Swegle.

Minimum counts were made of the humerus, radius, ulna, femur, tibia, and fibula and the petrous portion of the temporal (Table 11). For each element a single point on the bone was selected, and the count was made of these points. The points chosen for counting were selected because they were easily identified, easily sided, and well preserved. The observer believed that the points selected for counting were at least as well represented as any other points. It is possible that somewhat higher counts may have been made if other points had been used.

Several points were selected. The opening of the internal auditory meatus was used for the petrous portion of the temporal. The middle of the deltoid tuberosity of the humerus was counted. The base of the radial tuberosity of the radius and the base of the coronoid process of the ulna were counted. The base of the lesser trochanter of the femur was counted. The anterior crest at the level of the nutrient foramen of the tibia was selected, and the top of the triangular subcutaneous area near the distal end of the fibula was counted.

AD-A098 882 SOUTH DAKOTA UNIV VERMILLION ARCHAEOLOGY LAB F/G 5/6
THE CROW CREEK SITE (39BF11) MASSACRE: A PRELIMINARY REPORT.(U)
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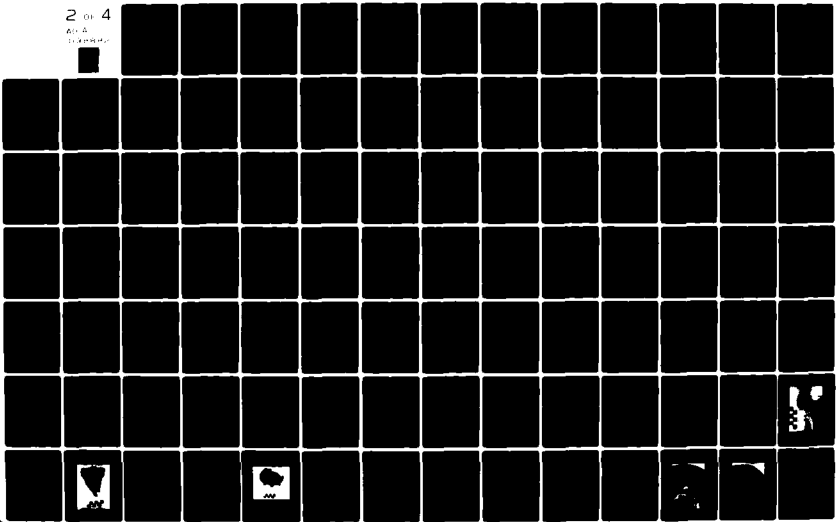
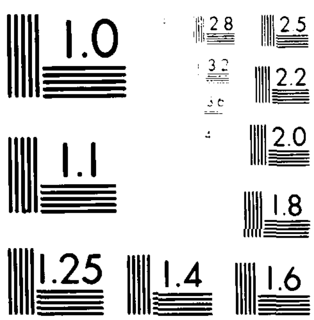




MICROCOPY RESOLUTION TEST CHART

The greatest minimum count, 486, was from the right petrous portion (Table 11). It was concluded that at least 486 individuals are represented in the sample taken from the ditch, and it is probable that more than 486 people are present in the sample.

At the other extreme, in the minimum element count were the 115 right radii (91 left). The differences between the counts of the different elements appear to be a function of size, density, and proximity to the torso. In general, the larger, denser bones closest to the torso are more frequently present than the smaller, lighter, more distal ones. The proximal limb elements are more fully represented than their distal counterparts. The humerus is more common ($n \geq 213$) than the ulna ($n \geq 131$) or the radius ($n \geq 115$), and the femur ($n \geq 367$) is more common than the tibia ($n \geq 269$) or the fibula ($n \geq 156$).

Following the same tendency, it is interesting to note that for all elements except the fibula, the count for the right side is at least as great as that for the left. Because seven bones were counted and the liklihood of one side outnumbering the other side is 0.5, the probability of this distribution happening by chance alone is $(0.5)^6$ or 0.0156. Because the larger, denser bones are more numerous, one would expect the differences between the sides to be greater than that of the smaller, lighter bones. This difference is just the opposite of the actual side count (Table 11). The side difference is greater in the lighter bones (radius side difference 24) than in the larger, denser bones (femur difference 0). The reason for this side difference is not known.

TABLE 11. Minimum element counts of major bones from Crow Creek.

Bone	Left	Right	Right minus Left
Petrous portion of temporal	477	486	9
Humeri	200	213	13
Ulnae	113	131	18
Radii	91	115	24
Femora	367	367	0
Tibiae	262	269	7
Fibulae	156	143	13

Age estimates were recorded for each element included in the minimum count. The age group totals for each element are presented in Table 12. The age categories used were: child (0-10 years), adolescent (11-17 years), adult (18+ years), subadult (0-17 years), adult or adolescent (11+ years), and adult or subadult (0+ years). Only estimates of age were possible due to the isolated nature of most of the bones and due to their often incomplete condition. Largely because of these two problems, the last three categories listed were necessary.

The major discrepancy between the counts for the petrous temporals and the counts for the long bones is in the number and proportion of adults represented. Several things may account for these differences. The higher proportion of adult long bones might have been caused by relatively greater destruction or scattering of the smaller bodies by scavengers or by differential selection of larger bodies and body parts for burial. After burial, greater fragmentation of the younger and smaller long bones may have also occurred. The greater number of adult femurs compared to adult temporals could be largely explained by the large number of temporals included in the adult or adolescent category, particularly with the right temporals. Isolated right temporals were often placed in this category if no associated cranial material were present or ageable, while left temporals were not treated this way so often. Few femurs, though, were placed in this category; if all observable epiphyses were fused,

TABLE 12. Minimum element counts by age group. Numbers in parentheses are percentages.

	Children 0-10	Adoles-cents 11-17	Subadults 0-17	Adults or Adolescents 11+	Adults 18+	Adults or Subadults 0+	Total
Right Petrous Temporal	128 (26.3)	40 (8.2)	29 (6.0)	50 (10.3)	237 (48.8)	2 (0.4)	486
Left Petrous Temporal	132 (27.7)	36 (7.5)	19 (4.0)	10 (2.1)	277 (58.1)	3 (0.6)	477
Left Femur	35 (9.5)	41 (11.2)	7 (1.9)	2 (0.5)	282 (76.8)	0	367
Right Femur	30 (8.2)	37 (10.1)	7 (1.9)	0	293 (79.8)	0	367
Right Tibia	11 (4.1)	27 (10.0)	4 (1.5)	3 (1.1)	224 (83.3)	0	269
Right Humerus	11 (5.2)	20 (9.4)	1 (0.5)	9 (4.2)	172 (80.8)	0	213
Left Fibula	1 (0.6)	4 (2.6)	3 (1.9)	1 (0.6)	147 (94.2)	0	156
Right Ulna	1 (0.8)	4 (3.1)	1 (0.8)	2 (1.5)	123 (93.9)	0	131
Right Radius	1 (0.9)	5 (4.3)	0	4 (3.5)	105 (91.3)	0	115

the bone was marked as being from an adult. This may have resulted in some adolescent femurs being recorded as adult femurs. Additional factors that might have had some slight effect on the discrepancies are the looter's activities and the presence of some unexcavated bone that remains in the fortification ditch. An increase in the minimum count based on comparisons of the age groupings for each element appears to be unjustified, primarily because of unavoidable imprecision in the age estimates.

In addition to the minimum number of elements, a "maximum" number of elements can be estimated (Table 13). This count was made by summing the inventories made for each bag. During the inventory, bones in each bag were assigned as belonging to different individuals based on repetitions of the same parts of the same element and differences in age and sex. In this way the minimum number of elements in each bag was determined. No attempt was made to reassemble elements in different bags, so it is certain that this element count in most cases is greater than an actual minimum count would have been. It is not, on the other hand, _the_ maximum count because fragments in a bag which did not duplicate others and appeared to be the same sex and approximate age were considered as being from the same individual, though in most instances they probably are not.

It seems likely that the counts of the more fragile bones, especially the large fragile ones, are higher than the actual number present. Intuitively it seems likely that the innominates, sacra, vertebrae, scapulae, sterna, and to an extent, the clavicles,

TABLE 13. Minimum and maximum element counts observed compared with expected numbers from Crow Creek. Expected frequencies based on minimum count of 486.

Bone	Left	Right	Total Observed	Expected	% of Expected Observed
Innominates			1133	972	117.7
Petrous portions*	477	486	963	972	99.1
Sacra			396	486	81.5
Femora*	367	367	734	972	75.5
Lumbar vertebrae			1694	2430	69.7
Thoracic vertebrae			3498	5832	60.0
Tibiae*	262	269	531	972	54.6
Scapulae			521	972	53.6
Cervical vertebrae			1665	3402	48.9
Humeri*	200	213	413	972	42.5
Fibulae*	143	156	299	972	30.8
Ulnae*	113	131	244	972	25.1
Clavicles			233	972	24.0
Radii*	91	115	206	972	21.2
Tarsals			577	6804	8.5
Sterna			61	486	12.6
Metatarsals			264	4860	5.4
Coccyges			41	486	8.4
Patellae			39	972	4.0
Carpals			99	7704	1.3
Metacarpals			47	4860	1.0
Hand phalanges			44	13608	0.3
Foot phalanges			11	13608	0.1

*Minimum element counts were performed for these bones. Maximum counts are used for all other bones.

are over-represented by this "maximum" count. It is not possible at present to determine how excessive the count is.

On the other hand, there are some maximum element counts which are probably fairly accurate. These counts are those of the small and durable bones: the carpals, metacarpals, phalanges, patellae, coccyges, tarsals, and metatarsals. It is unfortunate that there is no way of testing the accuracy of these counts.

With these limitations in mind, the maximum count remains the only means of inspecting the relative presence and absence of all elements. An examination of which elements are more frequently missing will add to the understanding of what happened during the raid and between the time of the raid and the time of the burial of the victims.

Inspecting Table 13, the impression is that generally the torso (vertebral column and hips) is better represented than most of the other parts. The elements seem to become less and less frequent the more distally they occur, but element size and density are also factors which complicate the matter. The smaller, less dense bones were less frequently found than the larger, more dense ones. The same generalizations concerning size, density, and proximity to the torso can also be made for the hands (Table 14) and the feet (Table 15) when these are considered separately.

There are five factors which may have influenced the element frequencies observed. Element groups may have been: 1) lost due to

TABLE 14. Maximum counts of Crow Creek wrist and hand elements* compared with expected numbers. Expected number of individuals based on right petrous portion of temporal.

Bone	Number Observed	Number Expected	% of Expected Observed
Naviculars	20	972	2.1
Capitates	16	972	1.6
Lunates	14	972	1.4
Triquetrals	13	972	1.3
Hamates	11	972	1.1
Metacarpals	47	4860	1.0
Greater multangulars	9	972	0.9
Lesser multangulars	9	972	0.9
Phalanges-proximal row	28	4860	0.6
Pisiforms	5	972	0.5
Phalanges-middle row	10	3888	0.3
Phalanges-distal row	0	4860	0

*This count excludes 2 carpals which were not more specifically identified.

TABLE 15. **Maximum counts of Crow Creek ankle and foot elements* compared with expected numbers. Expected number of individuals based on right petrous portion of temporal.**

Bone	Number Observed	Number Expected	% of Expected Observed
Tali	146	972	15.0
Calcanea	108	972	11.1
Naviculars	71	972	7.3
Third cuneiforms	70	972	7.2
Cuboids	69	972	7.1
First cuneiforms	58	972	6.0
Second cuneiforms	53	972	5.5
Metatarsals	264	4860	5.4
Proximal row phalanges	9	4860	0.2
Distal row phalanges	2	4860	0.0
Middle row phalanges	0	3888	0.0

*This count excludes 2 tarsals which were not more specifically identified.

mutilation and dismemberment by the raiding group, 2) destroyed by scavenging carnivores, 3) overlooked when the body parts were picked up for burial, 4) differentially preserved, or 5) lost during excavation, processing, or inspection procedures. Differential preservation is probably not an important consideration since all the bone present was well preserved. The large underrepresentation of the bones of the hands and feet cannot be due solely to loss during excavation, processing, and inspection. The events of the raid and between the raid and the burial of the victims probably played the largest role in determining the frequencies observed. These include loss of bones caused by mutilation and dismemberment, loss caused by carnivore scavenging, and the omission of some of the body parts while being gathered for burial in the fortification ditch.

POPULATION ESTIMATES

It is possible to make an estimate of the number of people living at Crow Creek based on the number of lodges present and the number of people living in each lodge. To make the estimation, certain assumptions must be made; that the average number of people living in each lodge was the same as during the historic period when the numbers of individuals in lodges were recorded, that the lodges at Crow Creek were all inhabited at the same time, and that all the lodges at the site were counted.

Given these assumptions, the two critical numbers in estimating the Crow Creek population are the number of lodges at the site and the number of people per lodge. In their report on Crow Creek, Kivett and Jensen (1976:68) say there are at least 50 lodges from the Initial Coalescent component. To estimate the number of individuals per lodge, Roberts (1977:174, FIG. 35) has provided formulae based on historic accounts. His figure for the number of people per lodge for groups with unknown cultural affiliation is almost 15 (14.88) and for the Arikara is 16.62. Using Robert's formula for groups of unknown cultural affiliation, at least 744 people would have been present. If his formula for Arikara is used, at least 831 people would have lived at the site.

That these are minimum figures cannot be stressed enough. One reason these figures must be considered minimal is because the village appears to have been expanding, which suggests that all or nearly all of the lodges were inhabited. The 50 lodge estimation is also considered minimal by Kivett and Jensen, and it is entirely possible that there are other silted-over lodges in the lower, southwestern part of the village.

Having estimated the probable minimum number of people who lived at Crow Creek and a minimum number of skeletons represented, it is appropriate to compare the two. Using the estimate of village population (831) and the minimum number of skeletons (486), it seems that only about 58.5 percent of the village's population is represented by the skeletons from the ditch. There are a number of possible explanations why the other 41.5 percent are missing. First, it is possible that the estimate of the number of people living at Crow Creek and the number of skeletons represented in the ditch are inaccurate. Secondly, it is known that there is additional, unrecovered skeletal material continuing east from the bone deposit in the fortification ditch, so not all of the material has been recovered. There may also be additional skeletal material present elsewhere in the ditch, the village, or outside the village. Some material may have been destroyed by natural causes and thus was not recoverable. Additional possibilities are that some members of the village were absent when the raid occurred, some people were able to escape from the village massacre, and/or some members were taken captive.

CROW CREEK PALEODEMOGRAPHY

Paleodemography has recently received a great deal of attention in skeletal studies. The reasons for the interest are many, but perhaps most important for archeological studies is that population structure and size reflect influences of both cultural and physical environments and indicate a group's adaptation or lack of adaptation to stresses. Paleodemographic information is particularly suited for approaching problems in cultural ecology and cultural processes.

The Crow Creek sample is relatively unique as a skeletal sample because all of the individuals were alive at a single time and died almost simultaneously in the massacre. Crow Creek is unusual because there is no slow-death selection as there is in cemetery samples, and warfare was the single cause of death. Crow Creek paleodemography therefore offers an exciting opportunity to look at a population profile.

Life tables, presenting vital statistics, are calculated to describe the Crow Creek population structure. The methods for determining sex and estimating age are first described because these are the crux of the paleodemographic results. The resulting vital statistics are then described and compared with those from the Larson site near Mobridge, South Dakota.

METHODS

The estimation of age and sex is crucial to studying population structure. Both aging and sexing the Crow Creek material have been done using standard osteological techniques. Age was estimated using two approaches: dental development for the subadults and pubic symphysis morphology for the adults.

Subadult age was estimated using dental development because it is acknowledged as a more accurate estimator of chronological age than is skeletal development. The dental standards of Morrees, et al. (1963a, b), which are considered the most accurate available (Merchant and Ubelaker 1977), were employed. Dental aging also seemed most appropriate given the commingled and fragmentary nature of the sample. Use of epiphyseal union as an aging standard was impractical due to the lack of complete or even nearly complete skeletons. Both the maxillae and mandibles of subadults and those adults with open M3 roots were X-rayed so that dental development could be assessed. When both sides of the mandible or maxilla were present, the side with the more complete dental set was X-rayed. If both sides had equal dental sets, left maxillae and right mandibles were preferred. To avoid duplication of fragmented jaws, only those pieces containing the m2 or PM2 tooth or socket crypt were included in the analysis.

All dental X-rays were taken and developed in The University of South Dakota's Department of Dental Hygiene. Standard DF-58 film packets were used, employing a paralleling, long cone technique. The photography and developing were done by Max Schmeling, Mark Swegle, and Jeff Swenson. Swegle scored the dental development using X-rays and inspected the actual tooth when it was loose enough for removal from the alveolus. All teeth, except deciduous incisors, were scored with the Moorrees, et al. (1963a, b) standards.

Although the Moorrees, et al., standards were used almost entirely for mandibular teeth, maxillary teeth were also X-rayed, and age estimates based on these were obtained by using the mandibular standards. This approach was taken because there were far more maxillae than mandibles, and there appears to be little difference between dental developement of mandible and maxilla (Owsley, personal communication). To test for dental development difference between mandible and maxilla, 50 mandible-maxilla pairs were aged independently and tested for statistical significance. A paired t-test was executed and found not significant ($t = 1.13$, d.f. = 49, $0.2 < p < 0.5$). A X^2 test was also executed on the distribution of mandible and maxilla age estimations which were divided into 10 subadult age categories (Table 16); it, too, was not significant ($X^2 = 11.01$, d.f. = 9, $0.5 > p > 0.25$). Because of the similarities between the mandible and maxilla, the researchers used the age estimations interchangeably. The subadult age distribution used employs the maximum number assessed for age, mandible or maxilla, for each age interval. Nevertheless, there are problems in aging the maxillae which should be noted. Because the X-ray films are usually placed at an angle, rather than parallel, to the maxillary teeth, more distortion was present than in the mandibular X-rays. It was also more difficult to consistently place the film packets on the maxilla than on the mandible.

Ages for adults and the oldest adolescents were estimated using pubic symphysis morphology following McKern and Stewart's (1957)

TABLE 16. Distribution of Crow Creek subadult dental ages.

Ages in Years	Mandible	Maxilla
0-0.5	3	0
0.5-2.5	19	22
2.5-4.5	12	21
4.5-6.5	26	45
6.5-8.5	13	15
8.5-10.5	15	24
10.5-12.5	9	13
12.5-14.5	5	11
14.5-16.5	17	15
16.5-18.5	10	6
Totals	129	172

$X^2 = 11.01$, d.f. $= 9$, $0.5 > p > 0.25$

technique for young adult males, Gilbert and McKern's (1973) technique for adult females, and Todd's (1921) phases for the oldest adults. The pubis was employed for the adult age and sex determinations because cranial age and sex determinations are less reliable and because more adult symphyses than complete crania were present in the series. The crania complete enough or reconstructible enough to be used in the distance studies were nevertheless scored for endocranial suture closure and for dental attrition.

While using the McKern and Stewart and the Gilbert and McKern methods, the plastic casts and the written descriptions of the pubic changes associated with the methods were employed. Using the Todd method, the written description and a xerox copy of the male standards were employed. Mark Swegle made all assessments, and most all were done twice.

There has been recent criticism of the Gilbert and McKern standards by Suchey (1977). Gilbert and McKern's standards were found to be more difficult to use than McKern and Stewart's, and intraobserver error was substantial. Nevertheless, age estimations based on the Gilbert and McKern technique were retained in this analysis to make them comparable to those determined for the Larson site population.

The other important variable in a demographic profile is sex. Sex estimation employed the pubis and followed Phenice's (1969) criteria, which are generally very reliable (Kelley 1978). Using the pubes for sex determination has the advantages of accuracy and the frequent association with an ageable symphysis. Phenice's technique is appropriate for adults only.

No attempt was made to determine subadult sex because of the difficulties in the assessment and relative lack of accuracy. Nevertheless, to consider the adult sexes separately, the life table manipulations require subadults to be sexed. This difficulty was overcome by dividing the number of un-sexed subadults in each age interval in half. If the number of individuals was odd, one was arbitrarily added to the male half. This was done for all categories 14 years and younger.

Life table computations were made for the sexes combined and for each sex separately. The aged individuals were classified into one of 13 age categories (x). For each age category the number dying (D_x), percentage dying (d_x), percentage of survivors (l_x), probability of death (q_x), total number of years lived, (L_x), total number of years lived after the age category (T_x), and life expectancy (e_x^o) were calculated. All computations followed standard procedures (Acsadi and Nemeskeri 1970; Owsley 1975).

The sample profiles produced using the number in each age category are erratic and cannot accurately reflect the actual population (Tables 17, 18, 19, and 20; FIG. 8). This statement is especially true of the adult age distribution. Note, for instance, the lack of any individuals in the 40-44 age category. These bumps and dips are understandable given the aging criteria. The reason there are no individuals in the 40-44 year interval is because

TABLE 17. Unsmoothed age and sex distribution of skeletons from the Crow Creek fortification ditch. Subadults ($\leq$ 14 years) arbitrarily divided into the sexes.

Age Interval	Male	Female	Total
0- 1	5	4	9
1- 4	16	16	32
5- 9	36	35	71
10-14	20	20	40
15-19	23	6	29*
20-24	20	9	29
25-29	31	6	37
30-34	0	5	5
35-39	4	17	21
40-44	0	0	0
45-49	3	13	16
50-54	4	0	4
55-59	13	26	39
Totals	175	157	332

*Excludes another 29 dentally aged for which no sex was assigned.

TABLE 18. Unsmoothed, abridged life table for both sexes from Crow Creek.

Age Interval	D_x	d_x	l_x	q_x	L_x	T_x	e^o_x	M_x
0- 1	9	2.7	100.0	.027	97.84	2274.77	22.75	43.96
1- 4	32	9.6	97.3	.099	393.18	2176.93	22.37	
5- 9	71	21.4	87.7	.244	385.00	1783.75	20.34	
10-14	40	12.0	66.3	.181	301.50	1398.75	21.10	
15-19	29	8.8	54.3	.162	249.50	1097.25	20.21	
20-24	29	8.8	45.5	.193	205.50	847.75	18.63	
25-29	37	11.1	36.7	.302	155.75	642.25	17.50	
30-34	5	1.5	25.6	.059	124.25	486.50	19.00	
35-39	21	6.3	24.1	.261	104.75	362.25	15.03	
40-44	0	0	17.8	.000	89.00	257.50	14.47	
45-49	16	4.8	17.8	.270	77.00	168.50	9.47	
50-54	4	1.2	13.0	.092	62.00	91.50	7.04	
55-59	39	11.8	11.8	1.000	29.50	29.50	2.5	
Total	332							

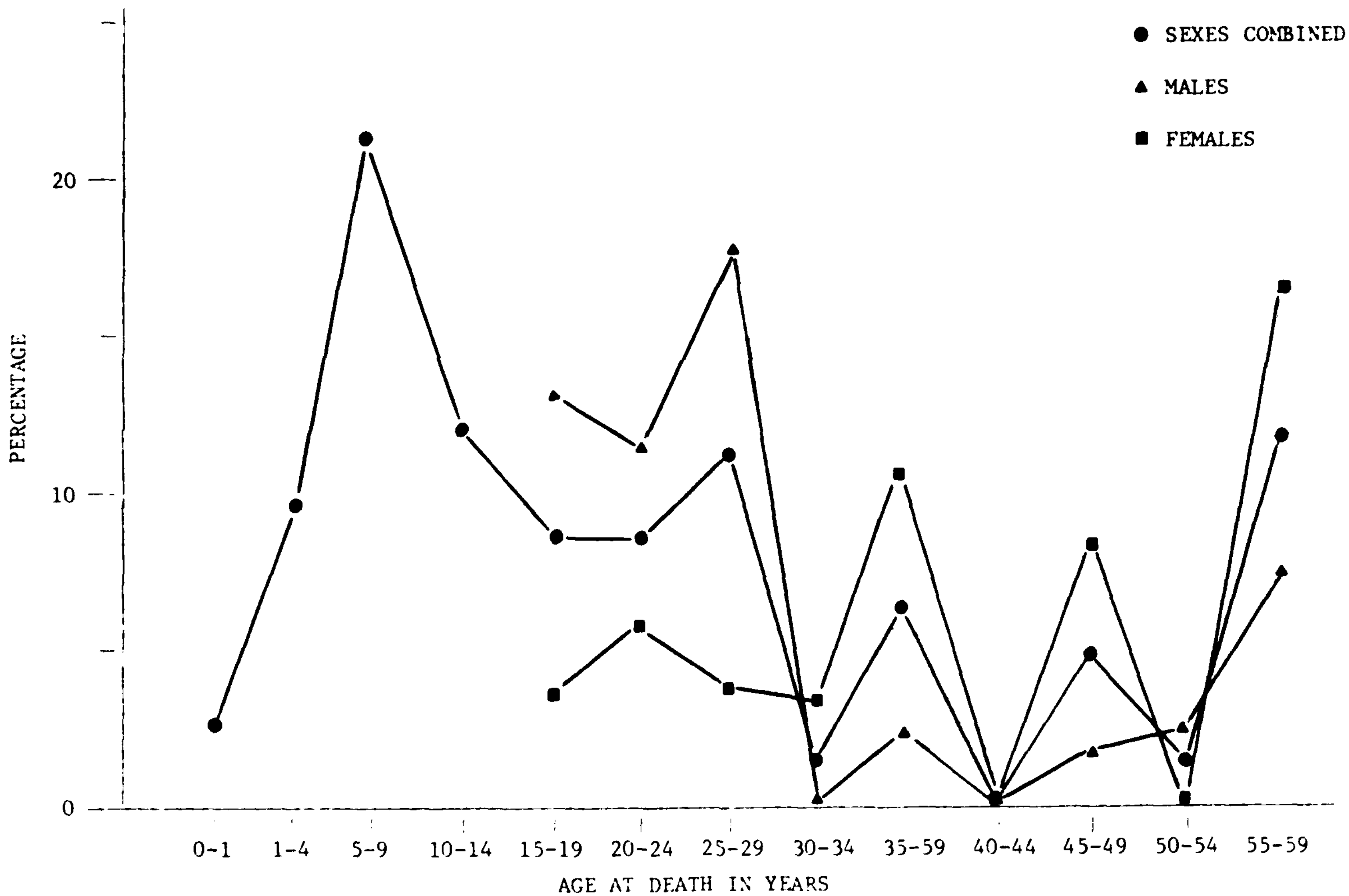
TABLE 19. Unsmoothed, abridged life table for Crow Creek males. Subadult (≤ 14 years) numbers are estimated.

Age Interval	D_x	d_x	l_x	q_x	L_x	T_x	e_x^o	M_x
0- 1	5	2.9	100.0	.029	97.68	2035.46	20.35	49.14
1- 4	16	9.1	97.1	.094	393.78	1937.78	19.96	
5- 9	36	20.6	88.0	.234	388.50	1544.00	17.55	
10-14	20	11.4	67.4	.169	309.5	1155.50	17.14	
15-19	23	13.1	56.0	.234	247.25	847.00	15.13	
20-24	20	11.4	42.9	.266	186.00	599.75	13.98	
25-29	31	17.7	31.5	.562	113.25	413.75	13.13	
30-34	0	0	13.8	0	69.00	300.50	21.78	
35-39	4	2.3	13.8	.167	58.75	231.50	16.78	
40-44	0	0	11.5	0	57.50	172.75	15.02	
45-49	3	1.7	11.5	.148	53.25	115.25	10.02	
50-54	4	2.3	9.8	.235	53.25	62.00	6.33	
55-59	13	7.4	7.5	.987	18.75	18.75	2.50	
Total	175							

TABLE 20. Unsmoothed abridged life table for Crow Creek females. Subadult ($\leq$ 14 years) numbers are estimated.

Age Interval	D_x	d_x	l_x	q_x	L_x	T_x	e^o_x	M_x
0- 1	4	2.5	100.0	.025	98.00	2542.61	25.43	39.3
1- 4	16	10.2	97.5	.105	392.31	2444.61	25.07	
5- 9	35	22.3	87.3	.255	380.75	2052.30	23.51	
10-14	20	12.7	65.0	.195	293.25	1671.55	25.72	
15-19	6	3.8	52.3	.073	252.00	1378.30	26.35	
20-24	9	5.7	48.5	.117	228.25	1126.30	23.22	
25-29	6	3.8	42.8	.089	204.50	898.95	20.98	
30-34	5	3.2	39.0	.082	187.00	693.55	17.78	
35-39	17	10.8	35.8	.302	152.00	506.55	14.15	
40-44	0	0	25.0	0	125.00	354.55	14.18	
45-49	13	8.3	25.0	.333	104.25	229.55	9.18	
50-54	0	0	16.7	0	83.50	125.30	7.50	
55-59	26	16.6	16.7	.994	41.75	41.75	2.50	
Total	157							

FIGURE 8. Non-smoothed mortality (d_x) curve of Crow Creek sample.



neither the McKern and Stewart nor Gilbert and McKern standards have mean estimated ages in the 40-44 range. Another problem with the distribution is that the older ages are heavily represented. This is not surprising because Brooks (1955) has shown that Todd's standards, used for these older age assessments, tend to over-age in the later decades. Those who might have been 60 years or older are placed into a younger category. Both of these problems suggest that alteration in adult age distribution is warranted.

Curve smoothing is a technique often used in similar situations to more closely approximate the actual distribution. Although there are various mathematical methods (eg., 3-member moving average) for smoothing, the most simple, graphic smoothing, was done. Age intervals with large numbers of individuals were decreased and adjacent intervals increased. No numbers were transferred further than the next younger or next older interval. The resulting tables and charts seem to much more accurately reflect the expected contours of a normal age distribution. It must be kept in mind, though, that this is a questionable practice and may have eliminated differences which were actually present. Nevertheless, smoothing the distribution seems preferable to using the raw values. All comments made in the subsequent sections are based on the smoothed data.

PALEODEMOGRAPHIC VITAL STATISTICS

The results from the data collected as described in the previous section constitute the life table. Data in the life table includes the number dying in each age interval (D_x), the percentage dying in each age interval, also called mortality (d_x), survivorship or the percentage surviving each age interval (l_x), the probability of dying in each age interval (q_x), life expectancy in each age interval (e^o_x), and crude death rate (M_x). The other information presented in the life table is merely used to calculate the parameters just mentioned, including L_x and T_x. The results are presented in tables for the sexes combined (Tables 21,22), males (Table 23), and females (Table 24). Graphs for the life table data are also presented (FIGS. 9,10,11,12).

Of the 180 adults sexed by pubic morphology, 98 (54.44 percent) were males and 82 (45.56 percent) were female. To test whether there is a disproportionate number of one sex, a binomial Z-score was calculated assuming a 1:1 sex ratio. The result was not significant ($Z = 1.192$, $F(Z) = 0.88$, $p < 0.12$). Although there is some indication that more males than females were present, the difference is not statistically significant.

Mortality data is probably the information most commonly presented in paleodemographic studies. The Crow Creek mortality curve (FIG. 9) is peculiar because so few infants and young children (0-4 years) are present, though there is a high proportion of older children (5-14 years) present. After childhood, the frequency of death decreases gradually through middle adulthood (35-44) and rises again in late adulthood.

There are some interesting sex differences in mortality. Female mortality remains relatively low in young through middle adult-

TABLE 21. Smoothed distribution of Crow Creek ages at death.

Age Interval	Males	Females	Total
0- 1	5	4	9
1- 4	16	16	32
5- 9	36	35	71
10-14	20	20	40
15-19	22	7	29
20-24	21	7	28
25-29	16	7	23
30-34	15	7	22
35-39	4	7	11
40-44	3	8	11
45-49	4	13	17
50-54	7	13	20
55-59	6	13	19
Total	175	157	332

TABLE 22. Smoothed, abridged life table for both sexes from Crow Creek.

Age Interval	D_x	d_x	l_x	q_x	L_x	T_x	e_x^o	M_x
0- 1	9	2.7	100.0	.027	97.84	2264.77	22.65	44.15
1- 4	32	9.6	97.3	.099	393.18	2166.93	22.27	
5- 9	71	21.4	87.7	.244	385.00	1773.75	20.23	
10-14	40	12.0	66.3	.181	301.50	1388.75	20.95	
15-19	29	8.8	54.3	.162	249.50	1087.25	20.02	
20-24	28	8.5	45.5	.187	206.25	837.75	18.41	
25-29	23	6.9	37.0	.186	167.75	631.50	17.07	
30-34	22	6.7	30.1	.223	133.75	463.75	15.41	
35-39	11	3.3	23.4	.141	108.75	330.00	14.10	
40-44	11	3.3	20.1	.164	92.25	221.25	11.01	
45-49	17	5.1	16.8	.304	71.25	129.00	7.68	
50-54	20	6.0	11.7	.513	43.50	57.75	4.94	
55-59	19	5.7	5.7	1.000	14.25	14.25	2.50	
Total	332							

TABLE 23. Smoothed, abridged life table for Crow Creek males. Subadult ($\leq$ 14 years) numbers are estimated.

Age Interval	D_x	d_x	l_x	q_x	L_x	T_x	e_x^o	M_x
0- 1	5	2.86	100.00	.029	97.71	2043.13	20.43	48.95
1- 4	16	9.14	97.14	.094	393.83	1945.42	20.03	
5- 9	36	20.57	88.00	.234	388.58	1551.59	17.63	
10-14	20	11.43	67.43	.170	308.58	1163.01	17.25	
15-19	22	12.57	56.00	.224	248.58	854.43	15.26	
20-24	21	12.00	43.43	.276	187.15	605.85	13.95	
25-29	16	9.14	31.43	.291	134.30	418.70	13.32	
30-34	15	8.46	22.29	.384	90.03	284.40	12.76	
35-39	4	2.29	13.72	.167	62.88	194.37	14.17	
40-44	3	1.71	11.43	.150	52.88	131.49	11.50	
45-49	4	2.29	9.72	.236	42.88	78.61	8.09	
50-54	7	4.00	7.43	.538	27.15	35.73	4.81	
55-59	6	3.43	3.43	1.000	8.58	8.58	2.50	
Total	175							

TABLE 24. Smoothed abridged life table for Crow Creek females. Subadult (≤ 14 years) numbers are estimated.

Age Interval	D_x	d_x	l_x	q_x	L_x	T_x	e^o_x	M_x
0- 1	4	2.5	100.0	.025	98.00	2520.56	25.21	39.67
1- 4	16	10.2	97.5	.105	392.31	2422.51	24.85	
5- 9	35	22.2	87.3	.254	381.00	2030.25	23.26	
10-14	20	12.6	65.1	.194	294.00	1649.25	25.33	
15-19	7	4.5	52.5	.086	251.25	1355.24	25.81	
20-24	7	4.5	48.0	.094	228.75	1104.00	23.00	
25-29	7	4.5	43.5	.103	206.25	875.25	20.12	
30-34	7	4.5	39.0	.115	183.75	669.00	17.15	
35-39	7	4.5	34.5	.130	161.25	485.25	14.07	
40-44	8	5.1	30.0	.170	137.25	324.00	10.08	
45-49	13	8.3	24.9	.333	103.75	186.75	7.50	
50-54	13	8.3	16.6	.500	62.25	83.00	5.00	
55-59	13	8.3	8.3	1.000	20.75	20.75	2.50	
Total	157							

FIGURE 9. Smoothed mortality (d_x) curves of Crow Creek sample.

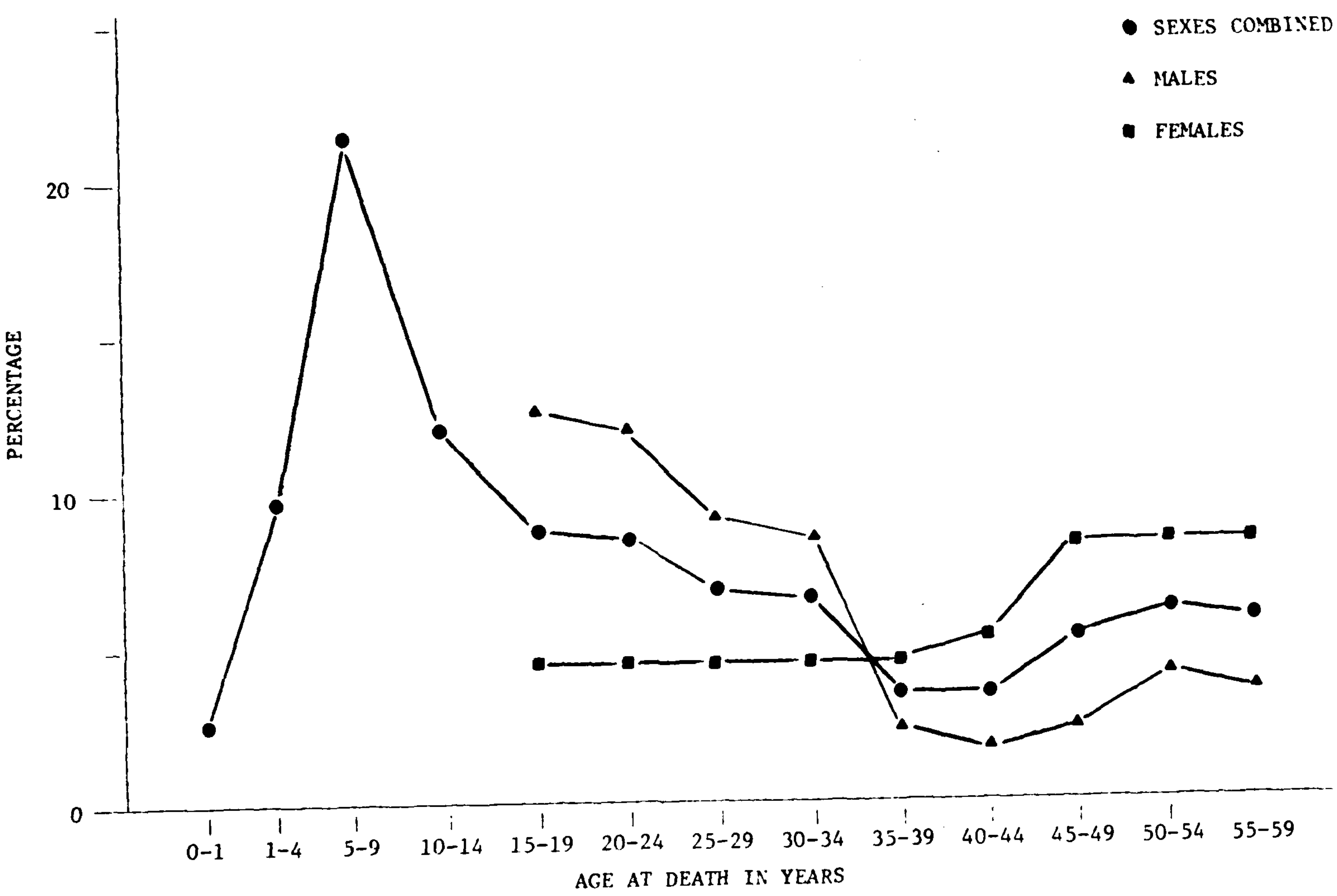


FIGURE 10. Smoothed survivorship (1_x) curve of Crow Creek sample.

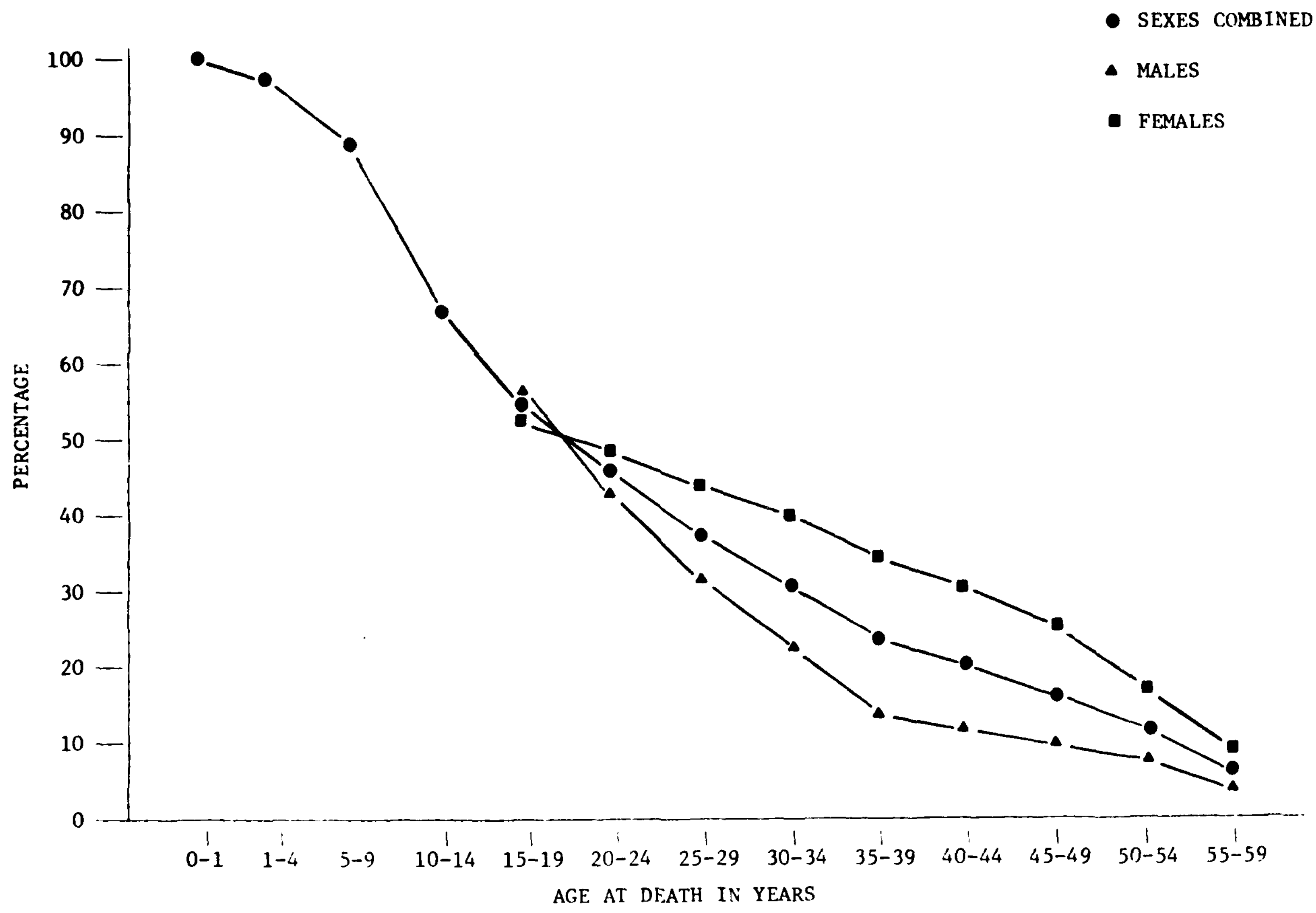


FIGURE 11. Smoothed probability of death (q_x) of Crow Creek skeletal sample.

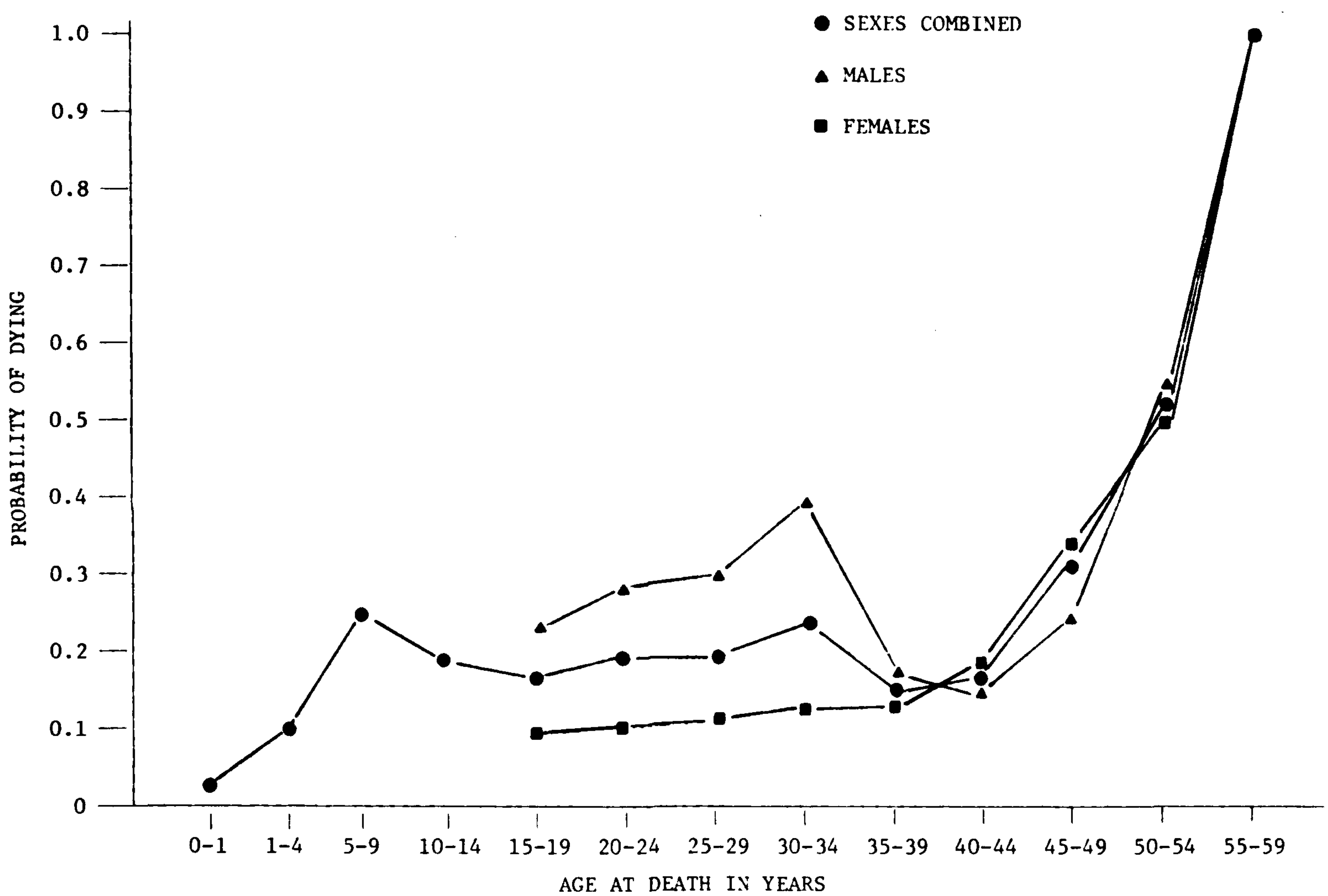
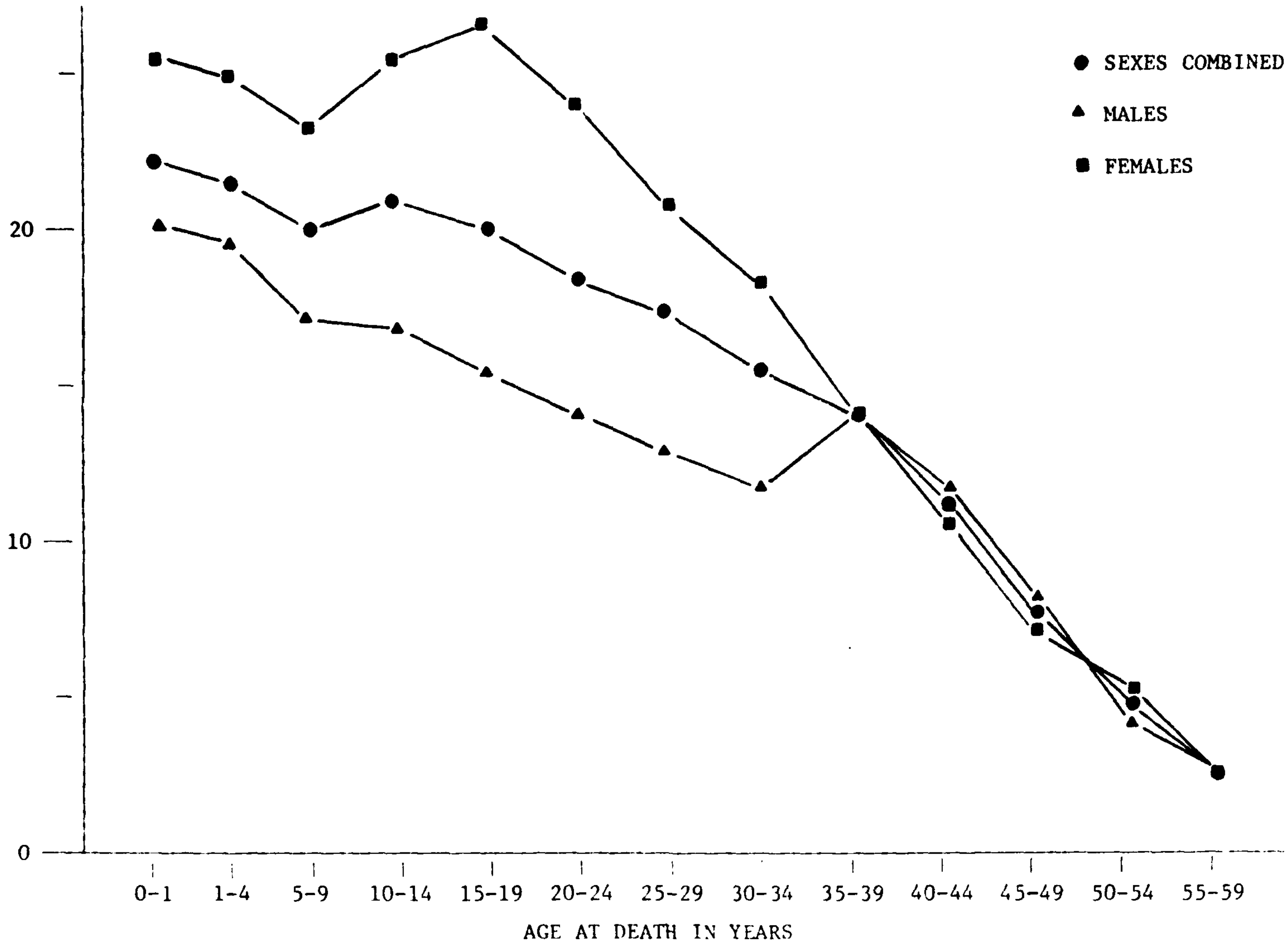


FIGURE 12. Smoothed life expectancy (e_x^o) curve of the Crow Creek sample.



hood (15-44 years), and rises in later adulthood. Male mortality is a little more complicated. Male mortality is very high in young adults (15-29), falls to a low during middle adulthood (35-49), and then rises slightly among the older adults (50-59). Possible reasons for these differences, as well as other aspects of the life table, will be discussed in the following sections.

Survivorship is the reverse of mortality. Because of the directly inverse relationship between these two parameters, the sort of information they present is similar.

The survivorship (FIG. 10) of the sexes combined is surprisingly high in the 0-1 year interval. Survivorship falls rapidly from 1-14, after which it continues to fall, but not so sharply. Considering the sexes separately, female survivorship is greater than male for all age intervals except 15-19 years. Male survivorship steeply falls from 15-39 years, then it levels off. Female survivorship, on the other hand, falls more gradually from 15-49 years, then drops rapidly in the 50-59 years interval.

The probability of dying in each age interval is calculated by dividing the percentage of individuals dying in age interval x by the percentage living in interval x - 1. Considering first the probability of death for the sexes combined (FIG. 11), there is a peak in the 5-9 year interval and another peak at 30-34, followed by a rapid increase after 44 years. One might have expected the first peak to be earlier with less change after that, but otherwise the probability of death curve for the sexes combined is as expected.

Taking the sexes separately, there are several marked differences. The probability of death for males is greater than that for females through age 39. The male probability rises to a peak in the 30-34 year interval and then falls until age 45, after which it sharply increases. The female probability of death, on the other hand, shows no major up and down fluctuations. It slowly rises from 15-39 and sharply increases after 40 years.

Life expectancy at birth for the sexes combined is 22.65 years (Table 22, FIG. 12), and it steadily drops after birth with the exception of the slight rise in the 10-14 year interval.

The sexes have different life expectancies, especially in the earlier years. Female life expectancy at birth is 25.21 years, almost 5 years more than that for males (20.43 years). Through middle adulthood, females continue to have a higher life expectancy (FIG. 12). From middle adulthood (35-39 years) on, life expectancy for the sexes is very similar.

The crude death rate (total number of individuals dying/1000/year) characterizes mortality in a single figure. The crude death rate for both sexes is 44.15 per year, 48.95 for the Crow Creek males and 39.67 for the females. The male death rate is much higher than the female rate. Perhaps the best use of the crude death rate is intersample paleodemographic comparison, the topic of the following section.

PALEODEMOGRAPHIC COMPARISONS

Several population profiles are appropriate for comparison with that from Crow Creek. The samples from the Larson Village and Larson Cemetery in north-central South Dakota are especially appropriate because of their geographic proximity, their relatively close protohistoric date (ca. A.D. 1750-1780), their similarity in subsistence base and the fact that the same aging and sexing techniques were used on all these samples. A final reason for the comparison is that the Larson Village was attacked and its inhabitants were murdered and left lying on earth lodge floors (Owsley, et al. 1977). The situation is similar to that at Crow Creek and merits closer examination.

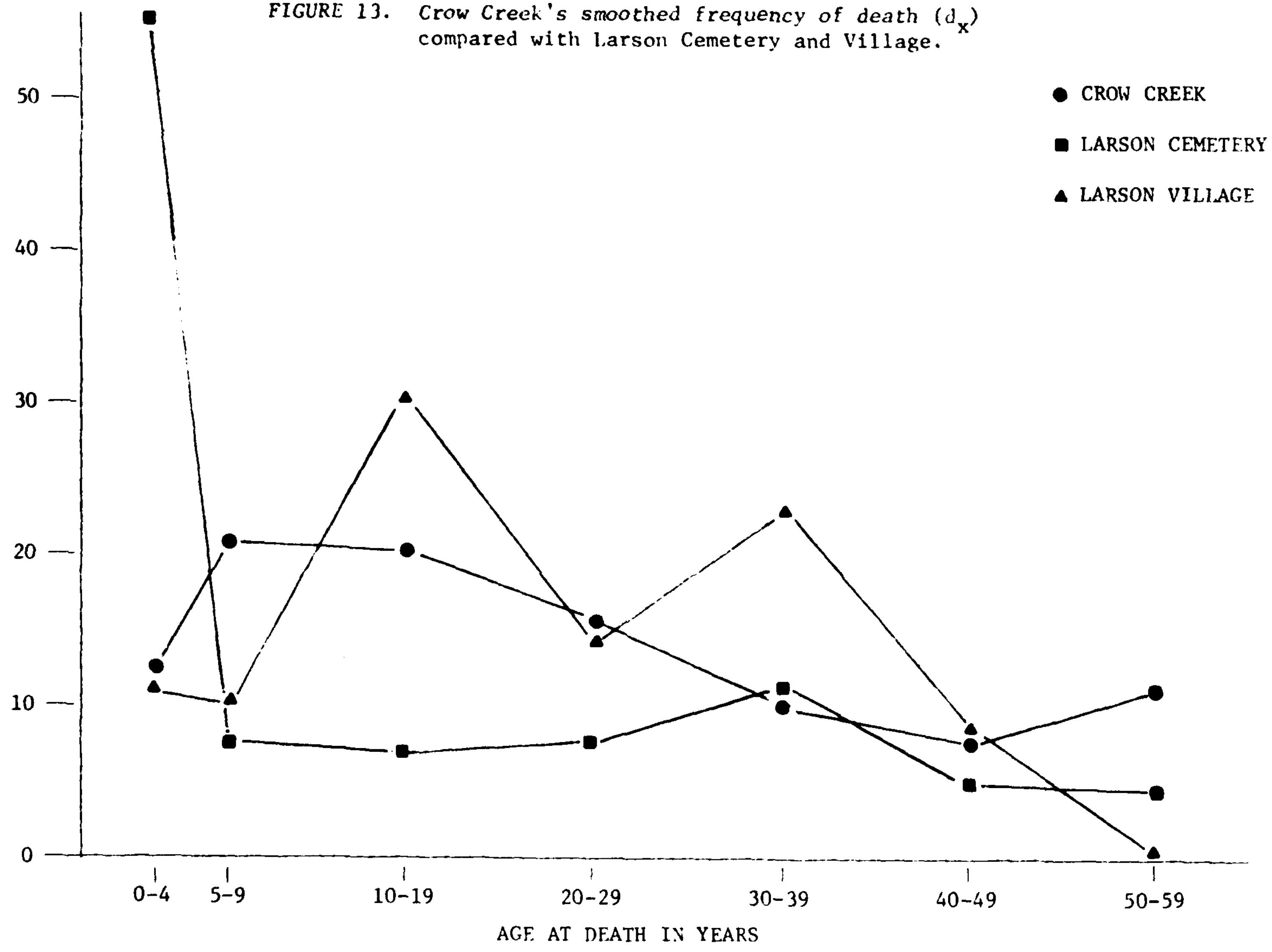
The frequency of deaths in the Crow Creek, Larson Village and Larson Cemetery samples will be considered in general terms (Table 25, FIG. 13). The high incidence of young (0-4 years) children's deaths at the Larson Cemetery followed by very few in the next age grouping is fairly typical of the pattern seen in other cemetery samples from the same region and same era (cf. Owsley 1975:86, Table 9; 87, Fig. 10). This trend is reversed at the two massacre sites, Larson Village and Crow Creek. There the frequencies of death in the 0-4 year interval are comparatively low and rise in the older subadults age groups. The high number in the 0-4 year interval in the Larson Cemetery probably results from birth trauma, birth defects, and infectious diseases. The low numbers in the Larson Village and Crow Creek samples might indicate that youngsters were taken as prisoners by the raiders or that their remains were carried away or devoured by carnivores, probably wolves and village dogs.

TABLE 25. Comparison of Crow Creek ages with the Larson Cemetery and Larson Village distributions.

Age Interval	Crow Creek Number	Crow Creek %	Larson Site* Village Number	Larson Site* Village %	Larson Site* Cemetery Number	Larson Site* Cemetery %
0- 4	41	12.3	8	11.8	348	56.0
5- 9	71	21.4	7	10.3	48	7.7
10-19	69	20.8	21	30.9	45	7.2
20-29	51	15.4	10	14.7	47	7.6
30-39	33	10.0	16	23.5	74	11.9
40-49	28	8.4	6	8.8	34	5.5
50-59	39	11.7	0	0.0	25	4.0
Total	332	100.0	68	100.0	621	99.9

*From Owsley, et al, 1977, Table 3, p. 126. Numbers of individuals are calculated from percentages presented in that paper.

FIGURE 13. *Crow Creek's smoothed frequency of death* (d_x) compared with Larson Cemetery and Village.



When the three samples are inspected more carefully for specific differences, a great many are found. The Crow Creek age distribution differs significantly from both Larson Village and Larson Cemetery samples. The number and frequency of individuals represented are reported in Table 25 and Figure 13. Considering the Larson Cemetery sample first, the greatest frequency is at 0-4 years, dropping rapidly and remaining low after that. A X^2 test comparing Larson Cemetery with Crow Creek and Larson Village combined was highly significant ($X^2 = 219.76$, df. = 6, $P < 0.001$).

The Crow Creek frequency of death curve is almost exactly the reverse of that for the Larson Cemetery. When Crow Creek's frequencies rise from 0-4 to 5-9 years and from 40-49 to 50-59 years, Larson Cemetery's fall; when Crow Creek's frequencies fall from 10-19 to 20-29 years and from 20-29 to 30-39 years, Larson Cemetery's rise. But from 5-9 to 10-19 years both slightly fall or stay the same, and from 30-39 to 40-49 years, both fall. This distribution indicates that generally those groups dying under "normal" conditions and being buried in cemeteries (eg., Larson Cemetery) are not as frequently represented in a catastrophic event like a massacre.

Both Larson Village and Crow Creek start with fairly low frequencies of deaths during 0-4 years but these rise through the second decade of life and then decline. Despite these general similarities, Crow Creek and Larson Village age distributions are significantly different ($X^2 = 40.73$, df = 6, $P < 0.001$).

The differences between Larson Village and Crow Creek are irregular. Specimens are proportionately more frequent from Crow Creek than Larson Village in age intervals 5-9 and 50-59, while there are proportionately more from Larson Village in age intervals 10-19 and 30-39. The frequencies of the two samples are almost identical in the 0-4, 20-29, and 40-49 year intervals. It is interesting that Larson Village and Crow Creek show different age profiles since both samples resulted from raids on villages.

The differences might be caused by: 1) interobserver error, 2) sampling error, 3) previous catastrophic events affecting the Larson Village and Cemetery samples,4) different treatment of some age/sex groups by the raiders, 5) different situations in which some individuals escaped or were not in camp, 6) some age/sex groups dying where they were not as likely to be recovered, or 7) different post-mortem treatment of some groups, or 8) different demograhpic profiles in life.

The differences in the age frequencies might be caused by consistent interobserver differences. Nevertheless, the osteologists analyzing the samples were using the same standards and essentially the same techniques, so bias should have been minimized. Sampling error is another possibility, especially considering the relatively small Larson Village sample (n = 68). If the differences between the Larson Village and Crow Creek samples are real, however, then other explanations are needed.

It is possible that the many fluctuations present in the Larson Village profile indicate periods of intense selection.

Perhaps the relatively under-represented age groups reflect previous mass deaths (eg., other raids or epidemics). Raiders may have taken captive some members of a particular sex or age group. It is possible that the raiders at the different massacre sites made captives of different groups. It is also possible that the raid at Larson Village and the raid at Crow Creek happened at different seasons when different segments of the village populations were present or that opportunities for escape from the raiders were different. Finally, it is possible that different groups received different post-mortem treatment; either the raiders preferred to mutilate and carry off certain age/sex groups or carnivores were better able to completely devour or drag off younsters at one site compared to the other. It is possible that these influences, singly or in combination, may have affected the age profile differences between the two samples.

An interesting similarity between Crow Creek and Larson Village is that both have a greater number of males than females. As already mentioned, the difference between the sexes at Crow Creek is not significant ($P < 0.12$). The difference at Larson Village, however, is significant ($Z = 1.697$, $F(Z) = 0.9554345$, $P < 0.05$). The disproportionately fewer females at Larson Village may have resulted from the raiders taking women as captives (Owsley, et al. 1977:126-127).

There are numerous historic references to Upper Missouri region Indian battles in which raiders attacked a group which included men, women and children. The general course was for the men to fight, allowing the women and children a chance to escape. These practices may have occurred prehistorically as well; a relative lack of females in a massacre might be explained in this way. There are other possibilities including sampling error, females incorrectly sexed as male (see Weiss [1972] for a discussion of sexing bias),and female escape.

CRANIAL MORPHOLOGICAL DISTANCES

Two data sources, cranial measurements and cranial non-metric observations, were used to estimate morphological distances within the Crow Creek sample and between Crow Creek and other samples. Using morphological distances, three problems were studied.

Looking for variation within the Crow Creek sample, principal component scores from cranial measurements were employed in an outlier analysis and in an analysis of morphological variability and burial location. The outlier analysis was performed to see if morphologically dissimilar skulls were present in the sample. Inspection of cranial variation and burial location was done to see if placement in the trench was associated with morphology.

The third problem studied compared Crow Creek cranial measurements and cranial observations with those from other samples from the Plains. The purpose of this analysis was to determine Crow Creek's morphological similarities with other samples and to suggest tribal affiliation.

Before considering the results of these analyses, the methods used to acquire the data are described. This section is detailed, but this is necessary so that the variety of data collected will be known, not just those measurements and observations used to assess morphological distances.

All relatively complete adult skulls were reconstructed, measured, and observed for discrete traits. Altogether 104 skulls were measured and 102 observed. Thirty-eight skull measurements and seven mandibular measurements were taken on each specimen. P. Willey took all measurements. The measurements (taken) and their definitions are largely from those Hugh Berryman selected for a similar study of Tennessee skeletal material. Berryman derived them primarily from four sources: Howells' (1973) Cranial Variation, Lin's (1973) dissertation, Bass' (1971) Human Osteology, and Hrdlicka's Practical Anthropometry (1952). The definitions and abbreviations which follow come almost entirely from Berryman's handwritten, first draft. Most of these are direct quotations from the original author's description.

Instruments used were on loan from the University of Tennessee's Department of Anthropology. Below are the Roman numerals which indicate the type of instruments used to take the measurements in the measurement list and the University of Tennessee's instrument number.

I. Hinge caliper (UT #9)

II. Sliding caliper (UT #9)

III. Coordinate caliper (UT #2)

IV. Western-Reserve Head Spanner (UT #225438)

The format of the following cranial and mandibular measurement definitions remains the same for all of the measurements. Following the measurement name is its abbreviation in parentheses, then a Roman numeral indicating the instrument used to take the measurement. Next the measurement definition and reference are presented. If no reference is given, the definition is from Berryman. Finally, pertinent comments specific to the Crow Creek specimens are made concerning modifications of and comments about the measurements.

DEFINITIONS OF CRANIAL MEASUREMENTS

Glabella-occipital length (GOL) I "Greatest length from the glabella region in the median sagittal plane," (Howells 1973:170). These not taken on external occipital protuberance or associated muscle markings. Grease pencil was used to mark glabella.

Maximum cranial breadth (XCB) I "The maximum cranial breadth perpendicular to the median sagittal plane (above the supramastoid crests)," (Howells 1973:172).

Maximum frontal breadth (XFB) I "The maximum breadth at the cornonal suture, perpendicular to the median plane," (Howells 1973:172).

Bistephanic breadth (STB) I "Breadth between the intersections, on either side, of the coronal suture and the inferior temporal line marking the origin of the temporal muscle (the stephanion points)." (Howells 1973:173). Grease pencil was used to mark the points.

Minimum frontal breadth (WFB) I "The minimum breadth between the two temporal ridges," (Hrdlicka 1952:142).

Bizygomatic breadth (ZYB) I "The maximum breadth across the zygomatic arches wherever found, perpendicular to the median plane," (Howells 1973:173). The zygomatic arches were often missing, and the measurements had to be estimated.

Biauricular breadth (AUB) I "The least exterior breadth across the roots of the zygomatic processes, wherever found," (Howells 1973:173).

Opisthion-supraglabella length (OSL) I "The maximum length from the glabella to the posterior margin of the foramen magnum on the medial sagittal plane, " (Lin 1973:39). Hinge calipers were hard to use in estimating the opisthion. The supraglabella was also hard to determine, so glabella proper was used.

Basion-nasion length (BNL) I "Direct length between nasion and (endo) basion," (Howells 1973:171). Sometimes a bony process was present at the basion. In these cases the measurement was taken to one side of the projection.

Basion-prosthion length (BPL) I "The facial length from prosthion to basion...," (Howells 1973:174). The prosthion, as stated, was used, not interdentale.

Basion-bregma height (BBH) I "Distance from bregma to basion...," (Howells 1973:172). Often there was a depression running along the sagittal and coronal sutures, especially where they met at bregma. The caliper was put in the depression as close tc bregma as possible.

Basion-gnathion (BGN) II BGN is measured from the endobasion to the lowest median point on the lower border of the mandible. The mandible and maxilla were occluded when this measurement and nasion-gnathion were taken. Because there was often much dental attrition, especially among older individuals, these measurements are not comparable between age groups.

Nasion-gnathion (NGN) II NGN is measured from the nasion to the lowest median point on the lower border of the mandible.

Basion-opisthion length (BOL) II "Direct length between basion and opisthion," (Lin 1973:39). This is a measure of the anterior-posterior length of the foramen magnum.

Nasal breadth (NLB) II "The maximum breadth of the nasal aperture as measured from the anterior borders of each side," (Hrdlicka 1952: 146).

Orbital breadth (OBB) II "Breadth from ectoconchion to dacryon... approximately the longitudinal axis which bisects the (left) orbit into equal upper and lower parts," (Howells 1973:175). Dacryon was frequently estimated.

Interorbital breadth (DKB) II "The breadth across the nasal space from dacryon to dacryon," (Howells 1973:178).

Biorbital breadth (EKB) II "The breadth across the orbits from ectoconchion to ectochonchion," (Howells 1973:178).

Nasion-prosthion height (NPH) II "Upper facial height from nasion to (alveolare)...," (Howells 1973:174). NPH was taken to the alveolare, not the prosthion.

Nasal height (NLH) II "Height from midpoint of line connecting lowest parts of borders to the two nasal notches, to nasion," (Hrdlicka 1952:146). Each of the nasal notches was measured from nasion then averaged to get nasal height.

Cheek height (WHM) II "The minimum distance, in any direction, from the lower border of the orbit to the lower margin of the maxilla, mesial to the masseter attachment, on the left side," (Howells 1973: 180).

Orbital height (OBH) II "The height between the upper and lower borders of the left orbit, perpendicular to the long axis of the orbit and bisecting it," (Howells 1973:175).

External alveolar length (EAL) II "The anterior-posterior diameter, in the median line, from...alveolare point to the mid-point of a line connecting the posterior limits of the arch," (Hrdlicka 1952: 147). A thin stick was used to mark the posterior limits of the arch.

External alveolar breadth (EAB) II "The maximum breadth of the greatest bulge of the process above the molar teeth," (Hrdlicka 1952:147).

Bimaxillary chord (ZMB) II The breadth between the most inferior points on the zygomaxillary sutures. Because the points Howells (1973:170) uses are difficult to determine consistently,this measurement follows that of Martin (1956:450).

Bifrontal chord (FMB) III "The breadth across the frontal bone between *frontomalar anterior* on each side, i.e., the most anterior point on the frontomalar suture," (Howells 1973:177). Care was taken so the points of the instruments were not inserted into open sutures.

Nasio-frontal subtense (NAS) III "The subtense from nasion to the bifrontal breadth," (Howells 1973:178).

Nasion-bregma chord (FRC) III "The frontal chord, or direct distance from nasion to bregma, taken in the midplane and at the external surface," (Howells 1973:181). Avoided depressions at bregma. In such instances, measurement taken from adjacent bone as near to bregma as possible.

Nasion-bregma subtense (FRS) III "The maximum subtense, at the highest point on the convexity of the frontal bone in the midplane, to the nasion-bregma chord," (Howells 1973:181).

Nasion-bregma fraction (FRF) III "The distance along the nasion-bregma chord, recorded from nasion, at which the nasion-bregma, or frontal, subtense falls," (Howells 1973:181).

Bregma-lambda chord (PAC) III"The external chord, or direct distance, from bregma to lambda, taken in the midplane and at the external surface," (Howells 1973:182).

Bregma-lambda subtense (PAS) III "The maximum subtense, at the highest point on the convexity of the parietal bones in the midplane, to the bregma-lambda chord," (Howells 1973:182).

Bregma-subtense fraction (PAF) III "The distance along the bregma-lambda chord, recorded from bregma, at which the bregma-lambda, or parietal, subtense falls," (Howells 1973:182).

Basion-biporion (BPO) III The subtense at basion of the porion to porion chord.

Auricular height (AUH) IV "From porion to the apex," (Bass 1971:67).

Nasion radius (NAR) IV "The perpendicular to the transmeatal axis from nasion," (Howells 1973:183). Western-Reserve Headspanner used rather than instrument Howells used.

Subspinale-radius (SSR) IV "The perpendicular to the transmeatal axis from subspinale," (Howells 1973:183). Western-Reserve Headspanner used.

Prosthion radius (PRR) IV "The perpendicular to the transmeatal axis from prosthion," (Howells 1973:183).

DEFINITIONS OF MANDIBULAR MEASUREMENTS

Mandibular symphyseal height (MSH) II "Gnathion (the lowest medial point on the lower border of the chin) to infradentale (the apex of the alveolar septum between the lower central incisors)," (Bass 1971:72).

Maximum mandibular thickness (MTS) II "The thickness of the mandibular symphsis measured from the inferior genial tubercle to the anterior-most, medial point (the mental protuberance)."

Minimum breadth of the ascending ramus (MAR) II "Minimum distance between the anterior and posterior borders of the ascending ramus ...left is standard...," (Bass 1971:72).

Bicondylar breadth (BIC) II "The maximum distance between the lateral surfaces of the condyles," (Bass 1971:72).

Bigonial breadth (BIG) II "From gonion to gonion. The maximum distance between the external surfaces of the gonial angles," (Bass 1971:72).

Horizontal Ramus length (HRL) II Left gonion to the most anterior point on the mental protuberance.

Height of the Ascending Ramus (HAR) II "From gonion to the uppermost part of the condyle," (Bass 1971:72).

METHODS

For the purposes of the cranial analyses, those skulls with 15 measurements which previously had been taken on other comparable samples were employed. The measurements used were glabella-occipital length (GOL), maximum cranial breadth (XCB), basion-bregma

(BBH), basion-nasion (BNL), basion-prosthion (BPL), minimum frontal breadth (WFB), bizygomatic breadth (ZYB), nasion-alveolare (NPH), external alveolar length (EAL), external alveolar breadth (EAB), nasal height (NLH), nasal breadth (NLB), bifrontal chord (FMB), basion-biporion (BPO), and auricular height (AUH). All 15 measurements were taken on 30 female and 33 male skulls.

Four additional skulls were added to the analyzed sample. Of these, three were missing one measurement and one was missing two measurements. Skull 11, a female, was missing AUH; Skull 284, a male, was missing FMB; and Skull 386, a male, was missing ZYB. Skull 370, a female, was lacking ZYB and FMB. These missing measurements were estimated using multiple regression formulae which employed all of the other measurements present. The regressions were performed separately for both sexes using the SAS76 subroutine (Barr, et al. 1976). With these four skulls added to the sample, 67 (32 female, 35 male) skulls were analyzed. Once the missing cranial measurements were estimated, principal component analyses were performed for each sex using the SPSS subprogram (Nie, et al. 1975). The principal component scores were used for the outlier analysis and to check for cranial heterogeneity in burial location.

As many as 20 paired and 9 single cranial and mandibular non-metric observations were also made on each of the 102 skulls and 49 associated mandibles. The observations made follow Jantz (1970) which was generally derived from Berry and Berry's (1967) observations. Paired observations made were lambdoid ossicle (medial and lateral), parietal foramen, mastoid suture exsutural, coronal ossicle, epiteric bone, fronto-temporal articulation, parietal notch bone, ossicle at asterion, ossicle in mastoid suture, foramen of Huschke, anterior condylar canal double, supraorbital foramen complete, frontal foramen, suture into the infraorbital foramen, accessory infraorbital foramen, mylohyoid bridge, and accessory mental foramen. Single observations made were lambdoidal ossicle, Inca bone, sagittal ossicle, bregmatic ossicle, palatine torus, mandibular torus, metopism, pharangeal fossa, and the direction of the superior sagittal sulcus turns. Unfortunately, these "discrete" traits were frequently difficult to classify, and arbitrary decisions had to be made in some of the assessments.

Ossicles were isolated pieces of bone in sutures which were large enough (usually > 1 cm in diameter) to be observable without difficulty. Exceptions to this rule were epiteric and parietal notch bones, where even the smallest ossicle was noted as present. Sometimes it was difficult to judge whether or not an ossicle near the juncture of two sutures was at that point or on one of the other sutures. Examples include bregmatic, lambdoidal, and asterionic areas, expecially the latter two. Bones near the junctures were called ossicles at those joints if, and only if, the ossicle had a side formed by each of the sutures. It should be noted, though, that there are a great number of similarities between asterionic and mastoid suture ossicles.

Extra foramen generally had to be larger than a pin-point to be counted. Any foramen on or near the mastoid suture was called a mastoid foramen. Any small or large foramen in the tympanic element was recorded as a foramen of Huschke. Any foramen near the palatine foramen was recorded as accessory. Recording the supraorbital foramen/notch was somewhat eclectic, and in taking the early observation, some frontal foramina may have been mistakenly identified as supraorbital foramina. Accessory infraorbital foramen were especially difficult to identify. In some skulls there seems to be a zone ringing the infraorbit, lateral and medial to the orbit, in which accessory foramen are common. Accessory foramen inferior to the orbit were labeled accessory infraorbital foramen only if they were present within the distance of the diameter of the infraorbital foramen measured from the nearest edge of the infraorbital foramen. Thus, supernumerary foramen occurring on the frontal process of the maxilla were excluded. Sutures into the infraorbital foramen were noted as present only if they extended to the infraorbital foramen or an accessory infraorbital foramen as defined above.

The torii were often hard to judge. In general, a torus on the palate was noted as present if the bulge was large and extended a distance laterally from the intermaxillary suture. But sometimes even this requirement was ignored and any torus along the intermaxillary suture was noted as being a palatine torus. Likewise even a small build-up along the mandibular alveolar process was noted as being a mandibular torus.

It was frequently hard to judge whether or not a pharangeal fossa was present. In borderline cases, if the depression was large enough to both see and feel, a pharangeal fossa was noted as present.

Usually the turning of the superior sagittal sulcus was obvious, but in some instances it was not apparent. In these cases, the sizes of the transverse sulci were inspected with the larger sulcus presumed to indicate the direction the sagittal sulcus had turned. In brief, these "discrete" non-metric observations could perhaps have been more distinct. There seems to be much room for observer interpretation.

For the purpose of the distance analysis--the only study performed with the non-metric traits--16 of the 29 observations were employed. These 16 traits were selected because Jantz (1970:70, Table 12) found no sex differences in trait frequency in a larger, similar sample, thus allowing the sexes to be combined. The 16 observations used were lambdoidal ossicle (medial and lateral), parietal foramen, coronal ossicle, epiteric bone, ossicle in mastoid suture, anterior condylar canal double, accessory palatine foramen, supraorbital foramen complete, frontal foramen, accessory infraorbital foramen, accessory mental foramen, ossicle at lambda, Inca bone, pharangeal fossa,and superior sagittal sulcus turns left. All of these observations are recommended by Berry and Berry (1967), except ossicle in mastoid suture, which Jantz noted. Paired observations were combined to get frequencies.

All but one of the comparative samples are from Jantz (1970). The one sample not previously published, the St. Helena (25CD4, 25CD7, 25DK10, and 25DK13), was kindly made available by Jantz. The Crow Creek sample used was comprised of the same crania used in the metric analysis, except for one male skull (number 294) for which observations were not recorded. A relatively simple statistical procedure was used. Following Grewal (1962) and Berry and Berry (1967), the frequencies of the 16 traits were converted to an angle, expressed in radians (θ)m and the distance between samples calculated based on the difference between the radians.

RESULTS

The outlier analysis was performed using principal component scores of cranial measurement to see if morphologically dissimilar skulls were present in the ditch. If there were morphologically dissimilar skulls in the ditch, it might indicate that some raiders were buried with their victims or that mate-exchange between groups was occurring. There are, of course, other possibilities. All 15 components from each individual were employed to calculate Mahalanobis' D^2 from the group's centroid for individual crania using a program written by William W. Baden. Those crania falling beyond the 0.05 limits are suspect.

Not one of the 32 female (Table 26) or 35 male (Table 27) crania fell outside the 0.05 probability range. Therefore, the null hypothesis--that there are no significantly different skulls present--must be accepted. The measureable skulls all appear to belong to a homogeneous group, presumably the Crow Creek village inhabitants.

TABLE 26. D^2 values of individual Crow Creek female crania from the group centroid. None is statistically significant. D.f. = 15.

Skull number	D^2 value	Probability
11	12.04	0.50-0.25
21	20.86	0.25-0.10
22	18.69	0.25-0.10
35	20.78	0.25-0.10
57	15.08	0.50-0.25
61	13.09	0.75-0.50
66	13.60	0.75-0.50
76	23.26	0.10-0.05
94	10.98	0.90-0.75
96	9.67	0.90-0.75
98	14.45	0.50-0.25
103	10.39	0.90-0.75
145	18.79	0.25-0.10
156	16.89	0.50-0.25
173	18.82	0.25-0.10
190	16.48	0.25-0.10
195	11.67	0.75-0.50
196	11.02	0.90-0.75
197	10.93	0.90-0.75
207	6.95	0.975-0.95
228	12.46	0.75-0.50
233	16.66	0.50-0.25
308	21.17	0.25-0.10
315	18.06	0.50-0.25
322	9.22	0.90-0.75
323	14.65	0.50-0.25
331	12.38	0.75-0.50
336	9.18	0.90-0.75
361	8.03	0.95-0.90
363	14.43	0.50-0.25
370	15.62	0.50-0.25
377	14.10	0.75-0.50

TABLE 27. D^2 values of individual Crow Creek male crania from the group centroid. None is statistically significant. D.f. = 15.

Skull number	D^2 value	Probability
1	12.04	0.75-0.50
8	10.22	0.90-0.75
12	17.31	0.50-0.25
18	20.47	0.25-0.10
51	12.27	0.75-0.50
63	12.59	0.75-0.50
83	15.19	0.50-0.25
91	15.14	0.50-0.25
95	21.79	0.25-0.10
100	11.52	0.75-0.50
108	15.78	0.50-0.25
134	13.40	0.75-0.50
135	13.95	0.75-0.50
151	13.02	0.75-0.50
186	11.43	0.75-0.50
216	11.76	0.75-0.50
218	11.10	0.75-0.50
229	13.15	0.75-0.50
236	13.99	0.75-0.50
265	21.13	0.25-0.10
269	13.90	0.75-0.50
284	22.17	0.25-0.10
286	15.37	0.50-0.25
294	16.24	0.50-0.25
301	12.13	0.75-0.50
302	10.84	0.90-0.75
306	21.15	0.25-0.10
307	18.71	0.25-0.10
317	16.35	0.50-0.25
348	9.32	0.90-0.75
356	5.68	0.99-0.975
358	8.81	0.90-0.75
360	21.89	0.25-0.10
368	16.20	0.50-0.25
392	14.00	0.75-0.50

The measureable skulls were also tested for morphological heterogeneity compared with the location in which they were found. If heterogeneity were present, it would suggest that the skulls were separated for burial, perhaps based on kin affiliation. First the measurable skulls were separated by excavation units, but because the sample size for each individual square was so small, skulls from all squares with the same number were combined. Thus, for example, the crania from squares 5A, 5B, and 5C were lumped together for the analysis. This allowed the testing of differences between groups of skulls on the East-West grid but not the North-South grid. This compromise is justifiable because of the sample size requirements and also because the North-South bone placement appears to be largely due to how likely the bone was to roll and the slope on which it was placed. The East-West grid seems to be the primary direction where cranial differences might occur because access to the deposit was better on the East-West axis than the North-South. It seems likely that if distinctions were made, they would be East-West. Another compromise was made. Because of the very small number of measureable skulls (see Table 28 for sample size) from combined squares 9 and combined squares 10, these two were also combined. The male and female skulls were divided by combined squares and analyzed with the discriminant subprogram of SPSS (Nie, et al. 1975). The principal component scores for each individual were employed, using only those components with an eigenvalue of greater than 1. The females had four significant components. The males had five

TABLE 28. Samples from Crow Creek squares combined for analyzing cranial morphology homogeneity among the squares.

Squares	Females	Males
5 A,B,C	11	7
6 A,B,C	4	8
7 A,B,C	6	6
8 A,B,C	7	7
9 and 10 A,B,C	4	7

significant components, but the sixth had an eigenvalue (0.99787), so close to 1 that it was included. Thus the males were analyzed using site components. No statistically significant differences were found in either sex. Cranial morphology did not vary with East-West location in the ditch.

Two approaches to establish cranial morphological distances between Crow Creek and other samples from the Central and Northern Plains were used. Cranial measurements have frequently been used to study morphological relationships of Northern Plains populations. Cranial measurements were employed here to estimate morphological distances and to classify individual crania into groups. The other approach often used in skeletal distance studies is based on discrete, non-metric cranial traits. This method was also used to analyze the relationship of Crow Creek to other skeletal samples.

To estimate the morphological distance between Crow Creek and 11 other samples from the Northern and Central Plains, canonical variates were calculated from the raw cranial measurements using the discriminant subprogram of SPSS (Nie, et al. 1975). Descriptive statistics of the Crow Creek crania are presented in Tables 29 and 30. All crania from the other 11 samples were measured by Jantz, using the same measurement techniques as those used on the Crow Creek material. Additional information concerning those samples is presented in Jantz, et al. (n.d.). For the most part, skulls from single sites were used, though sample sizes for Mandan, Omaha, Pawnee, and Ponca were so small that skulls from several sites were combined.

The first four canonical variates were statistically significant

TABLE 29. Descriptive statistics of female Crow Creek cranial measurements. Statistics based on 32 female crania with full complement of measurements. All figures in millimeters.

Measurements	Mean	Standard deviation	Minimum	Maximum	Range
GOL	170.22	4.72	160	181	21
XCB	142.31	5.69	129	151	22
BBH	132.53	4.04	125	142	17
BNL	100.50	4.24	91	112	21
BPL	97.38	5.05	86	109	23
WFB	91.56	4.04	83	98	15
ZYB	132.88	4.46	123	139	16
NPH	69.94	3.45	63	77	14
EAL	51.59	2.94	46	57	11
EAB	64.22	3.84	56	71	15
NLH	50.19	2.22	45	54	9
NLB	26.38	1.93	22	31	9
FMB	98.94	3.34	93	105	12
BPO	19.56	3.53	12	28	16
AUH	116.94	4.19	109	130	21

TABLE 30. Descriptive statistics of male Crow Creek cranial measurements. Statistics based on 35 male crania with full complement of measurements. All figures in millimeters.

Measurement	Mean	Standard deviation	Minimum	Maximum	Range
GOL	176.09	6.86	163	190	27
XCB	145.43	6.42	131	162	31
BBH	136.11	4.96	124	145	21
BNL	104.63	4.71	95	116	21
BPL	102.66	4.72	93	112	19
WFB	95.29	4.78	87	105	18
ZYB	140.49	7.12	126	155	29
NPH	73.80	3.72	67	81	14
EAL	54.06	3.10	49	60	11
EAB	67.97	3.04	62	79	17
NLH	53.80	3.11	47	59	12
NLB	27.46	1.80	23	31	8
FMB	103.54	4.00	94	111	17
BPO	20.17	3.29	11	25	14
AUH	120.57	4.25	111	128	17

in both sexes. The results in both sexes were so similar that they can be discussed together. The first canonical variate (CV I), which explains 35.7 percent of the female variability and 43.1 percent of the male, primarily separates Crow Creek and to a lesser extent the St. Helena sites (25DK9 and 25DK13) from the Mandan (FIG. 14). CV I arranges the Arikara sites near Mobridge, South Dakota, (Mobridge, Rygh, Larson, and Leavenworth) chronologically, and it appears to be doing the same with Crow Creek and possibly the St. Helena sites.

The second canonical variate (CV II) explains 33.3 percent and 24.3 percent of the female and male variability, respectively (FIG. 14) and it mainly separated the Omaha, Ponca, and to a lesser extent, the Pawnee from the other samples, especially the Arikara groups. Generally, this CV seems to be geographically influenced, with the southern groups at one end, the northern groups at the other. The Mandan are a notable exception to the generalization. Crow Creek falls near the center of the distribution, near the St. Helena (25DK9 and 25DK13) and some Arikara samples.

The third canonical variate (CV III), which explains 13.2 percent and 10.7 percent of the female and male variability respectively, separates the Mandan and St. Helena (25DK9 and 25DK13) samples from the Omaha, Ponca, and at least some of the Arikara samples (FIG. 15). There is no clear patterning to the distribution. Crow Creek again falls near the center of the distribution, near the Pawnee and some of the Arikara samples.

The fourth and final significant canonical variate, which ex-

FIGURE 14. Comparison of Crow Creek and other craniometric samples on canonical variates I and II.

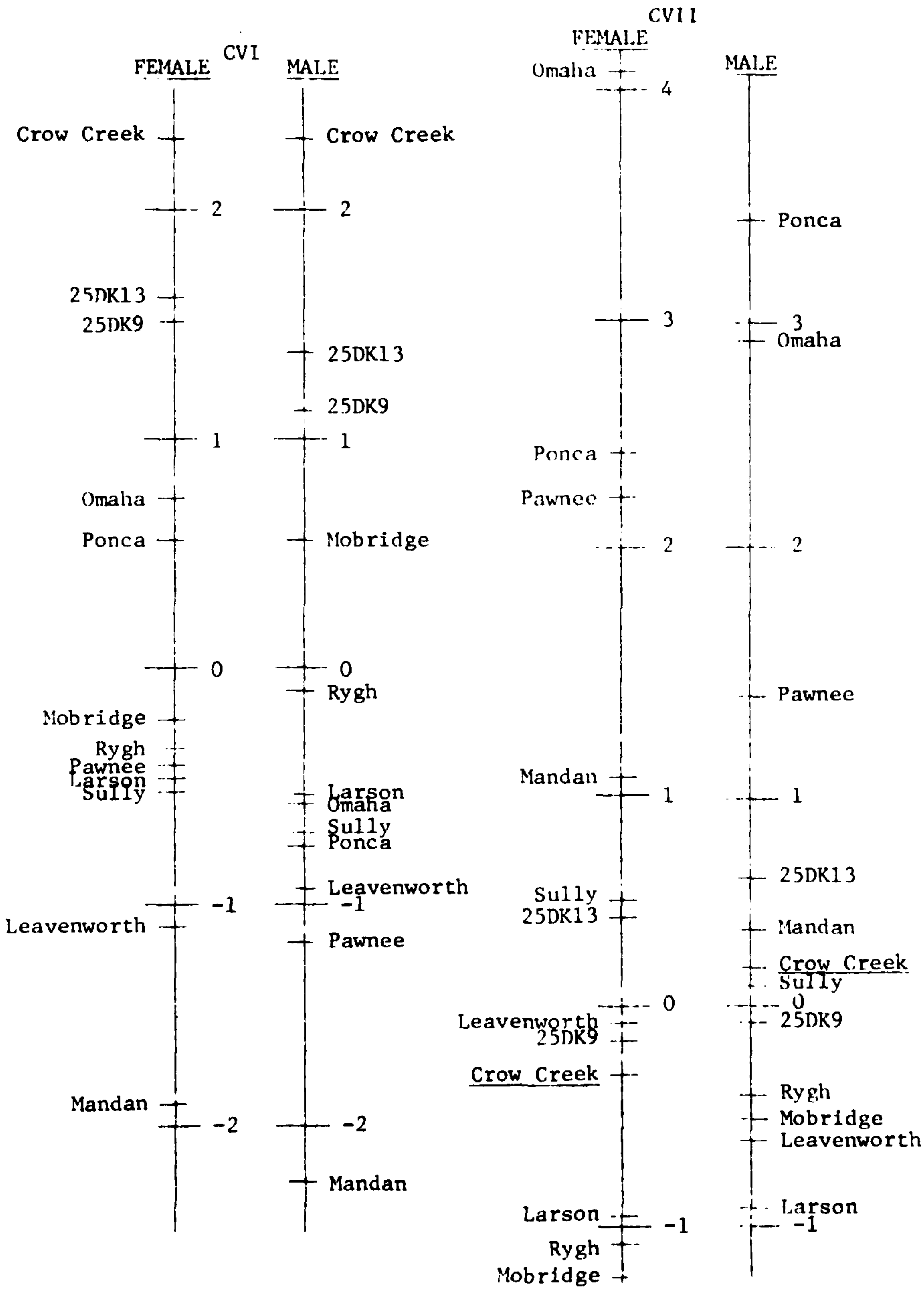
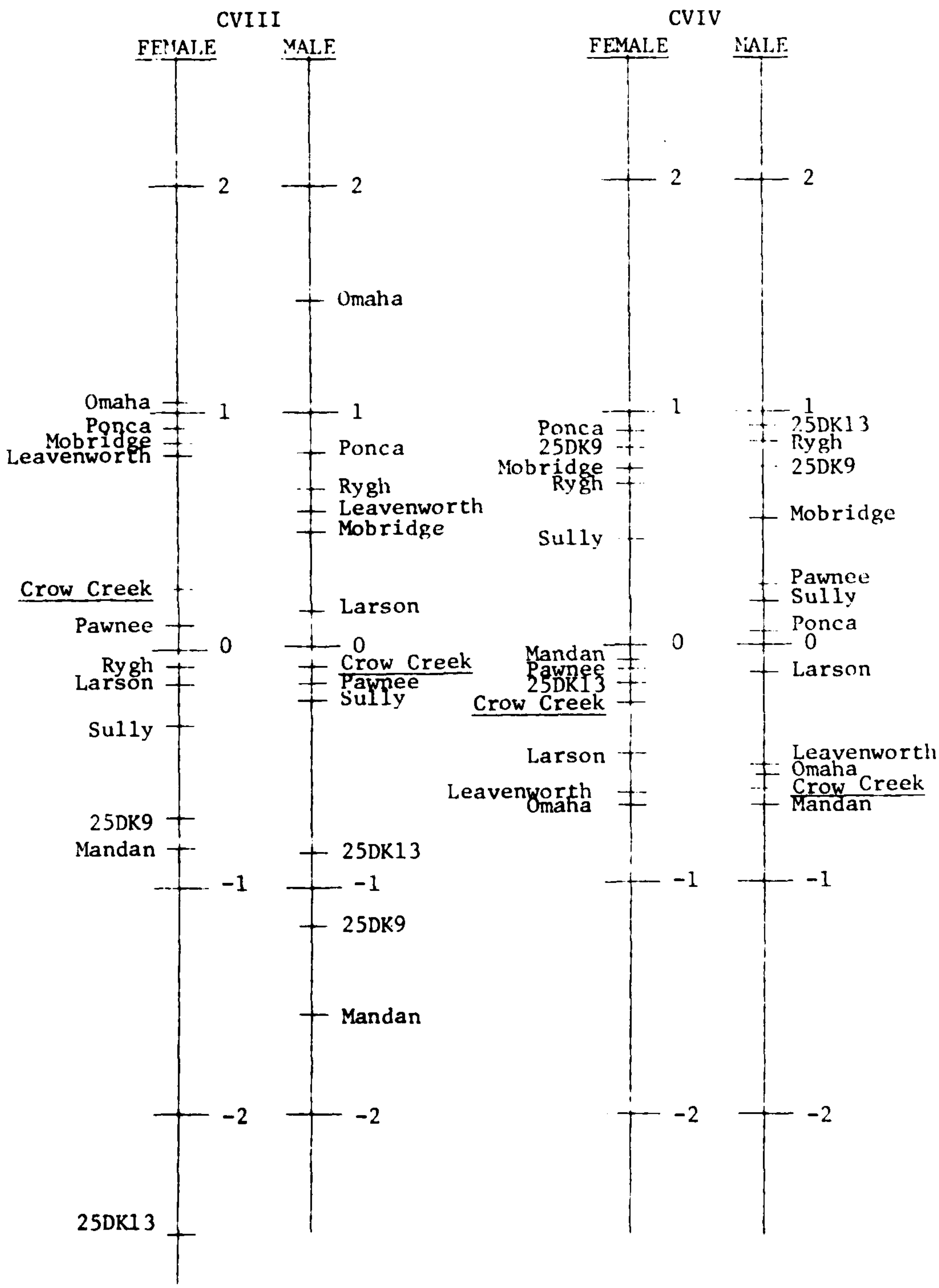


FIGURE 15. Comparison of Crow Creek and other craniometric samples on canonical variates III and IV.



plains 6.0 percent and 7.9 percent of the female and male variability respectively, is difficult to interpret because the female and male plots are somewhat different (FIG. 15). The female CV IV separates the Ponca, earlier Arikara (Mobridge, Rugh, and Sully), and 25DK9 from the Omaha and later Arikara (Larson and Leavenworth). The female Crow Creek sample falls among the Mandan, Pawnee, and 25DK13. The Male CV IV, on the other hand, separates both St. Helena sites (25DK9 and 25DK13) and some later Arikara (Mobridge and Rugh) from the Omaha, Mandan, one of the earlier Arikara (Leavenworth), and Crow Creek.

Each CV is interesting in itself, but discussing them individually makes trends difficult to grasp. CV's can be combined in multidimensional plots, thus making patterns more apparent. Plotting CV I and II displays the maximum variability on two axes--69.0 percent of the female and 67.4 percent of the male variability (FIGS. 16, 17). Crow Creek in both sexes rests closest to the St. Helena sites (25DK9 and 25DK13); next closest are the earlier Arikara sites.

Another way to examine the intersite and intergroup comparisons discussed above is to classify individuals into the group with the closest group centroid. Thus, rather than simply looking at the placement of group centroids, individual variability is considered by seeing into which group individuals are misclassified. This manipulation is available through an option of the same SPSS (Nie, et al. 1975) program which was used to get the canonical variate values. A hit-miss table results, and these results are displayed in Tables 31 and 32.

FIGURE 16. Crow Creek female and other group centroids displayed simultaneously on canonical variates I and II.

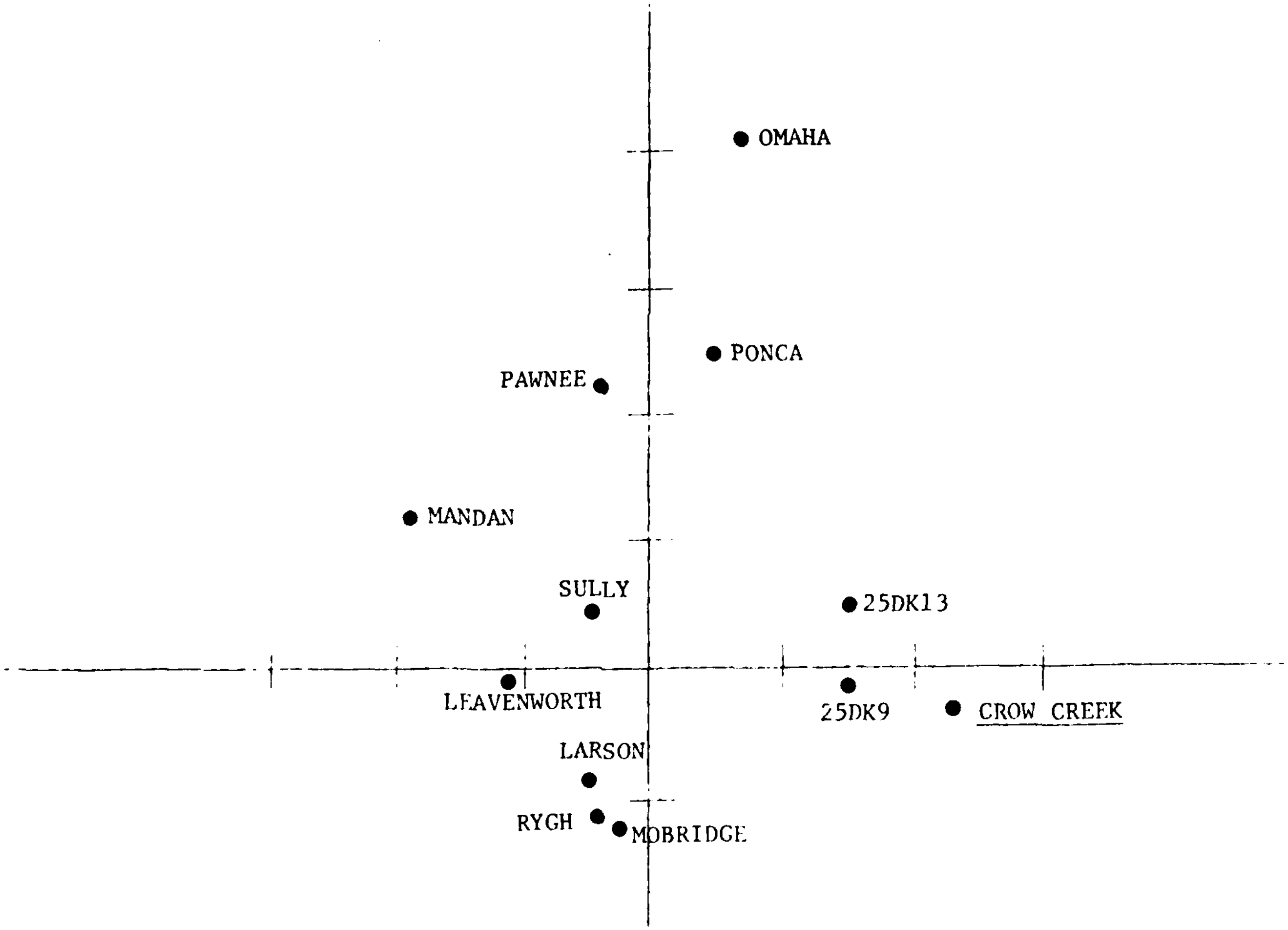


FIGURE 17. Crow Creek male and other group centroids displayed simultaneously on canonical variates I and II.

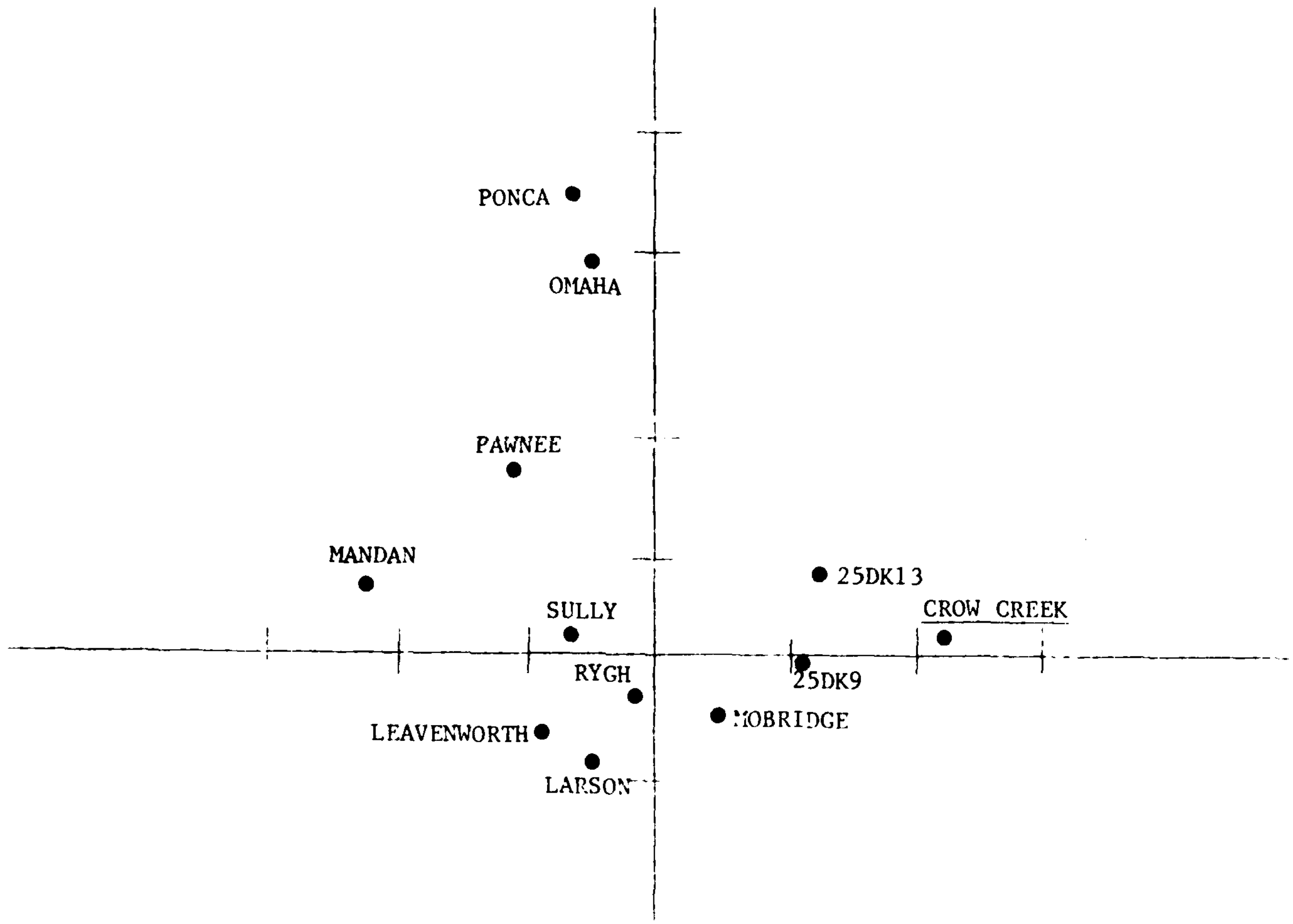


TABLE 31. Hit-miss distribution of female Crow Creek and other cranial samples. Numbers in parentheses are percentages.

	Crow Creek	Leavenworth	Larson	Sully	Mobridge	Rygh	Ponca	Omaha	Mandan	Pawnee	25DK9	25DK13
Crow Creek (39BF11)	25 (78.1)	0	0	0	2 (6.3)	1 (3.1)	0	0	0	0	3 (9.4)	1 (3.1)
Leavenworth (39CO9)	0	12 (63.2)	2 (10.5)	0	2 (10.5)	1 (5.3)	0	0	1 (5.3)	1 (5.3)	0	0
Larson (39WW2)	0	4 (8.5)	27 (57.4)	2 (4.3)	3 (6.4)	8 (17.0)	0	0	0	2 (4.3)	0	1 (2.1)
Sully (39SL4)	1 (3.6)	3 (10.7)	2 (7.1)	8 (28.6)	1 (3.6)	2 (7.1)	1 (3.6)	0	6 (21.4)	2 (7.1)	2 (7.1)	0
Mobridge (39WW1)	1 (5.9)	1 (5.9)	1 (5.9)	0	11 (64.7)	3 (17.6)	0	0	0	0	0	0
Rygh (39CA4)	0	0	3 (17.6)	1 (5.9)	2 (11.8)	7 (41.2)	0	0	1 (5.9)	0	1 (5.9)	2 (11.8)
Ponca	0	0	0	0	0	0	5 (62.5)	1 (12.5)	1 (12.5)	0	1 (12.5)	0
Omaha	0	0	0	0	0	0	1 (14.3)	6 (85.7)	0	0	0	0
Mandan	0	1 (5.6)	1 (5.6)	1 (5.6)	0	0	0	0	15 (83.3)	0	0	0
Pawnee	0	0	0	1 (20.0)	0	0	0	0	0	4 (80.0)	0	0

TABLE 31. (continued)

	Crow Creek	Leaven-worth	Larson	Sully	Mobridge	Rygh	Ponca	Omaha	Mandan	Pawnee	25DK9	25DK13
25DK9	0	0	0	0	0	0	0	0	0	0	2 (50.0)	2 (50.0)
25DK13	0	0	0	0	0	0	0	0	0	0	2 (22.2)	7 (77.8)

TABLE 32. Hit-miss distribution of male Crow Creek and other cranial samples. Numbers in parentheses are percentages.

	Crow Creek	Leaven-worth	Larson	Sully	Mobridge	Rygh	Ponca	Omaha	Mandan	Pawnee	25DK9	25DK13
Crow creek	23 (65.7)	0	0	2 (5.7)	2 (5.7)	3 (8.6)	0	0	0	1 (2.9)	2 (5.7)	2 (5.7)
Leavenworth	0	14 (70.0)	0 (15.0)	2 (10.0)	0	0	0	0	0	1 (5.0)	0	0
Larson	3 (6.7)	7 (15.6)	18 (40.0)	2 (4.4)	8 (17.8)	5 (11.1)	0	0	0	2 (4.4)	0	0
Sully	1 (2.7)	4 (10.8)	6 (16.2)	7 (18.9)	0	7 (18.9)	0	0	5 (13.5)	4 (10.8)	3 (8.1)	0
Mobridge	2 (11.8)	0	3 (17.6)	1 (5.9)	8 (47.1)	2 (11.8)	0	0	0	1 (5.9)	0	0
Rygh	1 (6.7)	1 (6.7)	0	1 (6.7)	2 (13.3)	8 (53.3)	0	0	0	0	0	2 (13.3)
Ponca	0	0	0	0	0	0	4 (67.7)	2 (33.3)	0	0	0	0
Omaha	0	0	0	0	0	0	0	4 (80.0)	0	1 (20.0)	0	0
Mandan	0	0	0	1 (8.3)	0	0	0	0	10 (83.3)	1 (8.3)	0	0
Pawnee	0	0	0	0	1 (11.1)	0	0	0	0	8 (88.9)	0	0

TABLE 32. (continued)

	Crow Creek	Leaven-worth	Larson	Sully	Mobridge	Rygh	Ponca	Omaha	Mandan	Pawnee	25DK9	25DK13
25DK9	1 (25.0)	0	0	0	0	0	0	0	0	0	2 (50.0)	1 (25.0)
25DK13	1 (7.1)	0	0	1 (7.1)	0	0	0	0	0	2 (14.3)	2 (14.3)	8 (57.1)

Before considering the misclassifications, a few general comments are in order. The Crow Creek female and male crania are correctly classified in 78.1 percent and 65.7 percent of the cases respectively. This correct classification frequency is better than any but the Mandan, Omaha, and Pawnee, the other groups which tend to fall on the extremes of the first three canonical variates and Leavenworth males. Crow Creek's correct classification frequency perhaps should be expected because it fell on one extreme of CV I, the CV explaining the greatest amount of variability. The pattern of the misclassifications are even more useful than the correct classifications.

Crow Creek crania generally misclassify as St. Helena (25DK9 and 25DK13) or early Arikara (Mobridge, Rygh, and Sully). One Crow Creek male, an exception to this generalization, is misclassified as Pawnee. As suggested by the misclassifications, Crow Creek is most similar to the St. Helena and the early Arikara samples. The hit-miss tables support what the first two CV's indicated. These results suggest that Crow Creek's morphological affiliations are closest to the St. Helena and early Arikara samples. It seems probable that the Crow Creek villagers were members of a proto-Caddoan-speaking group. Probably the descendants of the Crow Creek people or their close relatives would have been Arikara.

The number of observations absent and present, the percentage present, and the θ-value are in Table 33. The calculated morphological distances are in Table 34 and are shown in Figure 18. Crow

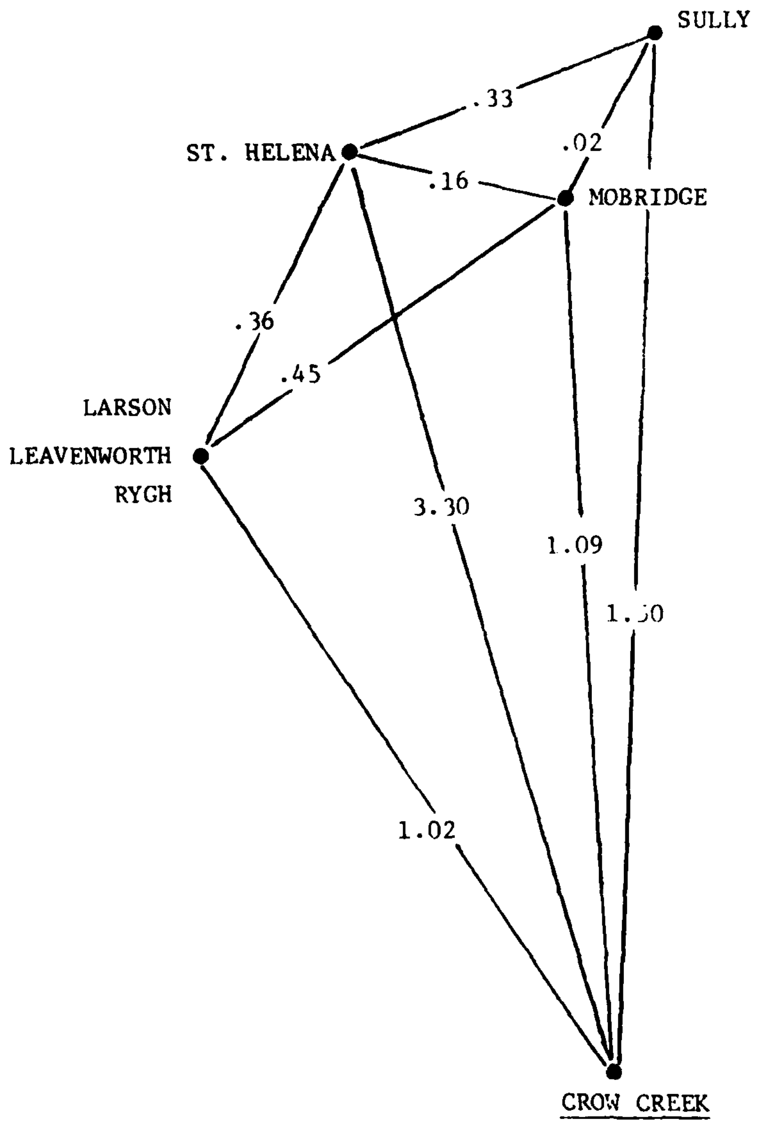
TABLE 33. Number of discrete traits absent and present, percentage present, and θ-value for the combined sexes of Crow Creek.

	Number Absent/Present	% Present	θ
Lambdoid ossicle-medial	79/31	28.2	.45
Lambdoid ossicle-lateral	88/22	20.0	.64
Parietal foramen	70/51	42.1	.16
Coronal ossicle	124/1	0.8	1.39
Epiteric bone	87/7	7.4	1.02
Ossicle in mastoid suture	82/22	21.2	.61
Anterior condylar canal double	100/26	20.6	.63
Accessory palatine foramen	12/97	89.0	-.89
Supraorbital foramen complete	82/48	36.9	.26
Frontal foramen	63/68	51.9	-.04
Accessory infraorbital foramen	92/22	19.3	.66
Accessory mental foramen	52/7	11.9	.87
Lambdoidal ossicle	52/7	11.9	.87
Inca bone	58/1	1.7	1.31
Pharangeal fossa	45/18	28.6	.44
Superior sagittal sulcus turns left	45/18	28.6	.44

TABLE 34. Morphological distances based on 16 cranial discrete trait frequencies of Crow Creek and other samples.

	Leavenworth	Larson	Mobridge	Rygh	Sully	St. Helena
Crow Creek	.90	1.23	1.09	0.93	1.50	3.30
Leavenworth		.00	1.36	.00	1.22	0.81
Larson			.00	.00	2.16	0.12
Mobridge				.00	.02	0.16
Rygh					2.74	0.14
Sully						0.33

FIGURE 18. Morphological distances based on non-metric traits between Crow Creek and other cranial samples.



Creek is the most distinct of the samples. It is most similar to Leavenworth and Rygh, though even these differ greatly from Crow Creek. On the other hand, the St. Helena sample is the most different from Crow Creek, the sample which was the most similar based on metric distances.

If the interpretations about the morphological affiliations were based solely on these results, the Crow Creek sample would be very different from the St. Helena and Arikara samples. Yet, intuitively, the material appears similar to the Arikara crania studied. An additional problem with the non-metric distances is they are not as readily interpretable as the metric data.

The meaning of non-metric traits and their comparability to metrics has been much discussed in the literature recently (e.g. Carpenter 1976, Cheverud, et al. 1979, Corruccini 1976). The purpose here is not to detail these discussions but to suggest practical reasons why the metric and non-metric distances differ. The first possibility is that the canonical variates used to determine the metric distances is relatively sophisticated while the non-metric statistic is fairly simple. Nevertheless, it is hard to believe that the difference in statistical sophistication alone would account for these divergent results. Another possible explanation for the differences is that non-metric observations may in this case be more susceptible to interobserver error. This error would tend to make samples artifically more dissimilar than they are in actuality.

MUTILATIONS

Mutilation of corpses and perhaps some torture of the living appears to have been a common part of Plains Indian warfare. Disfigurement of bodies included scalping, evulsion, blows, decapitation, dismemberment, and burning. Most of these mutilations are frequently mentioned in historic accounts; many leave marks which are preserved on bone. One of the most fascinating aspects of these atrocities is that they are a cultural phenomenon modifying biological material.

This section begins with a discussion of how the observations were made and includes additional notes about data collected but not presented in this report. Mutilations of the head are discussed first, then other body mutilations are discussed. General mutilations (burning) not limited to a single part of the body are also considered. This section also discusses animal scavenging, a topic which in a strict sense may not be a mutilation but can nevertheless be considered here.

Nearly all of the human skeletons from Crow Creek were inspected for mutilations by P. Willey. Mark Swegle studied and wrote the description of the burned bones. About 1700 sacks of material were inspected, though some of the material from the looter's hole may have been missed. A data collection form was used which listed the elements to be inspected and provided a space for notes.

To get a "feel" for the sorts of mutilations which might be present, all fragments of all bones were inspected for the first

100 bags or so. Any unusual traits were noted. Specifically, the bones were inspected for cutting, old but unhealed fractures, and chewing. This procedure was extremely tedious and too time-consuming, so the process was modified. The rest of the bones were observed for those traits which were readily observable and could be recorded as present or absent. Other unusual and obvious traits not consistently observed were noted, though frequency data for these features (e.g., postcranial cutting and burning) cannot be established based on these notes.

Inspection was done element-by-element. Skulls and mandibles were inspected for cutting, fracturing, and evulsions. Cutting of the cranial vault was generally interpreted as scalping. The bones which had been cut were noted on the mutilation inventory sheet. Cutting on the base of the skull (e.g. near the foramen magnum, especially the occipital condyles and first and second cervical vertebrae) were interpreted as decapitation. Occasionally cuts were noticed on the alveolar process and recorded, though no frequency data was taken. After more then 3/4 of the bags had been inspected, cuts were found near the nasal aperture, suggesting cut noses. At that point, an attempt was made to record the presence/absence of these cuts. Later, when the more complete skulls were removed from their sacks for sexing, they were also inspected for cut noses. Thus, some frequency data is available on this mutilation, but only for part of the collection. Mandibles, especially the inferior and posterior borders, were inspected for cutting.

Fractures in the cranial vault were also noted. Linear fractures were especially difficult to assess as to whether they had happened near the time of death or much later. Because of this uncertainty, linear fractures were not noted. Only depressed fractures were systematically searched for. The depressed fractures seemed to fall into one of two categories based on their shape. Some were round while others were oval. The oval fractures commonly had a central crack running down the long axis of the oval, suggesting a hatchet-like weapon. Another point to be considered is the likelihood that the most battered skulls would have tended to be more fragmentary than the whole or relatively whole skulls. Unfortunately only the more complete skulls were observable. As a consequence, the estimated frequency of blows is very conservative. Observation of fracturing on the fragile and unreconstructed subadult skulls was especially difficult.

Evulsions were also noted for both maxilla and mandible. Generally the criteria used to determine the presence or absence of evulsions were an old, stained color on the broken surface of a tooth root and/or a bizarre breakage pattern. The presence/absence of cutting, fracturing, and evulsion were noted on the forms. In those cases where there was not enough of the specimen present for an assessment of presence/absence, a dash was put beside the appropriate heading. Though no space was provided for scapulae and clavicles, they, too, were inspected. Only the acromial process of the scapulae was examined, and notes were made whether the process was whole, chewed, or splintered.

When recording the mutilations, the part and portion of the long bones present was first noted: The part of the bone present was listed as proximal, shaft, distal, or whole. Whole was used when both ends and the shaft were present, proximal was used when the proximal articular end was present, shaft was used when neither of the articular ends was present, and distal was used when the distal articular end was present. The proportion indicated how much of the specimen was there. Proportion was noted in fractions: 1/8's, 1/4's 1/3's and 1/2's (example, "Dist. 2/3"). Following the description of what part of the specimen was present, the location of the damage was noted (example, "Dist. chewed").

Spaces were provided for almost all long bones. In all cases, the proportion and part of the bone present were noted, followed by the condition of the ends. The missing ends were listed as being whole, chewed, snapped or lost post-mortem.

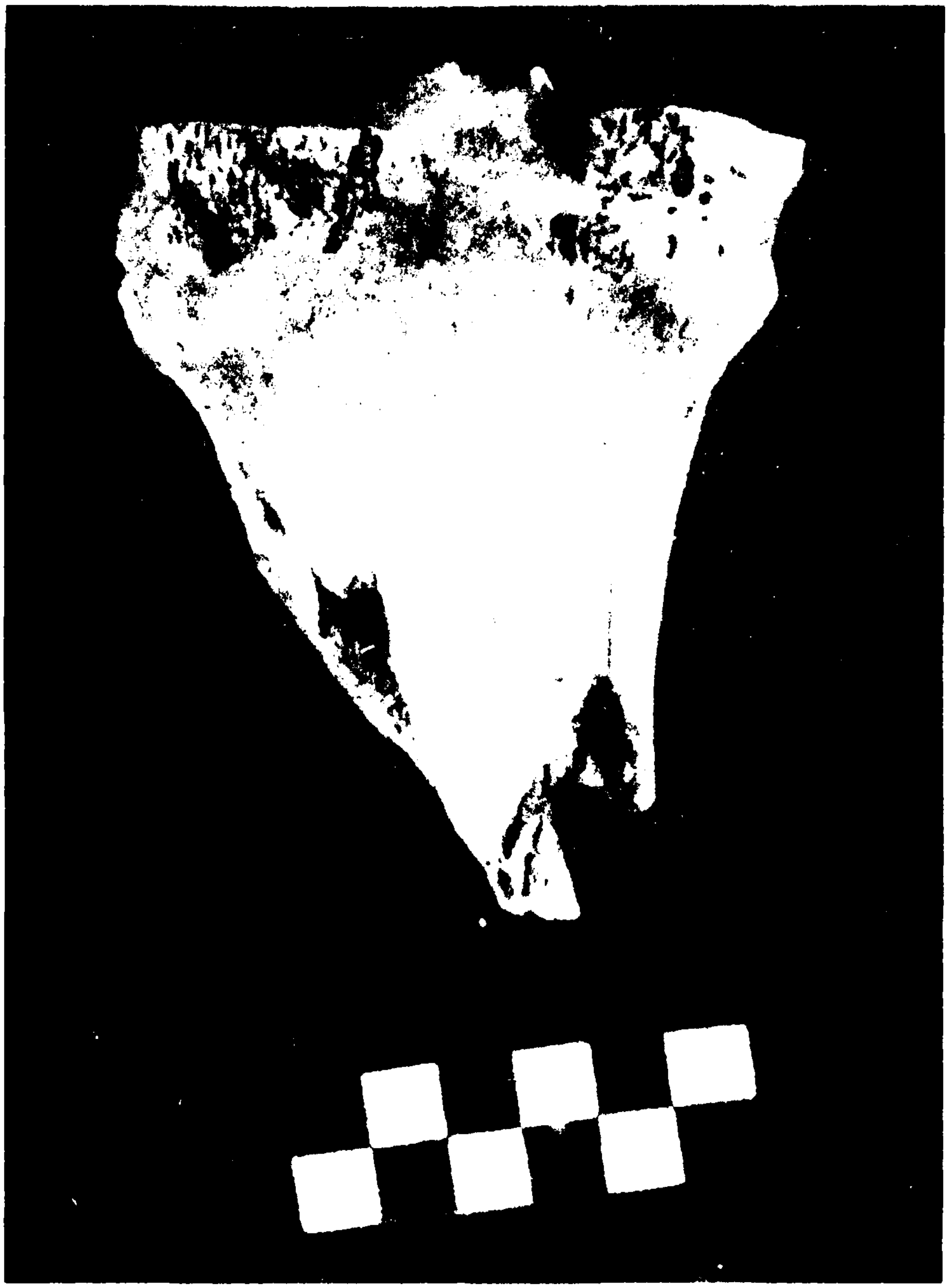
Because chewing, splintering, and snapping are unusual terms in an osteological report, their use needs to be explained. Chewing was used to describe small puncture marks which were commonly found near the ends of long bones and the projecting parts of other bones (Plate 5). This designation is based on the similarities of these marks on the Crow Creek material and marks found on present-day forensic cases on file at the University of Tennessee. The marks on the present-day material have been attributed to dogs chewing the

remains. While inspecting the Crow Creek material, changes in the chewing pattern were noted. Later in the study, broad, old grooves were noticed near some chewed ends. These grooves appear to have been caused by gnawing, rather than chewing per se; but chewing was used to describe the grooves, even when the characteristic puncture marks were absent.

Snapping was used when it appeared that the bones were broken by transverse pressure while the bone was viable. In many instances a "hinge" fracture was present, and hinging was usually considered the definitive criterion for snapping. In the earlier stages of the mutilation inspection, there was a tendency to identify more bones as snapped than later. Many of the bones noted as snapped earlier in the analysis would have been classified as splintered after box 50.

Splintering is when the end of the bone is not chewed or snapped but forms a jagged end and when the surfaces of the breaks are smooth, having happened before the bone lost its viability (Plate 6). Splintering may have resulted from direct blows, especially with some tool. Some bones termed splintered may actually have been chewed but lack the characteristic puncture marks or grooves. Crushing is similar, but results from activity after the bone lost its viability; breaks are not always smooth.

Innominates were inspected for the presence/absence of chewing on the iliac crest and the ischium. In many instances of chewing



on the iliac crest, the chewing centered around the anterior superior spine, and this was noted using the abbreviation ASSp.

Although there was no space provided on the recording sheets, patellae were also inspected for chewing, and its presence/absence noted. The bones of the hands and feet were also inspected. Each of the carpals was individually inspected and noted. The tarsals, except the cuneiforms, were indivdually inspected. The cuneiforms were not individually separated, though note was made of mutilation.

Absences of mutilations were noted by the end of the bone being listed as present but no mention of mutilation being present. This is a confusing way of noting the lack of mutilation, but it was speedy. Small fragments and those lacking definitive modifications were omitted. Questionable assessments were followed by a question mark. Combinations of modifications were noted by listing both conditions; unless separated by an and, the first modification is the more likely or more pronounced. A photographic catalog was made of some of the exceptional cases to provide a visual record of the categories.

Without a doubt, scalping is the best known mutilation. It has been frequently described in historic accounts of early Plains warfare. Descriptions of scalpings include Boller (1959:151; 1966: 203-206), Coues (1897:262), Denig (1928-29:491-492), Eastman (1849: 156), Godfrey (1974:112), Luttig (1964:124), and Paulding (1974:10-11). Audubon (1897, vol. 2:5) has even described an incident when a woman was scalped by Arikaras, later buried, then dug up and scalped again.

Scalping was systematic and patterned, not random. Perhaps Adair's (1775:387-388) description of scalping in the East is as explicit as any other:

> They seize the head of the disabled, or dead person, and placing one of their feet on the neck, they with one hand twist in the hair, extend it as far as they can--with the other hand, the barbarous artists speedily draw their long-pointed scalping knife out of a sheath from their breast, give a slash round the top of the skull and with a few dexterous scoops, soon strip it off. They are so expeditious as to take off a scalp in two minutes.

It is important to stress that some people lived through scalping, as Catlin (1844:238) and many others have noted.

The osteological indications of scalping are cut marks circling the scalped area, although it is entirely possible to remove the scalp without leaving cut marks (Hamperl 1967:630). The typical Crow Creek scalping has two elements: the primary, circling cuts and secondary scattered cuts (Plate 7). The circling begins with the deepest and most frequent cuts going transversely across the frontal midway between nasion and bregma. Sometimes there is a single, long cut, but usually there are several groups of cuts. The cuts become less frequent and less deep on the lateral and posterior parts of the vault, where crests generally best display the marks. These cuts apparently display the limits of the scalp removed. In addition to these primary cuts circling the skull, there are secondary cuts commonly scattered across the vault. The most likely function of the

secondary cuts is skinning or loosening the scalp from the head rather than establishing the boundaries of the area taken. Usually these secondary cuts are transverse, but there is much variation. The typical scalping pattern at Crow Creek has primary, circling cuts on the frontal with other primary cuts on the lateral and posterior vault with secondary cuts scattered over the vault. There are, of course, variations in the pattern.

Of the frontals, where the cuts were noted most frequently, in Bed B 17 (94.4 percent) were cut and one (5.6 percent) may have been. In Bed B, 254 (85.5 percent) were cut, 24 (8.1 percent) may have been, and 19 (6.4 percent) were not cut (Table 35). The great majority of Crow Creek skulls show signs of scalping. There seems to have been no sex or age group exempt from scalping; women and children as well as men display the distinctive cuts.

The variations noticed involved the location of the primary cuts. One variation is the location of the primary cuts on the frontal. These cuts usually are present midway on the frontal but sometimes they are low on the frontal,in some cases just above glabella. Occasionally, though,the cuts begin near bregma. Another variation sometimes occurs with depressed fractures, but not always. When present, the primary cuts occur on the side of the fracture where the majority of the scalp was. This pattern suggests the fractures in at least some cases happened before the scalping, and the scalper was attempting to avoid gashes and holes in the scalp.

Some historic accounts tell of scalped people living through

TABLE 35. Mutilations of skulls and vertebrae from Crow Creek. Percentages are in parentheses.

	Bone Bed A			Bone Bed B		
	Present	Present?	Absent	Present	Present?	Absent
Scalping	17 (94.4)	1 (5.6)	0	254 (85.5)	24 (8.1)	19 (6.4)
Cut noses	0	0	0	4 (4.5)	0	85 (95.5)
Evulsions	3 (75.0)	1 (25.0)	0	35 (23.5)	7 (4.7)	107 (71.8)
Decapitation						
Occipital	2 (66.7)	0	1 (33.3)	31 (13.6)	6 (2.6)	191 (83.8)
C-1	1 (100.0)	0	0	56 (24.5)	3 (1.3)	170 (74.2)
C-2	0	0	0	31 (16.5)	4 (2.1)	153 (81.4)

the event. At Crow Creek, two skulls (No. 13 and No. 264, see Plates 17, 19) show remodeling comparable to what has been described as the result of survival following scalping. Neither of these two skulls retain any cuts, the marks apparently being healed. The importance of these two skulls is that it indicates violence, as exemplified by scalping, was long-term at Crow Creek, not limited just to the massacre itself.

Blows to the head seem to have been a common part of killing and mutilation, though historic accounts are not so frequent as might be expected. Coues (1897:262), Denig (1928-29:491), Godfrey (1974:113), Luttig (1964:124), Marquis (1967:15), Paulding (1974: 10-11), and Wagner (1973:236) all mention head bashing.

Skull fractures were very common among the Crow Creek skulls. Because of the difficulty separating old, unhealed linear breaks from those happening long after death, only depressed fractures were consistently recorded. Because fragmentation apparently often accompanied fracturing, it seems likely that only the most complete fractures on the most complete skulls were noted. This reasoning suggests that the fractures on skulls with the most bashing, hence the most fragmented, would tend not to show up in the count of the number of fractures. In this analysis only the most complete skulls, presumably the skulls with the fewest fractures in the sample, were used.

One hundred one relatively complete skulls were inspected for depressed fractures by Max Schmeling. About 40 percent of these skulls had fractures (Table 36), most of them struck once, although two

TABLE 36. Skulls with and without depressed fractures from Crow Creek. Percentages are in parentheses.

	Skulls with fractures					Skulls without fractures
	28	8	2	2	2	
Number of fractures	1 (66.7)	2 (19.0)	3 (4.8)	4 (4.8)	5 (4.8)	
Total Count			42 (41.6)			59 (58.4)

skulls had as many as five depressed fractures. The majority of the fractures (Table 37), were on the parietals, fewer on the frontals, nearly none on the occipital, and none at all on the temporals. The blows, then, seem to have been directed toward the top, front, and sides of the vault.

The outlines of the depressions were in two shapes: round and ellipsoid (Plates 8,9). Of the 66 depressed fractures classified as either round or ellipsoid, 22 (33.3 percent) are round and 44 (66.7 percent) are ellipsoid. There were both large and small round depressed fractures. While in some cases the ellipsoid fractures may have been caused by a round (in cross-section) instrument obliquely striking a skull, in some instances it is apparent that the tool used had an axe-like cross-section. These ellipsoid depressions, when the bone was left intact, have a linear crack running the long-axis of the ellipsoid, as well as the oval crack forming the outline of the ellipsoid fracture.

Removal of the nose during mutilation has not often been recorded on the Northern Plains. There are only two historic accounts of Plains Indians cutting noses that the researchers have found, and these are only possible cases.

Luttig (1964:124) saw the body of a fort worker who had "his Head Broken, the Brains scattered about; his nose and ears cut off,..." Admittedly this reference is ambiguous and might just as well be interpreted otherwise. Paudling (1974:10-11), a surgeon with the Custer relief column, saw men killed in another skirmish whose faces

TABLE 37. Location of depressed fractures on Crow Creek skulls.

	Frontal	Parietal Left	Parietal Right	Occipital	Temporal
Number	20	18	27	3	0
Percentage	29.4	26.5	39.7	4.4	

PLATE 8. Round depressed fracture.

had been cut, though no specific mention of noses being cut is made. Nevertheless, cuts suggesting the probability of nose removal were observed on a few Crow Creek skulls.

When present, the cuts usually occurred immediately lateral to and parallel to the long axis of the nasal aperture. That more were not found so a more definitive pattern could be established is unfortunate. Only 4 (4.5 percent) of the 89 nasal apertures inspected were cut (Table 35).

Severing heads from the body seems to have been a fairly common practice in Plains Indian warfare; it is occasionally mentioned in historic accounts (Denig 1928-29:491, Fletcher and La Flesche 1905:434, Grinnell 1892:254; Marquis 1967:15; Mooney 1895-96:260; Wagner 1973:237). Perhaps Thompson's (Coues 1897:262) account of a battlefield will suffice. "My beau-pere's head was severed from his body even with the shoulders,.... The enemy had...taken away the skull of another man for a water dish;...." Osteological indications of decapitation come from four individuals at the Larson Village (Owsley, et al. 1977:124-125), where cuts were found on cervical vertebrae.

The Crow Creek material was inspected for cuts around the foramen magnum and on cervical vertebrae 1 and 2. The cuts observed near the foramen magnum tended to be anterior to the foramen on the condyles or lateral to the foramen of the lateral portions of the occipital. Cuts on C-1 and C-2 tended to be on the anterior surface of the vertebral bodies and the anterior surfaces of the

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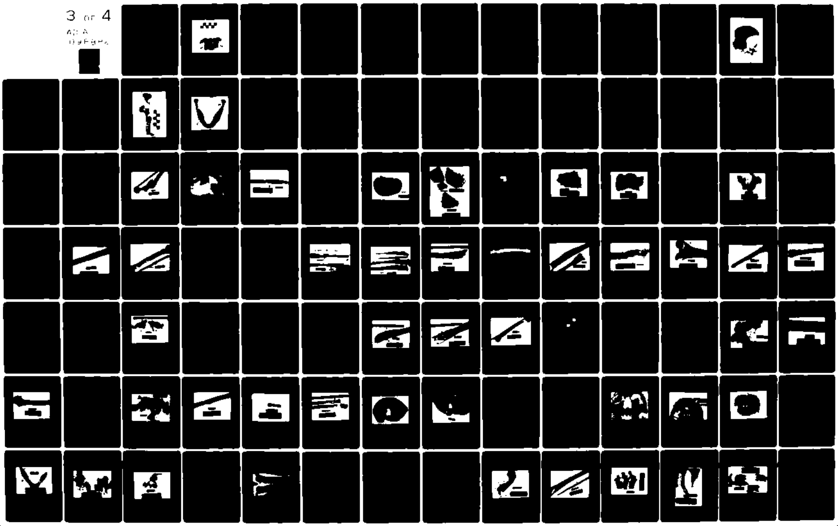

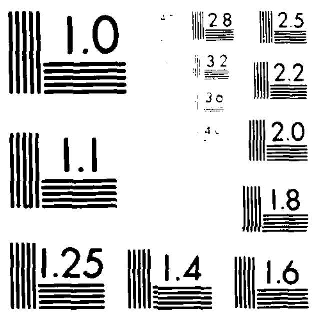

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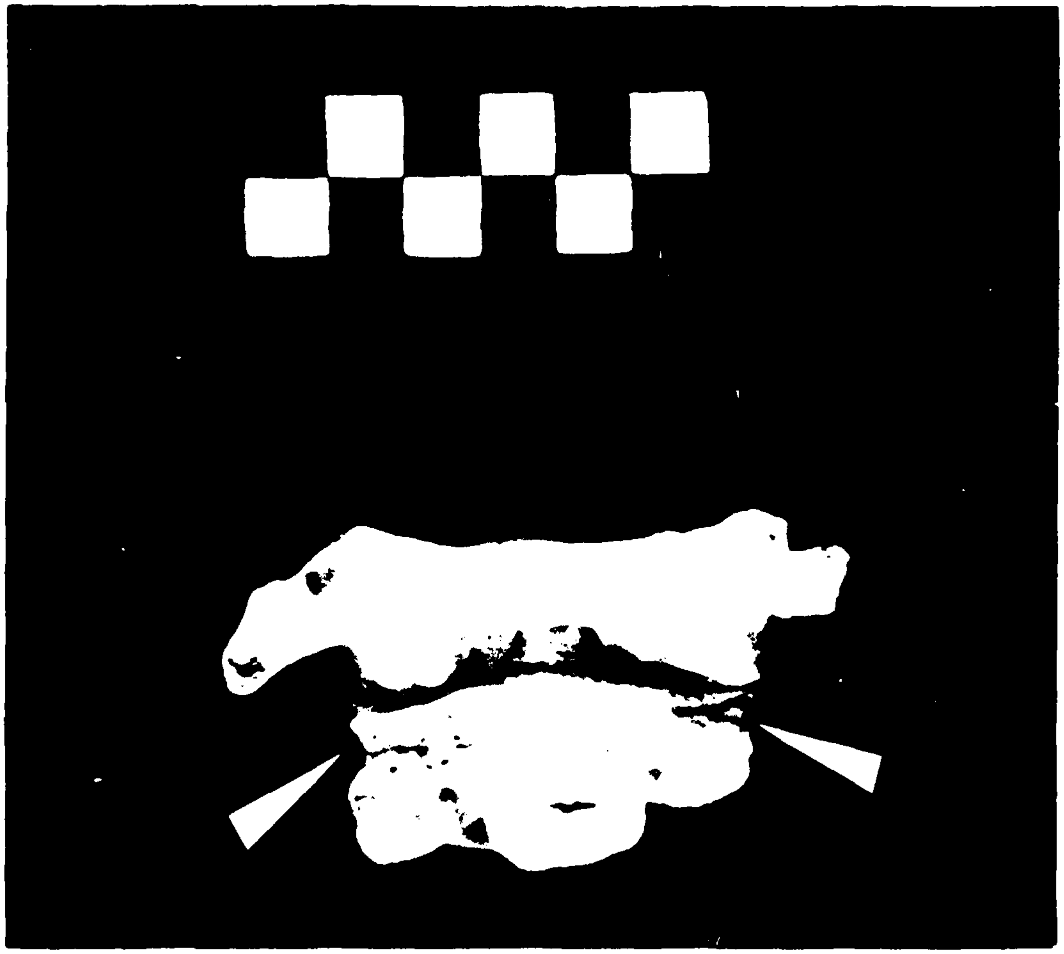
transverse processes (Plate 10). This pattern of cutting from anterior to posterior would avoid trying to cut through or get a blade between the spinous processes. Cuts were also noticed on the posterior border of the mandibular ascending ramus, the gonial angle, and the inferior border of the corpus. These cuts on the mandible may be additional indications of decapitation, but because of the material's disarticulation, no association between the cuts on the mandible, occipital, and first two cervical vertebrae could be established. Nevertheless, it is a possibility.

The frequency of beheading is presented in Table 35. Very few observations were possible on material from Bed A, so comments will be confined to that from Bed B. Cuts were most common on C-1, and if this frequency can be taken as an accurate reflection of decapitation attempts, then about a quarter (24.5 percent) were mutilated in this way.

The frequency of cuts on the occipital, C-1 and C-2 is interesting. X^2's on location of cuts divided by presence, presence?, absence ($X^2 = 10.22$, d.f. = 4, $p < 0.05$) and by presence and absence ($X^2 = 9.17$, d.f. = 2, $p < 0.05$) are both statistically significant. The cells which contribute most to the significance are relative under-representation of occipital cuts and the over-representation of C-1 cuts. This pattern suggests that the emphasis in decapitation was centered around C-1, right at the base of the skull.

Other than decapitation, dismemberment of bodies is often mentioned in historic accounts from the Northern Plains. Following



death, bodies were "butchered" (Coues 1897:262), "mangled " (Boller 1959; Kane cited in Ewers 1967:135; Lowie 1935;230), "cut" (Dorsey 1881:332; Eastman 1849:156; Grinnell 1892:254), or just plain "mutilated"(Coues 1897:260; Denig 1928-29:492; Dorsey 1881:313; DeSmet 1904, vol. 27:185). These general statements are interesting but are not specific enough for these researchers' purposes. William M. White (cited in Marquis 1967:15) was with the Custer relief column, and after observing the bodies noted "A hand, a foot, an arm, a leg, or more of these, or all of them, were detached and gone, with no indication of system having been followed as to which of such members were cut off." No specific search was made for cuts on the Crow Creek materials and those noticed were probably only the most obvious ones.

From historic accounts (Coues 1897:262; Fletcher and LaFlesche 1905; Grinnell 1892:254; Marquis 1967:15) it is specifically apparent that arms were severed from the body and taken as trophies. Cuts were found on all of the bones of the arm. Starting proximally and proceeding distally, on the proximal humerus (elements 41-6, 117-12, 158-9) three cuts were found, a possible cut near midshaft (22-2-D), and two near the distal end of the humerus (60-10, 150-3). All but one of the cuts were on the right humeri.

There were three ulnae with cuts, two near the proximal end (23-9, 74-7) and one near the distal end (164-14). One radius (71-12A) had a cut 1/3 of the bone's length from the distal end on the anterior surface.

The cuts on the distal ends of the ulna and radius may have been from severing hands. Fingers and hands seem to have been the popular trophies as noted in historic accounts (Denig 1928-29:491-492; Ginnell 1892:254; Marquis 1967:15). Hand and fingers were used as necklaces (Bourke 1887), as offerings (Boller 1959:151), and in games (Kelley 1871:143). Many of the finger and hand bones missing from Crow Creek may have served similar functions. It is also possible that many more hands were taken by smashing the radius and ulna rather than attempting to cut through these bones.

Historic accounts mention legs being severed following battles (Coues 1897:262; Fletcher and LaFlesche 1905; Grinnell 1892:254; Marquis 1967:15). There are a number of Crow Creek specimens which had indications of leg dismemberment. An innominate (29-16) was cut on the lateral surface of the ilium. The only other cut found near the hip was on the medial surface, proximal femur (47-1). Other cuts were found on the distal portions of the femur (125-1, 129-5, 134-7, 151-12-C, 156-1-A, 166-12-A-B). All but one of the cuts (125-1) were on the right femora. A right tibia (164-3) and right? fibula (51-6-A-C) have been cut on the proximal ends.

In historic accounts, feet were also recorded as being taken (Coues 1897:262; Denig 1928-29; Grinnell 1892:254; Marquis 1967:15). While no cuts were observed on the foot bones, snapping and splintering may have been used to sever toes from feet. Table 38 shows the frequency of metatarsal modification, and how snapping and splintering are more frequent toward the distal end than the proximal, as would be expected if toes were being taken. Snapping, and especially splintering,may also have been caused by carnivore scavenging.

TABLE 38. Crow Creek metatarsal modification. Percentages are in parentheses.

	Chewed	Snapped or Splintered	Crushed	Not Modified	Total
Bone Bed A					
Proximal	---	---	---	4	4
Shaft	---	3	----	4	7
Distal	---	4	---	---	4
Bone Bed B					
Proximal	7 (3.3)	8 (3.7)	---	199 (93.0)	214 (100.0)
Shaft	4 (1.7)	30 (12.7)	---	202 (85.6)	236 (100.0)
Distal	21 (11.4)	48 (26.1)	11 (0.5)	114 (62.0)	194 (100.0)
Bed B Total	32 (5.0)	86 (13.6)	1 (0.2)	515 (81.2)	634 (100.0)

When all of the cut bones are considered, there is an interesting difference in side frequency (Table 39). Almost four times more rights are cut than lefts. Assuming cutting was equally probable on each side and the sides were equally represented, the distribution of cutting is statistically significant ($Z = 2.52$, $F(Z) = 0.9941$, $p < 0.01$). But it is also known from the minimum element count discussed in a previous section that rights ($n = 1737$) are more common than lefts ($n = 1653$). Lefts amount to 95.7 percent of the right total, and the probability of randomly drawing a left is 0.4876, while a right 0.5124. Using this revised probability, the distribution of cutting is still significant ($Z = 2.42$, $F(Z) = 0.9922$, $p < 0.01$), so the cut distribution is not due to the over-representation of rights. What this means is at this time problematic.

If, as appears to be the case from the present data, rights were more often cut and rights presumably more frequently severed from the trunk, then one would expect right elements to be less common than the lefts, the reverse of what was observed. The right side of the body was perhaps more developed with muscles and tissue and while being severed required more cutting than the left, thus leaving more cuts on the right. The major left-right differences in cutting frequency are on the more proximal limb bones, which had greater muscle mass, the humerus and femur, as would be expected. Admittedly, this explanation is tenuous.

Burned human bone was found in the fortification ditch. At

TABLE 39. Number of Crow Creek long bones with cuts.

	Left	Right	Total
Humerus	1	5	6
Ulna	2	1	3
Radius	0	1	1
Femur	1	6	7
Tibia	0	1	1
Fibula	0	1	1
Total	4	15	19

one point most of this material was separately examined, but no attempt was made to determine the frequencies at which the different elements were burned. The burning was relatively light; all the burned areas were charred, and none were calcined. Additionally, most of the burned parts were from areas not covered by much soft tissue.

Parts of at least seven individuals (based on seven skulls) were burned. Three adults (two probably female, one possibly male), three adolescents (one 12 years old, two 14-18 years old), and one child (3-5 years old) are represented. A femur (166-17) may represent a second burned child, but this is uncertain. Individuals 12-18 years old are overrepresented, but the sample size is so small that this may be insignificant.

The burning patterns on the long bones are the most difficult to explain because the areas that are burned are those that should have been covered by much soft tissue, and if burning destroyed this soft tissue, more severely burned bone should have resulted. Eight of the nine burned long bones are broken somewhere on the shaft, and these are burned at the broken edges. Additionally, one of the femurs (42-5) is also burned anterior to the greater trochanter and slightly on the femur head. This area is not within the acetabulum in standard anatomical position. In these cases the bone proximal to the burned shaft is present and the distal end is not. Deeply blackened areas represent the most severe burning for these cases. There are also some light reddish-brown areas peripheral to these black areas that seem to be only slightly affected by burning. There are at least three situations which could have caused the pattern of burning seen on these long bones.

First, distal ends of limb segments could have been put in fires while the proximal ends remained out of them. Possibly the distal ends were destroyed by the fire, not retrieved from the fire for burial, or were later carried off by carnivores. Second, limbs could have been cut through and the cut ends placed in fires. This seems unlikely since it would be difficult to completely cut through a thigh. Neither of these suggestions explain why the distal ends are always missing, unless it was due to chance alone ($p < \frac{1}{2}^8 = 0.0039$) or was intentionally done. Third, the flesh might have been removed from the bones distal to the burned areas or, more likely, dismemberment of the distal joint may have occurred before the limbs were placed in the fire. Baby's (1954) suggestion that incineration of disarticulated limbs causes the contraction of the freed muscles has much merit. If the distal ends of the Crow Creek bones were then destroyed by or left in the fire, this could explain the pattern observed. None of these possibilities adequately explain the other burned areas on femur 42-5, but these might have some other cause.

The third of these possibilities may be the most likely. There is no way to be sure that all the bones were burned in the same fire or even in the same way. Even so, a likely explanation for the amount and patterning of burning might be that the raiders threw a few bodies or body parts on the camp fires that were burning at the time of the attack. The light degree and the relatively superficial location of burning could be expected if fleshed bodies or parts were thrown into campfires and not tended further. Substantial effort is required to thoroughly burn a whole body. While the earth lodges were burned, it seems that individuals burned in them might still be there since once the roof collapsed, much effort would be required to retrieve their remains for burial in the fortification ditch.

Possibly this behavior was an extension of the mutilation that occurred. All seven burned skulls had been scalped as well as burned, and in three cases the burned areas correspond fairly well with the areas that would have been exposed after scalping (Plate 11). This indicates that these heads were scalped before they were burned. The burning on the bases of skulls 62-2 and 112-3 suggests that these two might have been separated from the rest of the body before being burned, but neither has cut marks indicating decapitation.

Historic accounts commonly mention carnivores devouring human bodies. The animals most commonly mentioned are dogs and wolves. Catlin (cited in Dunn 1963:187) and Thompson (1916) write that dogs and wolves ate the remains of epidemic victims. A few days following a battle, Alexander Henry (Coues 1897:264) walked over a field noting that wolves and crows "interred" many of the dead, and further, so little remained that "I gathered up the remaining bones of my belle-mere in a hankerchief." Wolves were even so persistent that burial did not always deter them from getting to the bodies (Boller 1966, vol. 33:40-141); they even pulled bodies from the grave (Maxmilion 1906, vol. 24:86).

Some of the Crow Creek bones have tooth puncture marks which are commonly near the ends of long bones and apparently were made by carnivores. They are very similar to the marks found in present-day police cases which have been attributed to dogs. In addition, crushed, snapped and splintered (especially the splintered) ends may also have been chewed, though this is much less certain than those which have puncture marks.

Tooth marks are most common at the ends of the bones (Table 40) with very few on the shafts. The marks are most frequent at the elbow, hip, and ankle. Tooth marks, snapping, and splintering are about equally common.

Some of the snapping and splintering may have been caused by chewing. In general, the bones appear to be snapped and splintered in the same places that are most commonly chewed. If snapping and splintering can be considered caused by chewing, then a somewhat similar pattern as the tooth marks is seen (Table 40). The shafts are less often snapped or splintered than the ends. The distal ends of all bones, except the humerus, are most frequently snapped or splintered than the proximal. The missing hands and feet might have been taken by the raiders, but it is also possible that these parts were devoured by the carnivores.

From these observations many of the bodies appear to have been chewed; it is likely that not all the chewing left marks on the bones, so more chewing may have occurred than is apparent. The

TABLE 40. Crow Creek long bone modification from Bone Bed B. Questionable identifications omitted. Numbers in parentheses are percentages for that bone.

	Chewed	Snapped or Splintered	Crushed	Not modified	Total
Humerus					
Proximal	50 (4.2)	83 (7.0)	4 (0.3)	214 (18.1)	351 (29.6)
Shaft	1 (0.1)	24 (2.0)	0	384 (32.4)	409 (34.5)
Distal	168 (14.2)	82 (6.9)	4 (0.3)	170 (14.4)	424 (35.8)
Total	219 (18.5)	189 (15.9)	8 (0.6)	768 (64.9)	1184 (99.9)
Radius					
Proximal	27 (5.0)	28 (5.2)	2 (0.4)	129 (24.0)	186 (34.6)
Shaft	0	24 (4.5)	2 (0.4)	158 (29.4)	184 (34.2)
Distal	17 (3.2)	86 (15.9)	0	65 (12.1)	168 (31.2)
Total	44 (8.2)	138 (25.6)	4 (0.8)	352 (65.4)	538 (100.0)
Ulna					
Proximal	75 (12.8)	52 (8.9)	7 (1.2)	86 (14.7)	220 (37.5)
Shaft	2 (0.3)	32 (5.5)	1 (0.2)	176 (30.0)	211 (36.0)
Distal	13 (2.2)	76 (12.9)	1 (0.2)	66 (11.2)	156 (26.5)
Total	90 (15.3)	160 (27.3)	9 (1.6)	328 (55.9)	587 (100.0)
Femur					
Proximal	250 (12.7)	36 (1.8)	11 (0.6)	373 (18.9)	670 (34.0)
Shaft	7 (0.4)	14 (0.7)	0	629 (31.8)	650 (32.9)
Distal	183 (9.3)	169 (8.6)	13 (0.7)	291 (14.7)	656 (33.3)
Total	440 (22.4)	219 (11.1)	24 (1.3)	1293 (65.4)	1976 (100.2)
Tibia					
Proximal	69 (5.1)	102 (7.5)	8 (0.6)	273 (20.0)	452 (33.2)
Shaft	4 (0.3)	49 (3.6)	3 (0.2)	413 (30.3)	469 (34.4)
Distal	87 (6.4)	125 (9.2)	9 (0.7)	222 (16.3)	443 (32.6)
Total	160 (11.8)	276 (20.3)	20 (1.5)	908 (66.6)	1364 (100.2)
Fibula					
Proximal	5 (0.7)	30 (4.5)	0	175 (26.0)	210 (31.2)
Shaft	0	23 (3.4)	1 (0.1)	219 (32.5)	243 (36.0)
Distal	29 (4.3)	62 (9.2)	3 (0.4)	127 (18.8)	221 (32.7)
Total	34 (5.0)	115 (17.1)	4 (0.5)	521 (77.3)	674 (99.9)

amount of chewing suggests that the bodies were exposed for some time before being covered. The mural painted--wolves and village dogs chewing the already mutilated bodies--is unpleasant.

Parenthetically it is worth speculating about the village dogs consuming their masters. Dogs were eaten by many Plains Indian groups (e.g., Brackenridge vol. 6:114; Gilmore 1933). One has to wonder if, as the village dogs devoured the villagers, any of them appreciated the irony.

In addition to those disfigurements discussed above, there are two other mutilations which should be mentioned. These mutilations are evulsion and removal of tongues. Evulsion, the removal of teeth, occurred in historic times. Luttig (1964:124) mentions that a fort worker; killed in the early 1800's, was mutilated, including having "his teeth Knocked out,...." Evulsions were fairly frequent among the Crow Creek specimens (Plate 12). There were three jaws (75.0 percent) with, and one (25.0 percent) without evulsions in Bed A. Bed B showed the almost reverse proportions: 35 (23.5 percent) with, 107 (71.8 percent) without, and the rest (7, or 4.7 percent) with questionable evulsions.

Tongues may have been cut from the mouths of the people at Crow Creek. Cuts on the posterior border of the ascending ramus of the mandible may have been incidentally produced by a double-edged blade during decapitation. Cuts on the inferior border of the corpus, however, are harder to interpret this way (Plate 13). Even more difficult to include as part of decapitation are the

cuts on the inner surface of the mandibular corpus. The most reasonable explanation for these marks is that tongues were being cut, at least in some cases, beginning in the throat under the chin rather than through the mouth.

Mutilations may well have been missed in this study for two reasons. One reason is methodological, the other a limitation of archeological material. The methodological problem was caused by limits of time and money. Historic accounts of mutilation indicate the variety of others which might have been present. Bones of the thorax from Crow Creek were only sporadically observed, but it is likely that some may have been mutilated. Alexander Henry (Coues 1897: 262), for instance, noted a mutilated body "with the belly and breast ripped up and thrown over the face;...." Other observers recorded similar destruction (Custer 1962:255; Godfrey 1974:112-113; Marquis 1967:15; Pauling 1974:11; Roe 1927:10). These sorts of cuts and breaks are not likely to have been observed in this study. Punctures left by removed arrows are also likely to have been missed in this analysis. Certainly many of the Crow Creek victims must have been killed by arrows, but few bone-embedded projectiles or points associated with the bone bed were found. The lack of points suggests that time permitted recovery or removal of nearly all arrows.

The other sort of mutilations which may have been present but not seen on the Crow Creek material were not observable because no obvious indications were left. The mutilations mentioned in historic accounts but generally not observable on skeletal material include severing genitals (Coues 1897:262; Custer 1962:225; Denig 1928-29; 124; Dorsey 1881: 313; possibly Luttig 1964:124; Wagner 1973:237) and severing ears (Boller 1959:151; Luttig 1964:124). Ear severing may have been a part of scalping and not a special category of mutilation.

Scalping was one of the most obvious mutilations. Since the Crow Creek massacre appears to date to the 1300's and the first recorded visit by whites to the area was over 200 years later, the practice of scalping was not white-introduced. It is, of course, possible some Indian groups lacked the practice and that it was introduced to them by whites. But the Crow Creek scalping emphasizes what has been recorded elsewhere (Neumann 1940; Owsley and Berryman 1975; Snow 1941): namely, that scalping was not solely introduced by whites to all Indians.

ABNORMALITIES, ANOMALIES, AND DISEASES IDENTIFIABLE IN THE BONES OF THE CROW CREEK MASSACRE VICTIMS

As stated previously, in about 1350 A.D., more than 486 proto-Arikara were massacred and their remnants deposited in a common grave. During a very brief interval in 1978-1979 their bones were available for scientific analysis. The investigations performed were designed to gain as much insight as possible into the physical characteristics of these people, their general health at the time of death, and the incidence of various processes which may have affected their bones during their lifetime. The fact that they lived in the pre-Contact era allowed study of a sizable skeletal population which represented people who existed before white admixture. The demographic data relating to the Crow Creek victims has been compiled thoroughly by Willey and Swegle; they included in their work an evaluation of probable fatal trauma and post mortem mutilation, as well as an analysis of anthropomorphic data. Therefore, this segment is confined to a study of the bones for evidence of diseases, anomalies, or abnormalities which antedated death and which may or may not have been active at that time.

Probably the greatest contribution which could have been hoped for from this study would have been to obtain data which reflected the incidence of various diseases which might be found in a homogeneous skeletal population. Unfortunately, certain factors precluded obtaining as much relevant information as might be desirable. They were:

1. A determination of the actual number of individuals who

lived in the village at the time of the massacre was not possible. The skeletal population was weighted toward remnants of older children and adults, very young children's remains being notably few in number. This age dichotomy was most significant when the demographic data of Crow Creek was compared to that of other Arikara cemetery populations from villages which had existed along the Missouri River (Bass et al. 1971; Owsley et al. 1977; Owsley and Bass 1978).

2. A selective destruction or elimination of one sex was not apparent in the Crow Creek skeletons. A slight preponderance of males in the ages 12-29 years was found by Owsley and Bass (1978) in the Larson Cemetery site. They attributed the discrepancy by sex to the effects of pregnancy upon the female population. The Crow Creek population statistics are quite similar to those of Owsley and Bass.
3. There was no way to determine exactly how many people and of what ages and sex may have escaped or have been taken away from the massacre site.
4. Although probably very insignificant, the amount and type of skeletal and cultural material which was taken by the grave robber prior to the controlled excavation cannot be determined.
5. The 1978 archeological investigation explored only the northwest 20 feet of the 1,250 foot long ditch which surrounded the Crow Creek village. It is known that there is still an

undetermined number of bones in the ground east of the furthest extent of the 1978 excavation.

6. The bodies of the victims had been brutally dismembered and dumped indiscriminately into the ditch in such fashion that is was difficult to articulate more than a few bones of a particular skeleton, precluding identification of any complete individual.

7. The distal portions of extremities, especially the hands, were missing from the majority of bodies, often along with the distal ends of the long bones. Very few patellae and sterna were found, and clavicles were few. Other bones were also underrepresented in the series. This finding strongly suggests that many bones did not find their way into the common grave and may have been carried off by scavengers or buried elsewhere. The absence of many bones precluded investigation for certain diseases and anomalies.

8. Although there are many manifestations of aggressive trauma, primarily in the skulls, the majority of the Crow Creek bones show very few manifestations of defensive trauma such as fresh parry fractures. Despite the number of people who were killed, very, very few projectile points were found during the entire excavation. Only one projectile point was found in bone and it had probably been therein for some time prior to death. Malnutrition or an epidemic illness possibly lessened the victims' ability to defend themselves.

9. The bones as received in the paleopathology laboratory were relatively well preserved but quite fragmented. Some of the fragmentation was old but much breakage was due to difficulties encountered during exhumation and in processing them prior to analysis. The disruption of many of the smaller and less durable bones such as the face, especially the palate, supra-orbital plates, and intranasal structures precluded studies which were intended upon these structures. The dismemberment of the bodies as a part of the massacre prevented analysis for various anomalies and abnormalities which may have been multiple in the same individual.

10. By agreement with the Indians of the Crow Creek Reservation, the bones were to be reburied in the spring of 1979, allowing only about 3½ months for the pathology study and about 5½ months for the other studies in the laboratory. The evaluation of these specimens was therefore hurried but as complete as the situation allowed. Despite the less than optimum circumstances, it was possible to go through all of the bones for pathology at least four times. The first analysis of the bones, as received, was done by John and Pauline Gregg. Subsequent screens were performed by P. Willey and M. Swegle and confirmed by John Gregg. That any obvious abnormality escaped these screenings is unlikely.

METHOD OF ANALYSIS

After exhumation at the Crow Creek site and preliminary field cleaning, the bones were transported about 200 miles to The University of South Dakota in Vermillion. The bones arrived at the laboratory periodically over a 4½ month interval in 172 various-sized cardboard boxes. Within the boxes there were paper bags filled with bones and fragments, between 5 and 63 bags per box, averaging 10. Provenience data had been inscribed upon each bag before it left the field, i.e., "9-28-78 9A, SE¼ Artic. 172, Adult Thoracic Vertebrae." There was intermingling of sex and age in almost all boxes and many bags included some animal (primarily bison) bone and rock fragments. The boxes went from the receiving area to the washroom and then were brought to the paleopathology study area. They arrived in a loose sequential pattern. For logistical reasons it was necessary that the investigation for pathology precede the other studies for demographic and anthropomorphic data.

To catalogue the material and to systematize the research, each box of bones was assigned a number immediately prior to analysis of its contents and each bag within the individual boxes was numbered, i.e., Box 122, Bag 14. The Box/Bag designations were retained for identification purposes throughout the investigation.

Over 700 articulations of two or more bones were recovered during the excavation. Most of the articulations were of only a small number of bones. For this reason the investigation for pathology had to be confined to an analysis of the bones or articulations as individual specimens which demonstrated evidence of a disease or anomaly. Some of the abnormal bones, fragments, or articulations which could have been parts of the same individual were found in different portions of the common grave. Whenever possible the remnants were matched and re-assessed. However, in most instances it was not possible to establish conclusively whether commonality of pathology in lookalikes represented the same individual. Because of the disparity in the number of different elements, it was not possible to report the pathology (other than with disease of the temporal bones) as a function of the total number of persons. The bones, articulations, and reassembled specimens were assessed individually and collectively and the findings are reported here as the total number of abnormalities found in the common grave. Unfortunately, it was difficult to make direct comparisons between these findings and those from other Upper Missouri Basin cemetery populations.

Pathology as reported herein is interpreted as any process, disease, anomaly, or abnormality which had affected the bones prior to the death of the individual. The skeletal mutilations which occurred at the time of death or thereafter are described elsewhere. An assay for dental disease has also been made by other researchers. Dental problems which might be reflected as disease in contiguous structures are reported herein and discussed (e.g. antral-oral fistula secondary to dental disease).

Because the skeletal material was to be reburied, precluding future evaluation, after careful cataloguing of all abnormalities, two photographs were made of each bone which demonstrated an abnormality, one in color and one in black and white. Exceptions to the photographic documentation were some vertebrae which showed evidence of degenerative changes, some specimens which had evidence of mild periostitis which could not be seen well in photographs, and some specimens showing evidence of dental wear, attrition, and tooth loss. On each photograph the date upon which the picture was taken and a code number were imprinted. Photos of the specimens which had been discarded by the grave robber were identified with a series of numbers typewritten upon a card, the last number used being inked out, i.e., ([redacted] [redacted] 9 10). For the majority of the specimens found during the survey for pathology, Roman numerals were the identifiers (I---CCCLXXII inclusive). Identification of the specimens found during the subsequent screenings was done with encircled Arabic numerals, (1), (2)---(90), inclusive.

To correlate with previous studies which have been done upon human skeletons exhumed from the Upper Missouri River Basin and for comparison with projects which are ongoing or to be done, X-rays were taken of the bones with demonstrated pathology. Also X-rayed were mastoids, the ends of the long bones, and the mandibular teeth of the subadults. The results of the X-ray studies have not been completed and will be reported later.

Within this paper, findings by Gregg from the examination of other prehistoric and proto-historic skeletal groups which had their origin in North and South Dakota are used for purposes of comparison.

Much of this information is unpublished. Previous investigations have included inspections of the William H. Over Museum collection, the Historical Society of North Dakota collection, specimens which are within private collections in the Dakotas, skeletons from North and South Dakota (Sioux-Hrdlicka's collections, and salvage archeology skeletons) which are a part of the collection at the United States National Museum, and the salvage archeology material from South Dakota which is at the Anthropology Department of the University of Tennessee-Knoxville. The primary emphasis of these previous investigations has been upon pathology in the cranio-facial area.

To facilitate the documentation of pathology in the Crow Creek skeletons, abnormalitites have been categorized as follows:

1. traumatic lesions
2. inflammatory and infectious (pyogenic and granulomatous) processes
3. tumors and cyst-like lesions
4. metabolic and nutritional disturbances
5. degenerative processes
6. congenital and development anomalies.

The findings made during this survey are presented in tabular form and discussed. Exemplary individual specimens are illustrated. Appropriate negative findings are included. The data have been compiled in this fashion in the hope that they will be of interest to the casual observer and will also be informative to researchers in the future, long after the skeletal material is buried.

TRAUMATIC LESIONS (Table 41)

One well-healed fracture in the upper femur of an adult male (Plate 14) showed moderately severe angulation deformity and about 5-6 cm of shortening. The amount of shortening and deformity undoubtedly would have caused considerable discomfort and disability during the life of the afflicted individual. Unfortunately the bones forming the joints above and below the site of the injury were not articulated and could not be evaluated for concomitant pathology. The individual who had sustained this injury had lived for at least 6-8 months afterwards. Four other adult femurs from the northern Great Plains show evidence of similar femoral injuries and variable degrees of residua.

Plate 15 shows an old, well-healed, markedly depressed (about 20 mm deep) fracture in the left frontal area of an adult male's skull. A blow with considerable force would have been required to produce such an injury. The degree of healing of the damaged bone suggests that the injury occurred quite some time prior to death. Because the skull was not articulated with other portions of the skeleton,it was not possible to find evidence of neurological or other bone damage which might have accompanied or followed this injury. Sequelae of skull injuries, but none of this magnitude, have been noted previously in skeletons from North and South Dakota.

The remaining 28 bones which showed defects suggesting residua of fractures were all well healed and demonstrated quite good anatomic alignment (Plate 16). They should not have caused much functional difficulty to the affected individuals during life. The compression

TABLE 41. Traumatic Lesions.

PHYSICAL TRAUMA	MILD	SEVERE	
Fractures, old, healed--			30
Frontal	3	1	
Parietal	3		
Nasal	4	1	
Vertebra, body, lumbar	1		
Vertebra, spinous process, thoracic	1		
Rib	2		
Clavicle, midportion	1		
Humerus, proximal	1		
Humerus, distal	1	1	
Radius, proximal	1		
Radius, distal	1		
Ulna, proximal	1		
Ulna, distal	3		
Femur, proximal		1	
Tibia, proximal	1		
Tibia, distal	1		
Fibula, midportion	1		
Dislocations--			2
Proximal tibia-fibula articulation	1		
Distal tibia-fibula articulation	1		
Epiphysitis---			1
Radius, biceps muscle tendon insertion	1		
Embedded projectile point showing bony reaction---			1
Innominate	1		
Nasal septal deformity--			13
Moderately severe	8		
Severe	5		
Scalping, old, with reaction on outer and inner skull surfaces---			2
Total traumatic injuries---------------------------------------			49

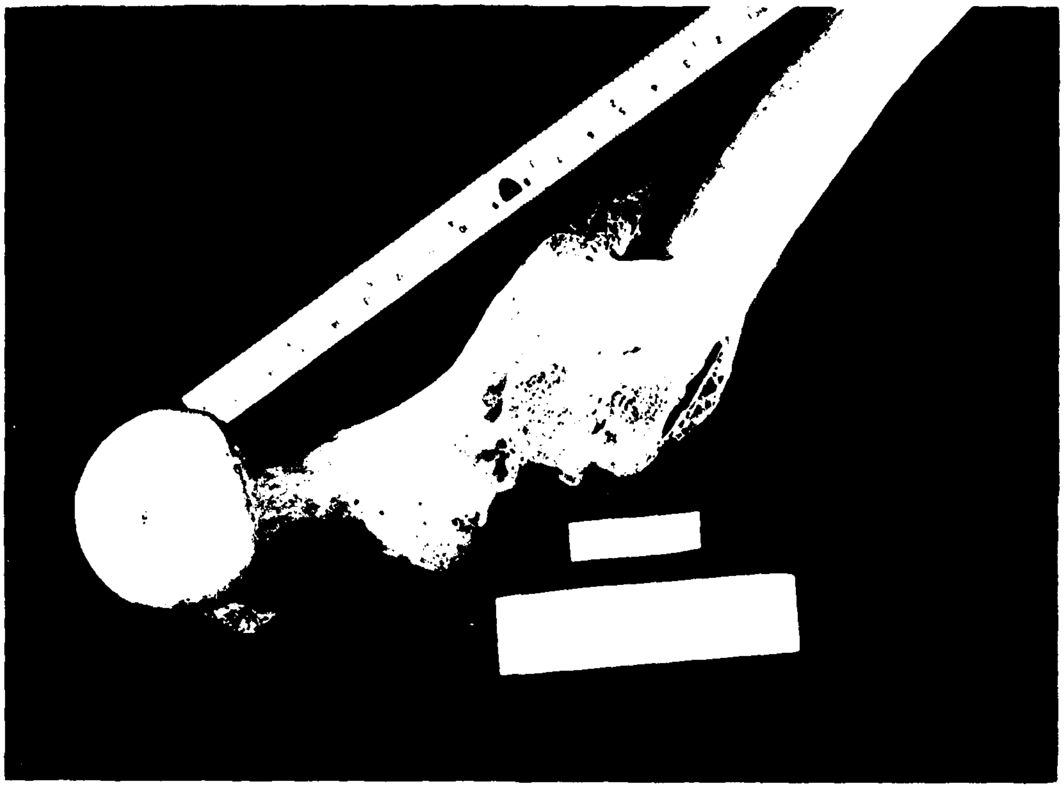
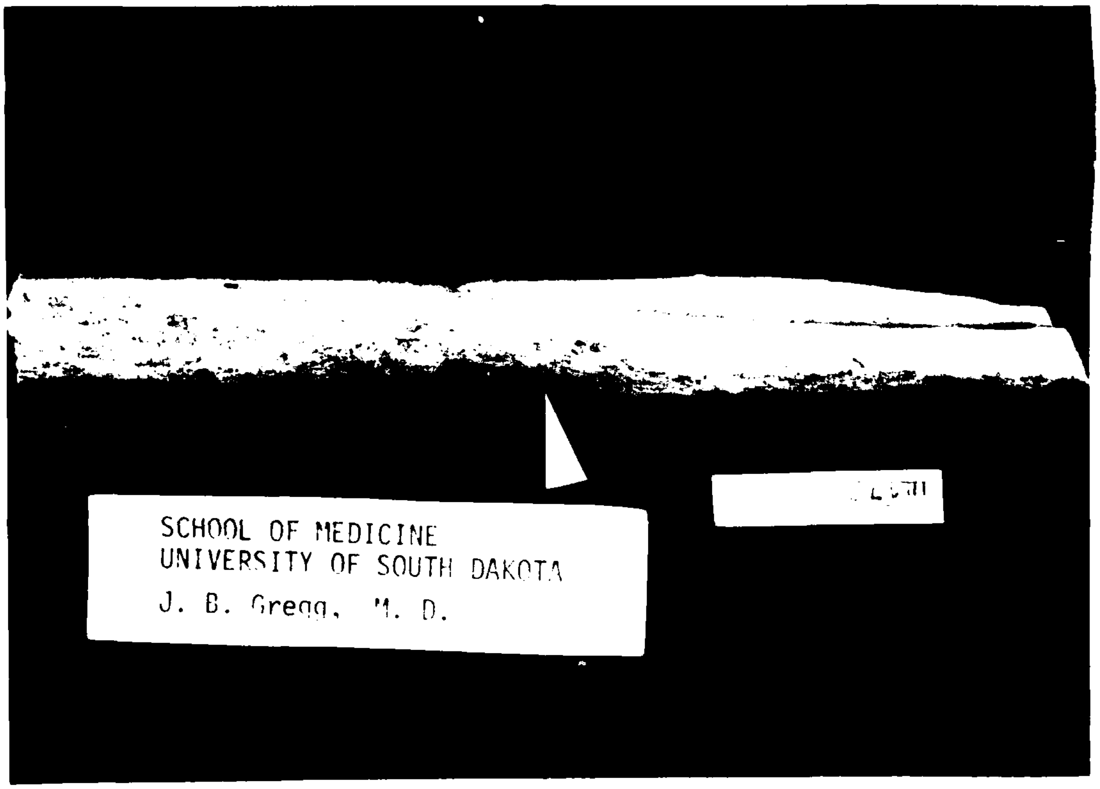


PLATE 16. Fracture, old, green-stick, ulna, showing good alignment.



deformity of a lumbar vertebra which appeared to be a healed fracture is unlikely to have produced any neurological deficit. Other compression deformities of vertebrae in the Crow Creek material, probably secondary to osteoporosis, have been discussed in the section, Degenerative Changes in Bone. Similar changes in vertebrae have been previously noted in skeletons from North and South Dakota.

Two adult Crow Creek skulls presented findings strongly suggesting old scalping, i.e., probably two months or more prior to death. Skull No. 264, (Plate 17) was found semi-intact but Skull No. 13 (Plate 18) was fragmented and the pieces scattered over 3/4 of a square meter in the common grave (FIG. 19). Markings on the inner surfaces of both calvariums due to vascular engorgement indicated reparative response to the scalping injuries (Plate 19).

A piece of flint, probably from a projectile point, was found embedded within the bone of the lateral surface of an adult innominate, superior to the acetabulum (Plate 20). Bony reaction surrounding the foreign body indicated that it had been *in situ* for some time but the minimal response suggested that the injury had not been complicated by osteomyelitis. The fragmented condition of the point indicated further that the missile had been partially removed. In this location it is not likely that there was much functional disturbance for the individual who sustained this injury. No other old projectile type injuries were found in the Crow Creek skeletons. Although projectile point wounds have been found previously in South Dakota, they have not been common.

In one instance, alteration in bone in the area of insertion [illegible] Skull [illegible] at least two months before death. Note evidence of bone [illegible] osteogenesis, indicating [illegible].

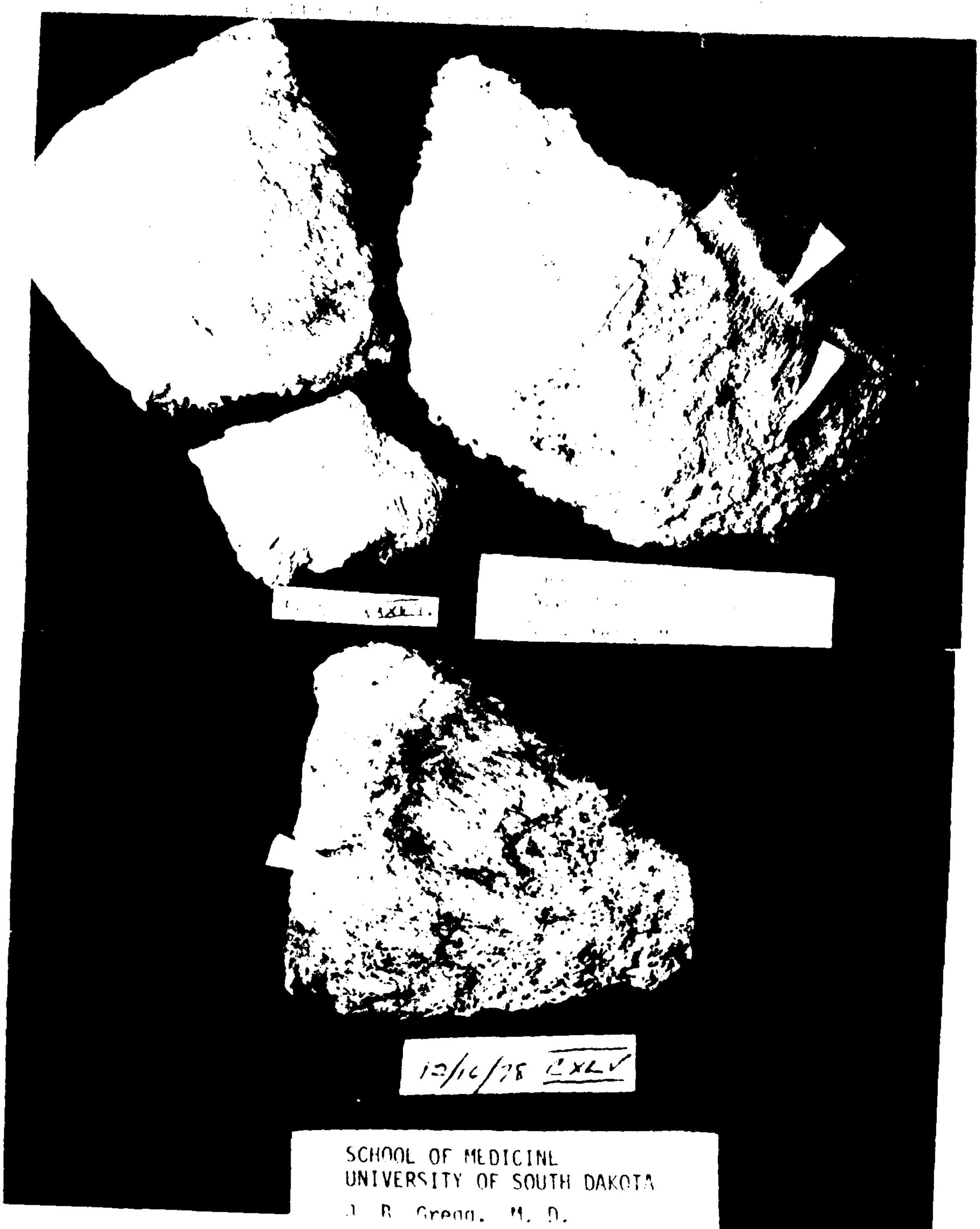

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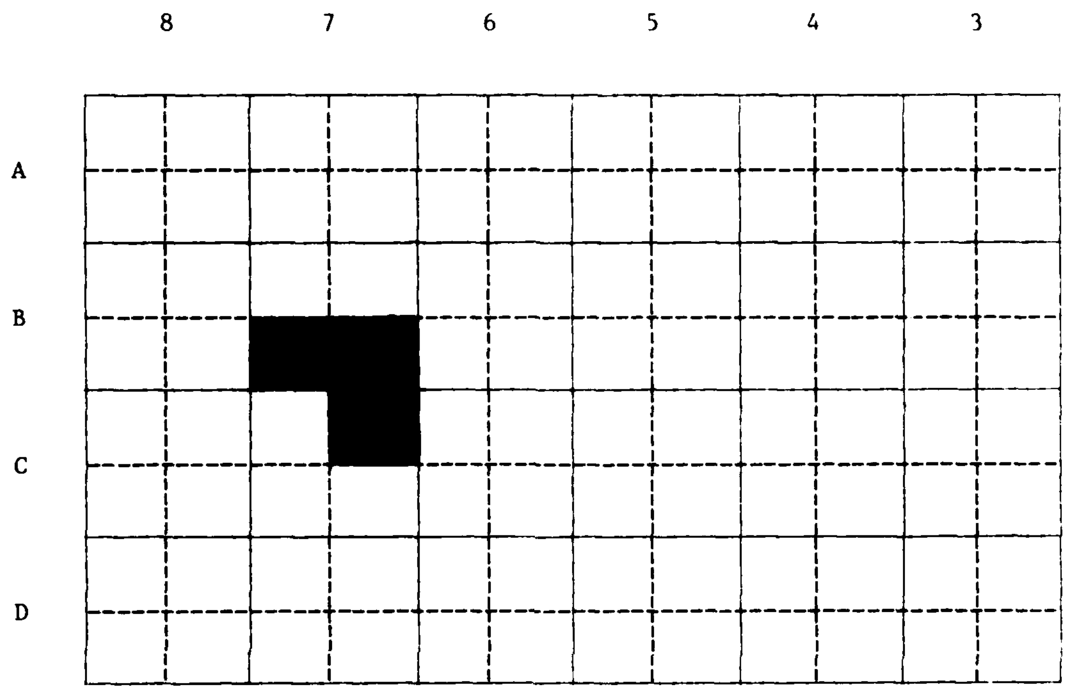
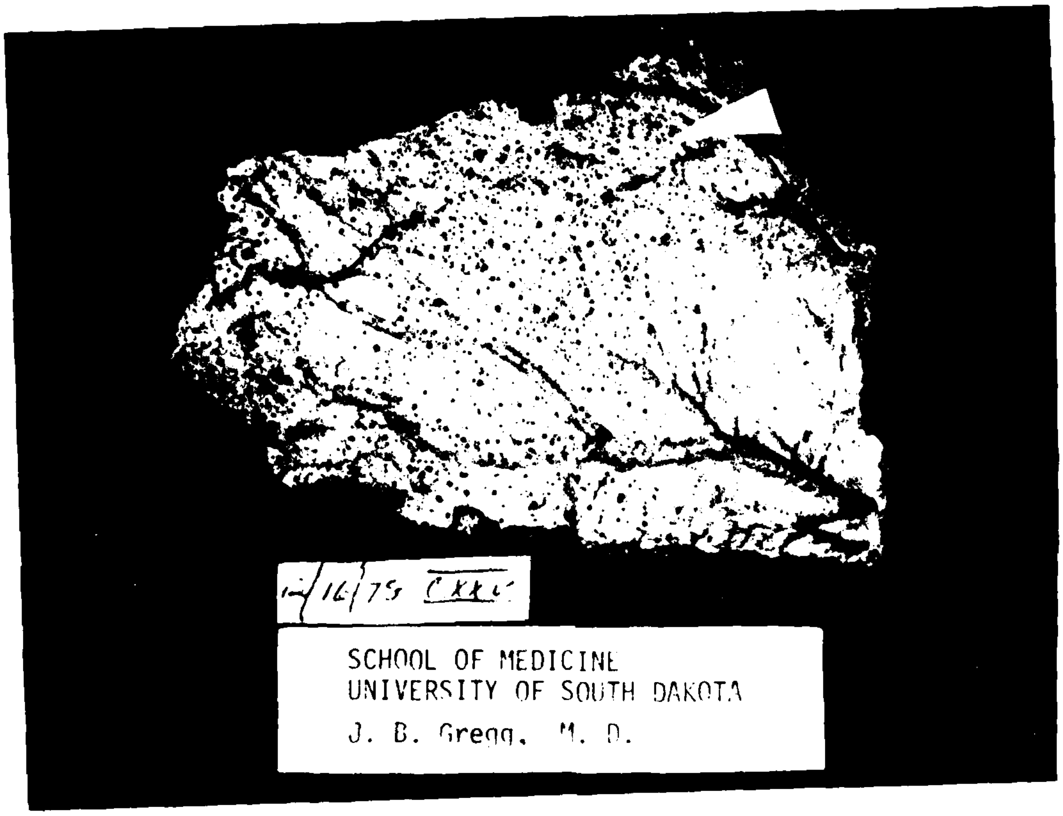
FIGURE 19. Grid Chart I. Crow Creek excavation Grid Lines.

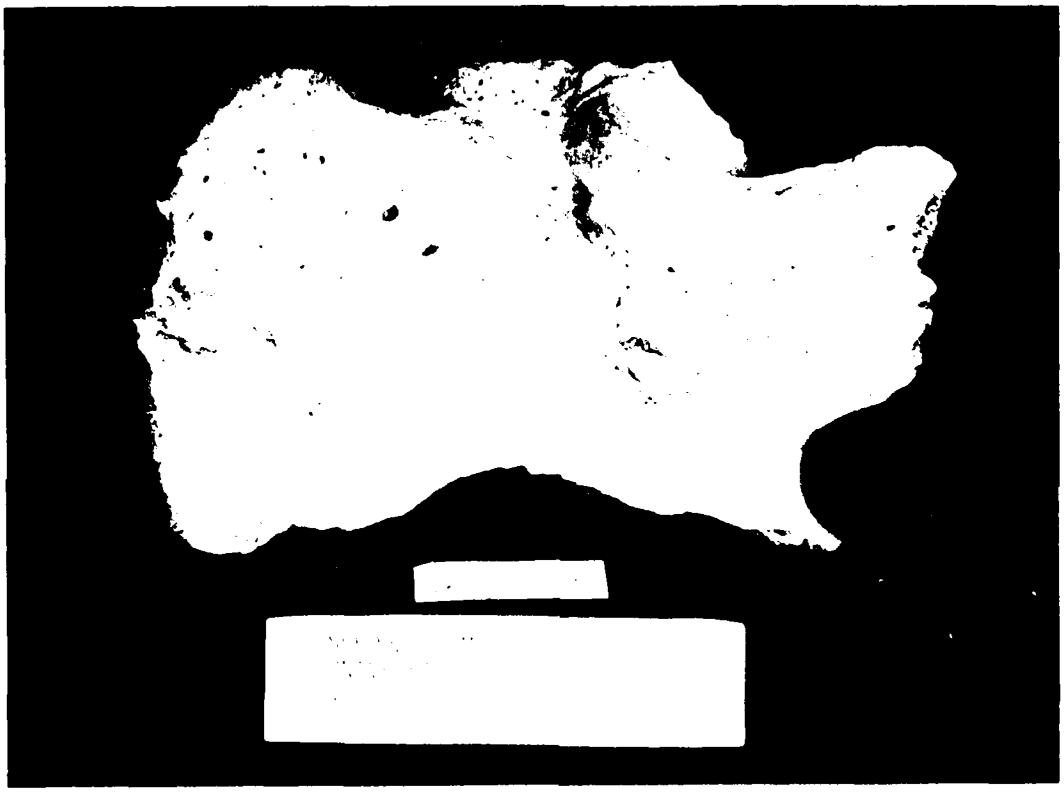


Scale : one meter

Location of scalped skull fragments. 7B SE
(Skull #13) 7B SW
7C NE

PLATE 19. Fragmented Skull #13, medial surface of calvarium. Note vascular markings indicating inflammatory response to the previous scalping.



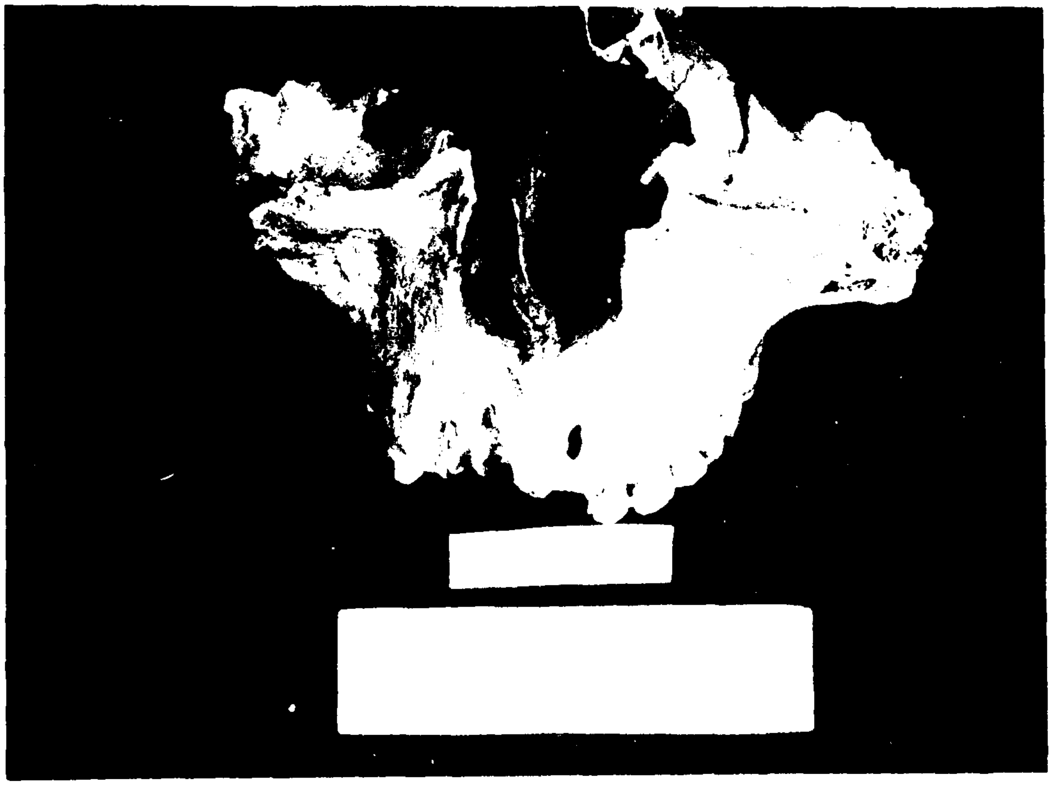


of the biceps tendon into an adult radius may have resulted from epiphyseal injury during growth. This injury was well healed and should not have produced any significant functional disturbance. Similar changes have been found in other skeletal specimens from the upper Missouri River Basin.

Deformities of the nasal septum, variable in degree, were found in 13 skulls (Plate 21). Unfortunately, the bony septum and maxillary crest, which can often be utilized as an indicator of septal cartilage deformity anteriorly, were missing from the majority of the Crow Creek skulls precluding analysis for the incidence of abnormalities in the bony or cartilaginous septum. A study by Steele, et al.(1965) of a large group of skulls exhumed from North and South Dakota reported nasal septal deformities in about 50 percent of both males and females. Because of the diversity of opinion as to the genesis of nasal septal abnormalities (Gray 1978; Gregg 1978c; Olesen 1970; Pease 1969; Post 1966; Titsche 1977), it had been hoped that data relating to the frequency of this abnormality in a homogeneous pre-Contact Indian skeletal population might be obtained. Unfortunately, such data were not forthcoming.

Two specimens showing probable ankle sprain-dislocation injuries were seen, both in adults. One affected the proximal tibia-fibula articulation. Both were old and probably had little effect upon the individuals. Similar bony changes have been seen in other specimens from North and South Dakota.

The total number and pattern of old traumatic lesions found



in the bones of the Crow Creek victims were in general quite similar to those which have been found in comparable skeletal populations elsewhere (Bowers 1966; Brothwell and Sandison 1967; Goldstein 1976; Greene 1972; Jarco 1965b; Miles 1975; Morse 1969; Neumann 1966; Roney 1959; Steele et al. 1965; Steinbock 1976; Strothers 1976; Warren 1971).

INFLAMMATORY AND INFECTIOUS PROCESS (Table 42)

Osteomyelitis

Bone pathology characterized by destructive changes associated with vigorous osteoneogenesis and probable sequestrum and sinus formation were found in two instances, both in tibiae and fibulae (Plates 22,23). These both were indicative of pyogenic osteomyelitis. Gross examination suggested that both processes were still in the active or sub-acute stages. In the calvarium of two adult skulls (reported previously in the section, Traumatic Lesions) there were findings compatible with non-lethal scalping complicated by secondary osteomyelitis. The victims had survived the original trauma but had succumbed during the massacre. There was no evidence of osteomyelitis secondary to open fracture in any of these bones. Primary osteomyelitis, infection secondary to non-lethal scalping, and infections in bone secondary to other causes, have been seen on several occasions in bones from other burials in North and South Dakota (Gregg, unpublished data; Owsley et al. 1977; Steele, et al. 1965) and have been reported elsewhere (Berryman 1979; Brothwell and Sandison 1967; Bruesch 1974; Morse 1969; Nadean 1941; Neumann 1940;Steinbock 1976).

TABLE 42. Inflammatory and infectious process.

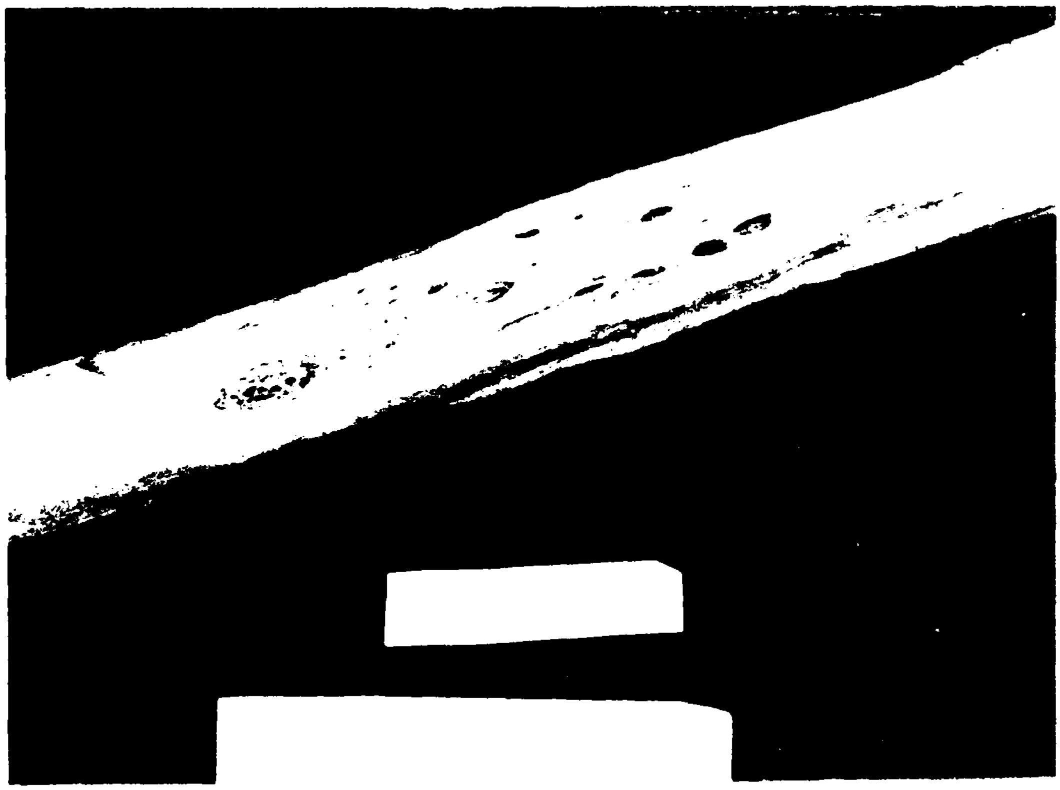
Osteomyelitis -- 4
Skull, secondary to old scalping 2
Tibia and fibula, sub-adult 2
NOTE: the two instances of osteomyelitis in the skull are also listed under trauma.

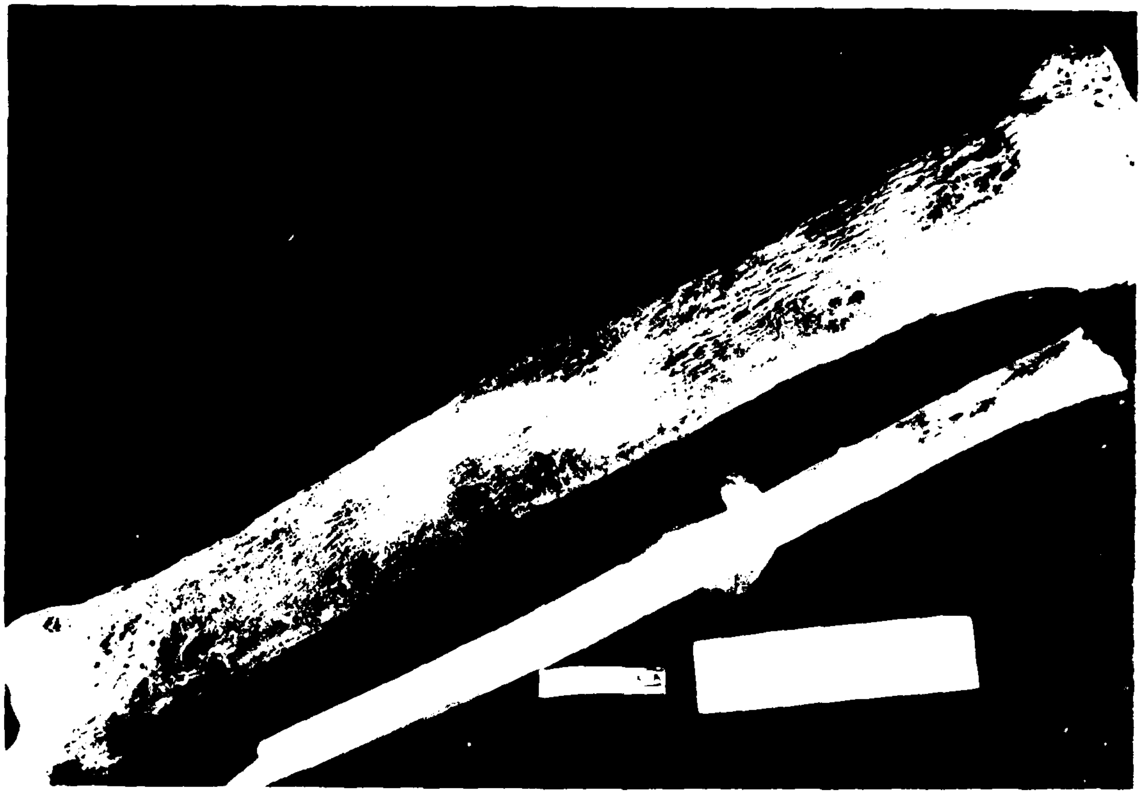
Periostitis and Accentuated Periosteal Markings -------- 148

	ADULTS				SUB-ADULTS		
Bones	General-ized	Ends Long Bones	Patchy and Localized	Local Trauma	General-ized	Ends Long Bones	Patchy and Localized
Multiple		1	1	1		7	2
Temporal							5
Occipital			1				
Mandible							1
Maxillary sinus			2				
Palate			1				
Clavicle	1		1				1
Scapula			1				1
Humerus		3			2	1	8
Radius and ulna	1	1					
Ulna			2	1			
Ischial Tuberosity			1				
Femur	2	1	3	1		11	2
Tibia	20		8	17		15	6
Tibia and fibula	4			1			
Fibula	8		2				
Totals	36	6	23	21	2	34	26

Sinusitis, maxillary ------------------------------------ 1
Sinusitis, maxillary, unilateral secondary to antral oral fistula -- 4
(also listed under Nutritional and Metabolic Processes)

Altered mastoid air cell development suggestive of old infectious diseases -------------------------- to be determined





Granulomatous infections

On no occasion during the survey of the bones from the Crow Creek massacre was anything found which would be characteristic of the effects of chronic granulomatous diseases such as tuberculosis or blastomycosis. This is especially significant in view of the fact that this is a pre-Columbian skeletal population from the upper Missouri River Basin. Most other comparable skeletal collections from North and South Dakota contain bones from people and communities which were post-Contact. In quite a few of these skeletons there is evidence of granulomatous disease in the bone. According to Morse (1969) bone involvement is found in about seven percent of individuals who have tuberculosis. Tuli (1975:1) reported from India, "Of all patients suffering from tuberculosis nearly one to three percent have osseous involvement." If any granulomatosis had been present in the Crow Creek people, a small number of bone lesions might have been seen. No bone lesions suggesting a gumma or a Charcot type joint were found in the Crow Creek specimens.

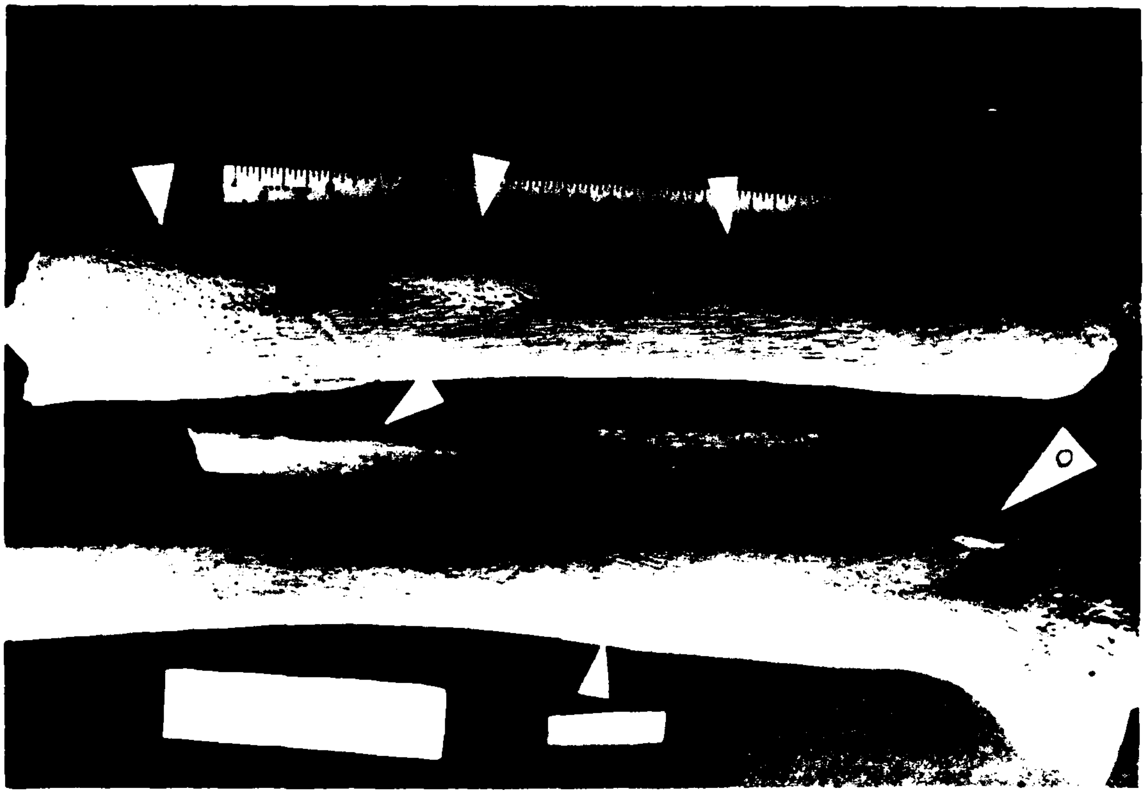
Periostitis

Many bones from different portions of the Crow Creek skeletons showed evidence of periosteal new bone formation and changes indicating inflammatory reaction in the cortex area. To categorize the periosteal inflammatory processes the affected bones were separated into adult and sub-adult groups. The individual lesions were reported as; Generalized (involving the entire bone), Ends of Long Bones, Patchy and Localized (restricted to portions of bones other than the ends), and lesions probably the result of Local Trauma. Localized new bone formation suggesting inflammatory reaction to physical trauma accompanied by subperiosteal hematoma was found in 21 instances (Plate 24). Because of the commingling of the bones by sex and age it was seldom possible to evaluate more than a few bones as a part of the same individual. In some instances the bag contained two or more bones, at least some of which could have been from the same person, all of which showed periosteal changes. In the tabulation, these have been listed as "Multiple" bones.

"Generalized" periosteal changes were seen more often in adult long bones (Plate 25). Isolated lesions which were usually patchy in appearance and located in both long and flat bones were found with about equal frequency in adult and sub-adult bones (Plates 26,27). Periosteal reaction restricted to the ends of long bones was much more common in children and teen-agers.

The amount and degree of change attributable to periosteal inflammation in different bones varied from mild to extremely severe. In some of the adult specimens the generalized periostitis, especially in the tibiae, was highly suggestive of that which is associated with spirochetal infections (Plate 28,29). The inflammatory change in bone near the junction of the shaft with the epiphyseal plates in children and young adults showed extreme variability between individual bones but also between similar bones of individuals who would have been of the same age (Plates 30,31,32). The bones in which this reaction appeared most frequently were in the upper

[illegible] Tibiae and [illegible]
localized periosteal [illegible]
lowed calcified [illegible]
Note small [illegible] (o) [illegible]
junction portion of lower tibia.



[illegible]

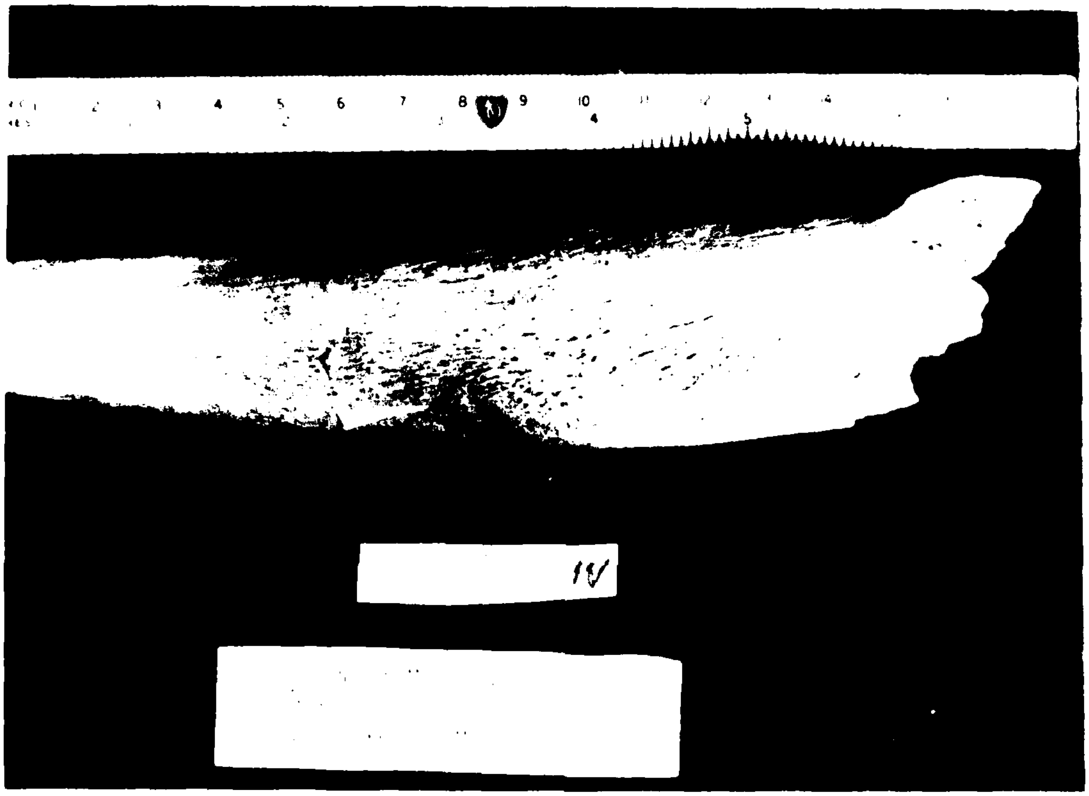


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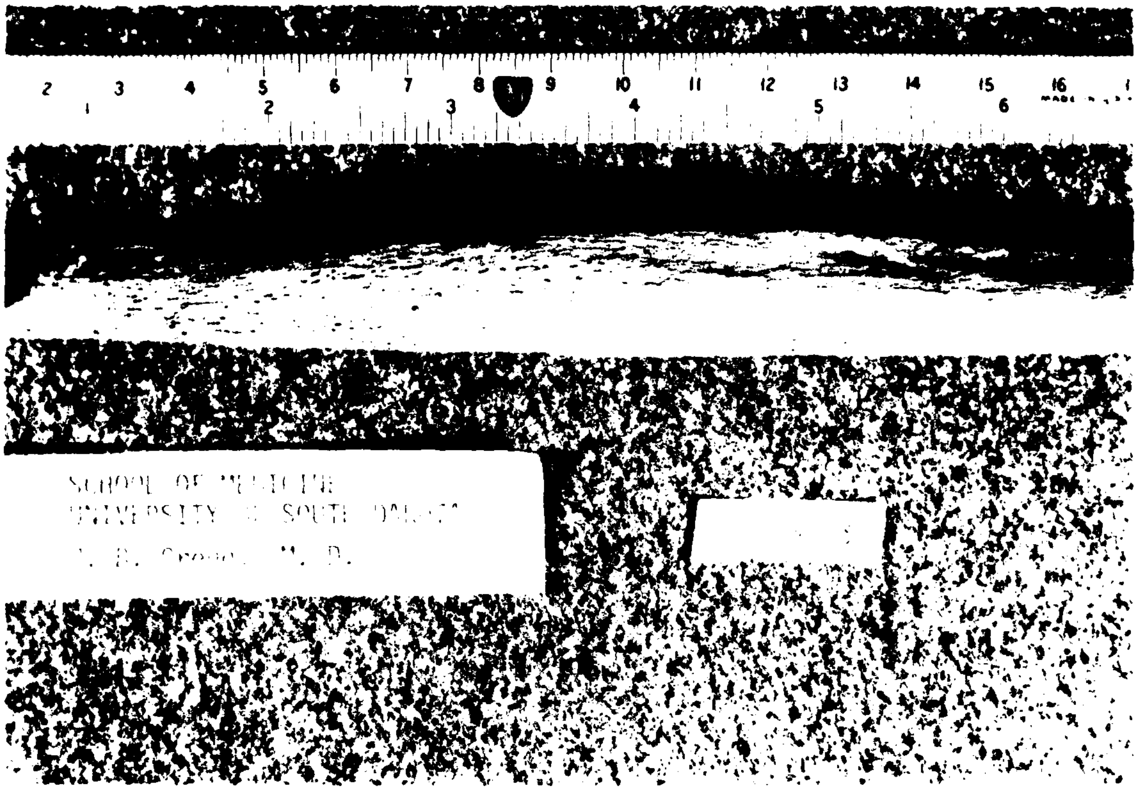
PLATE [illegible]. Localized periosteal reaction in [illegible]tal portion of [illegible] adult tibia.



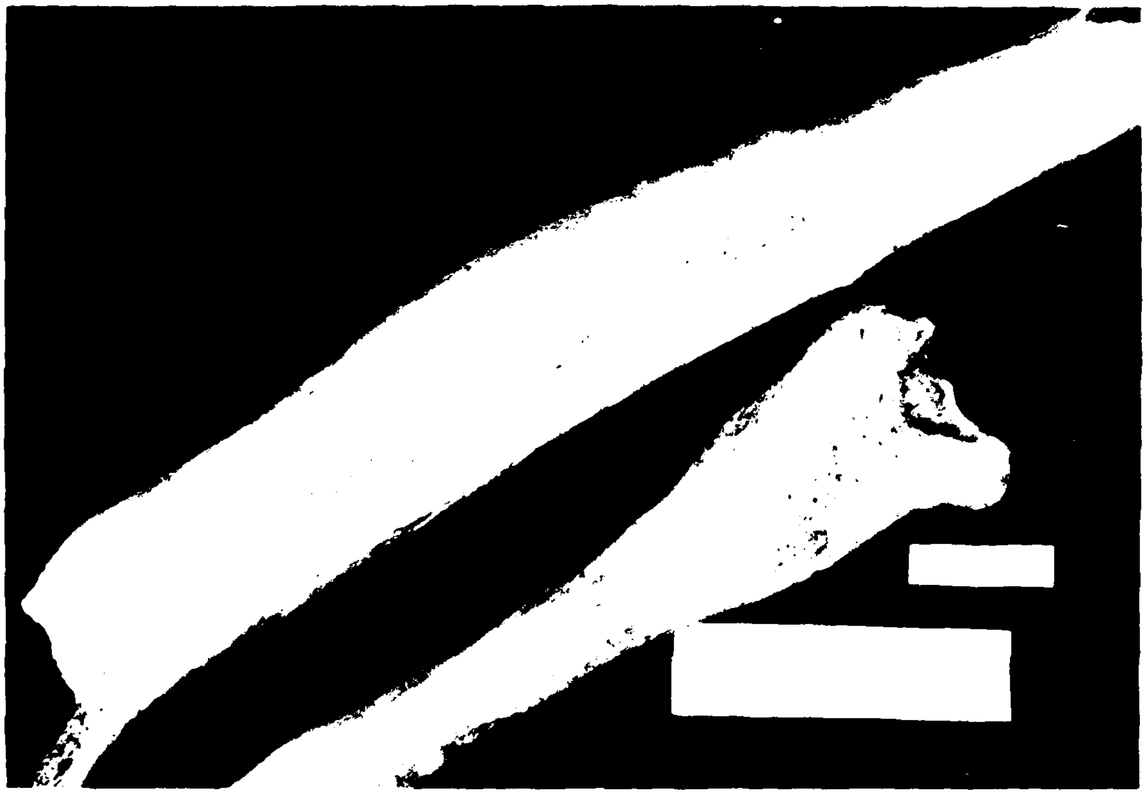


Plate 29. Severe periostitis [illegible] tibia, [illegible].

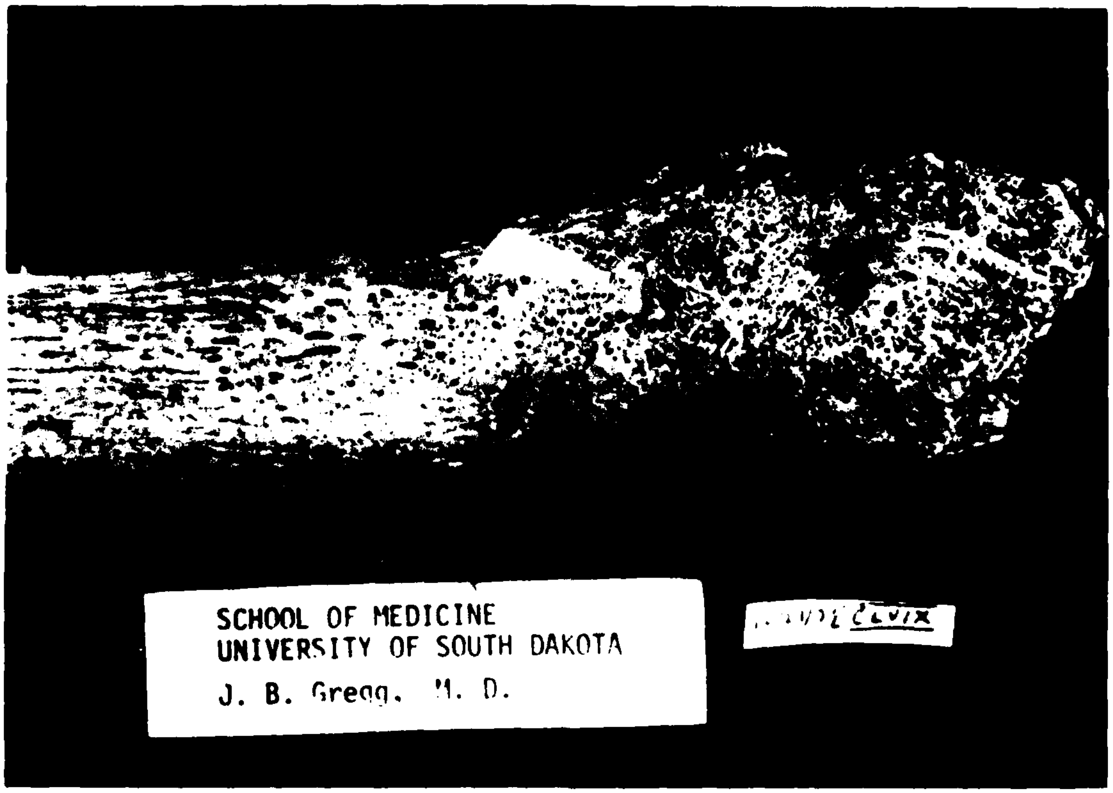
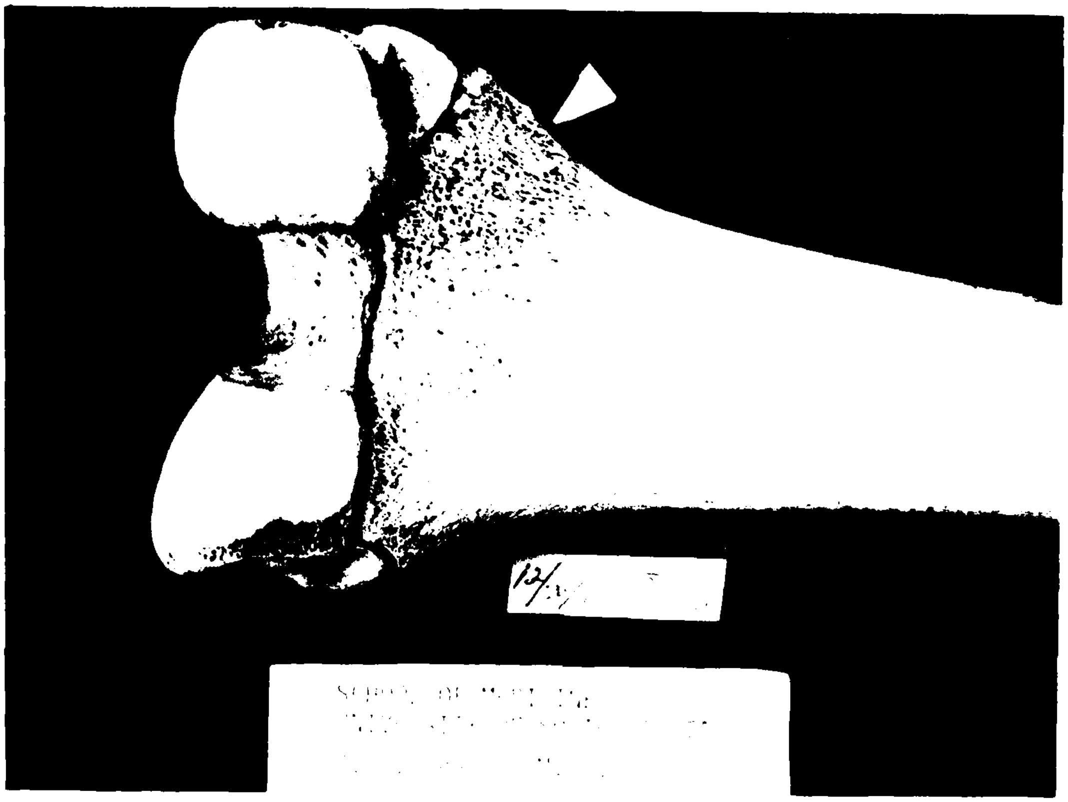
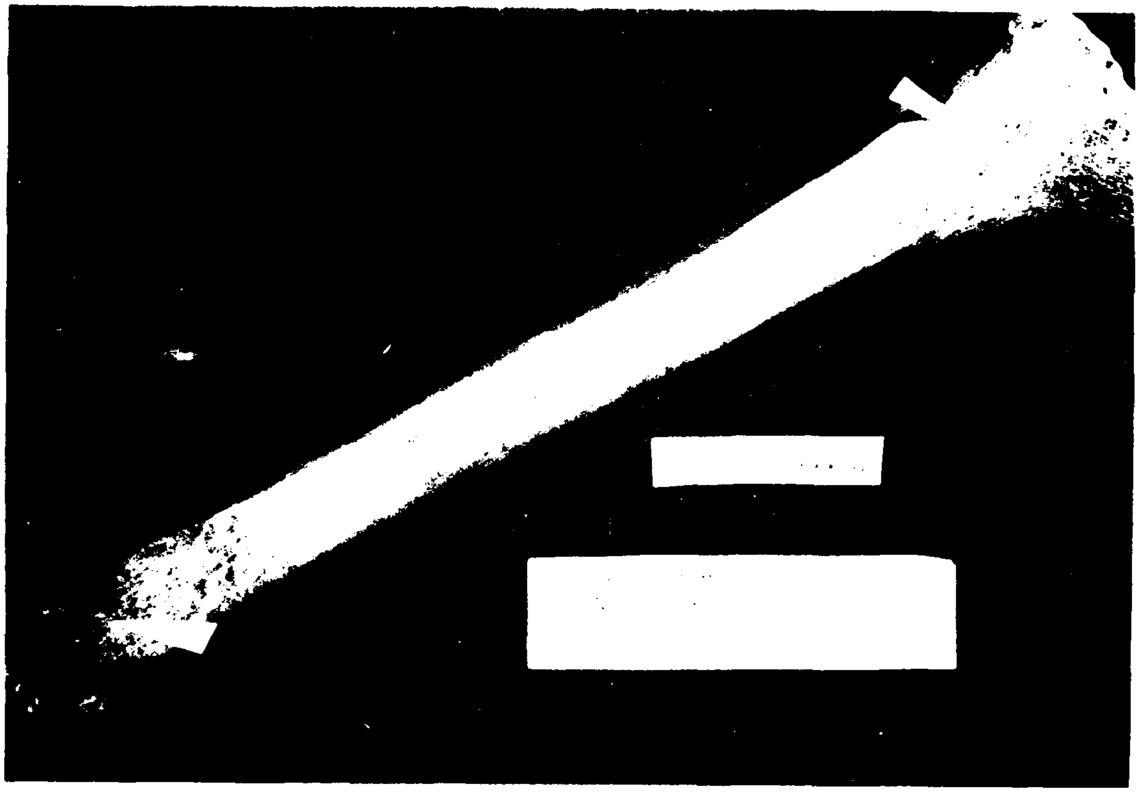
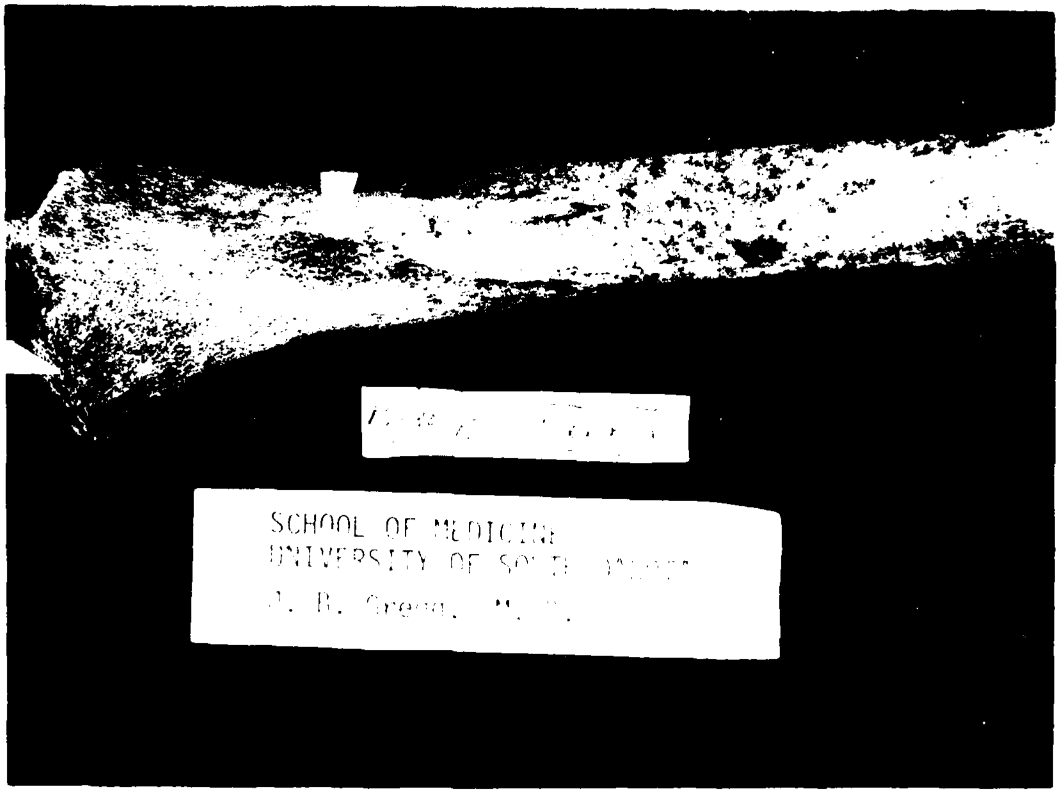


PLATE 3[illegible]. Reaction in the periosteum in the distal portion of a sub-adult femur near the epiphyseal plate.



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tibiae, distal and proximal femora, and the proximal humeri. It is recognized that these are areas of rapid growth and highly vascularized during this portion of life. However, the extremely variable degree of periosteal inflammatory response in individuals who were of the same age strongly suggests that some factor other than growth was operative. This same type of inflammatory response is seen in the ends of long bones of children and sub-adults who lived and died in other pre- and proto-historic villages in South Dakota (Sully, Leavenworth, Rygh, Mobridge and Larson--Gregg unpublished data). The periosteal reaction in some of the Crow Creek sub-adult bones appeared to be more pronounced than that which has been seen in other groups of skeletons from North and South Dakota. Unfortunately, because a great number of the Crow Creek bones were missing, or the bone ends were mutilated, it was possible to determine only the total number of bones which demonstrated evidence of periostitis. Therefore the significance of the observed changes at the ends of the Crow Creek sub-adult long bones is less easily evaluated and explained. Explanations of what could have affected the ends of growing bones include disturbances in nutrition or metabolism and infections which involve the epiphyseal area of the bones.

Morse (1969:17) reported that multiple or generalized periostitis had been observed quite often in prehistoric skeletons and illustrated four cases which were recovered from burials in Illinois. All were adults. In his discussion of nutritional deficiencies Morse (1969:29) cites a study by Hunter of the 400 skeletons from the Klunk site in

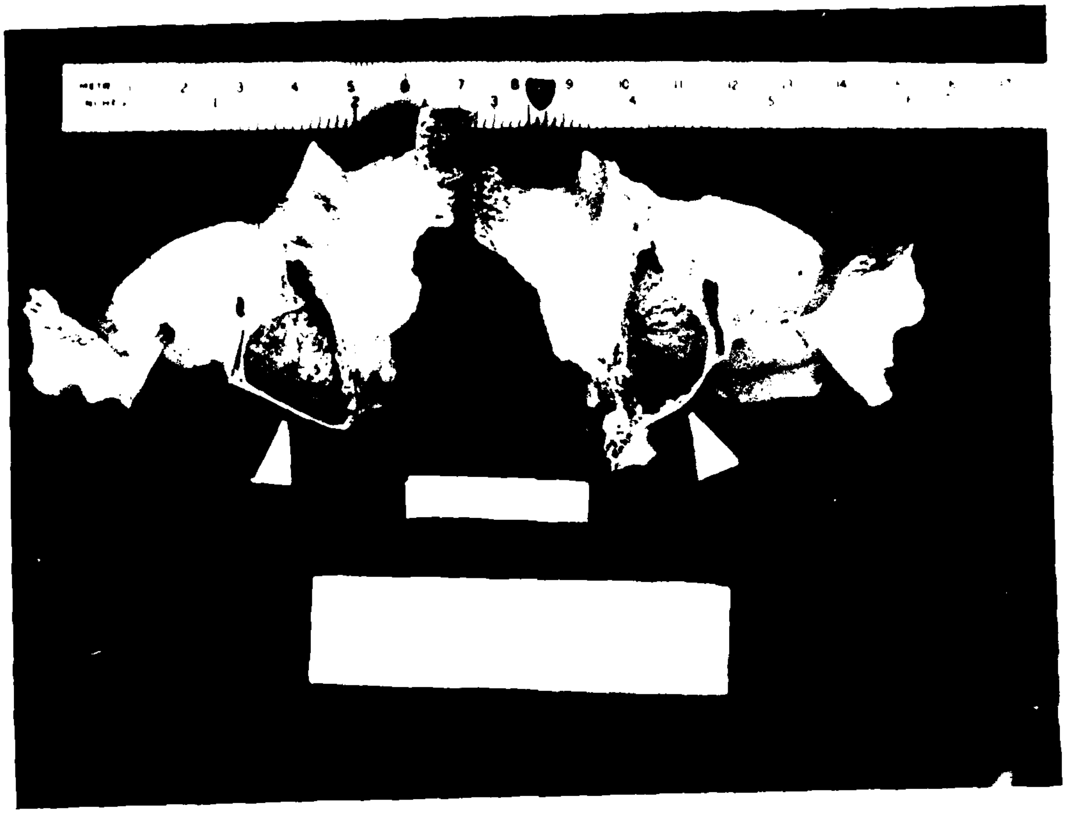
Illinois. Of these, 20 percent were less than two years of age. Nearly all of these and many older children showed variable degrees of osteoporosis. "Some showed swelling of bone ends, a few had growth-arrest lines and at least six had obliteration or partial loss of the medullary spaces." No pictures accompanied this discussion.

An attempt is being made by Marvin J. Allison of Richmond, Virginia, with serological tests, to determine whether some of the cases of adult periostitis from Crow Creek may have been the result of treponematosis. The result of this study will be reported later.

Sinusitis

The nose of one skull was markedly widened and there was periosteal new bone formation along the floor of the maxillary sinuses. This is very suggestive of the findings which occur in an individual who has long standing severe nasal obstruction, nasal polyposis, and secondary chronic maxillary sinusitis (Plate 33). Similar changes in the maxillary sinuses have been seen previously in other skulls from North and South Dakota (Gregg, unpublished data), in a Caddoan skull from Texas (Loveland 1979), and in skulls which are in the United States National Museum (St. Hoyme 1967).

In four Crow Creek skulls communications between the maxillary sinuses and the oral cavity (antral-oral fistula) were found (see Plate 51). In each of these skulls, there was evidence of periosteal new bone formation within the maxillary sinuses indicating bacterial contamination from the mouth and long standing infection. Such fistulae are quite common if the tooth roots are infected when teeth are lost



or if the roots extend into the floor of the maxillary sinus. Morse (1969:146-147) illustrates bilateral antral-oral fistulae in a 45 year old female (Burial No. 55) from Sm4, Smith County, Tennessee. Such fistulae have been noted frequently in other burials in North and South Dakota.

Otitis media

In the Crow Creek skulls many of the mastoids were small and contained poorly developed air cell systems. This phenomenon can be used as a means of determining the probability and an approximation of the severity of otitis media in the individual during his life (Tremble 1934). Because otitis media has its origin as a respiratory infection in the nose-throat area, an estimate can also be made regarding the frequency of upper respiratory infections in individuals during the period of growth of the mastoids. The mastoids are usually quite well pneumatized by about four-to-five years of age but continue to develop until the early to mid-teens.

X-rays have been taken of the mastoids in the Crow Creek skeletons.These will be evaluated for evidence of the effects of infectious disease. The findings which emanate from this radiological evaluation will be compared with the observations made during previous studies of temporal bones which came from prehistoric and proto-historic South Dakota burials (Gregg 1978a,b; Gregg et al. 1965a, 1965b, 1965c). The present X-ray study will supplement the previous investigations and provide data concerning the amount of altered mastoid air cell development, attributable to otitis media, in a homogeneous pre-Contact skeletal population.

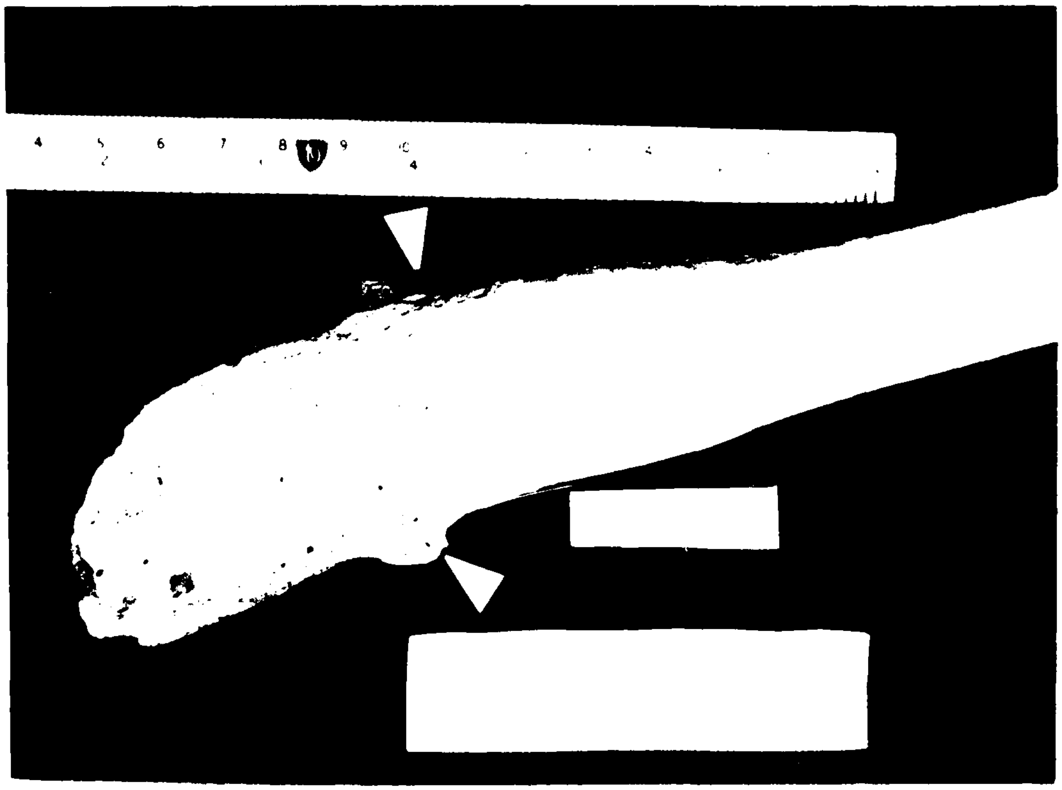
TUMORS AND CYST-LIKE LESIONS (Table 43)

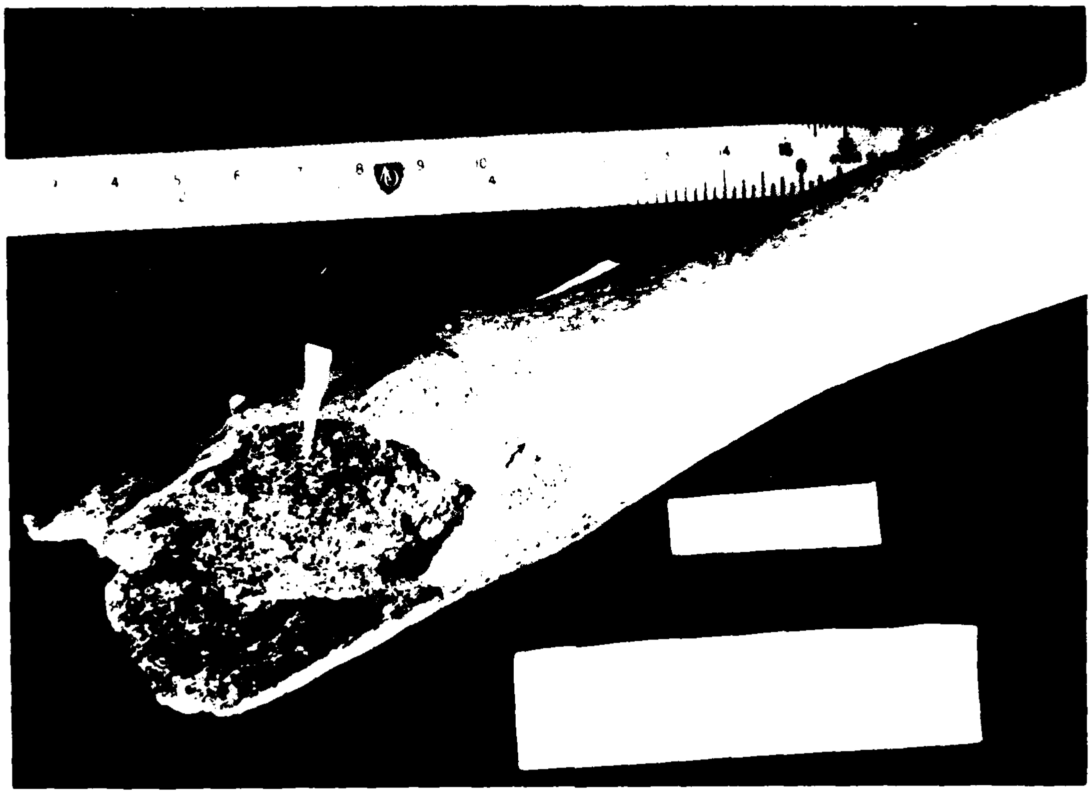
Possible malignant tumors

Two bone replacing neoplasms were found during the survey for pathology. One lesion originated in the medullary cavity of the distal end of an adult tibia. The bone as received in the paleopathology laboratory was partially fragmented at its distal end in the area of the tumor such that it wasn't possible to determine whether there was joint involvement (Plates 34,35). The normal architecture of the distal tibia was replaced by an expanding tumor composed of coarsely trabeculated bone. The cortex was extensively thinned circumferentially. Bone excresences were present upon the intact surface of the tibia. There was no obvious pathological fracture involving the tumor. No other bones were articulated with this bone. The second tumor presented in the proximal portion of an adult humerus eccentrically on the antero-medial aspect (Plate 36). It appeared to have arisen in the medullary cavity and expanded outward unilaterally. The configuration of the broken surface of this tumor was that of very coarsely trabeculated bone. Its location and gross appearance suggested an osteochondroma. No other bones articulated with this humerus. The affected tibia came from Square 5A NE of the Crow Creek excavation and the humerus was found in 6B NE (FIG. 20). Although there was no evidence of continuity between the two bones, since they were found only about 0.5 to 1.5 meters apart it is possible that they are from the same individual. No lesions similar to these two were found in any other bones recovered during this project. Both of these tumors were referred to the Bone Pathology

TABLE 43. Tumors and cyst-like lesions in bone.

Bone destructive tumors						2
Distal tibia	1					
Proximal humerus	1					
Osteoma (including exostoses)						42
Femur, proximal	2					
Femur, distal	1					
Tibia, mid	1					
Parietal	2					
Temporal	1				7	
Exostoses		SMALL	MEDIUM	LARGE		
External Auditory Canal						
Right		2	4	1		
Left		1	10	1		
Bilateral		1	9	3	32	
Torus palatinus			2	1	3	
Osteoid osteoma						2
Tibia, mid	1					
Humerus, proximal	1					
Bone spur						7
Clavicle	1					
Tibia, proximal	2					
Tibia, mid	1					
Tibia, distal	1					
Fibula	1					
Femur, proximal	1					
Heterotopic bone and myositis ossificans						14
Humerus, mid	2					
Tibia, distal	2					
Fibula, proximal	7					
Pubis	1					
Innominate	2					
Cyst-like lesions						12
Frontal	1					
Parietal	1					
Orbital roof	1					
Clavicle	2					
Scapula, glenoid fossa	2					
Radius	1					
Ulna	1					
Fibula	1					
Pubis	1					
Femur	1					





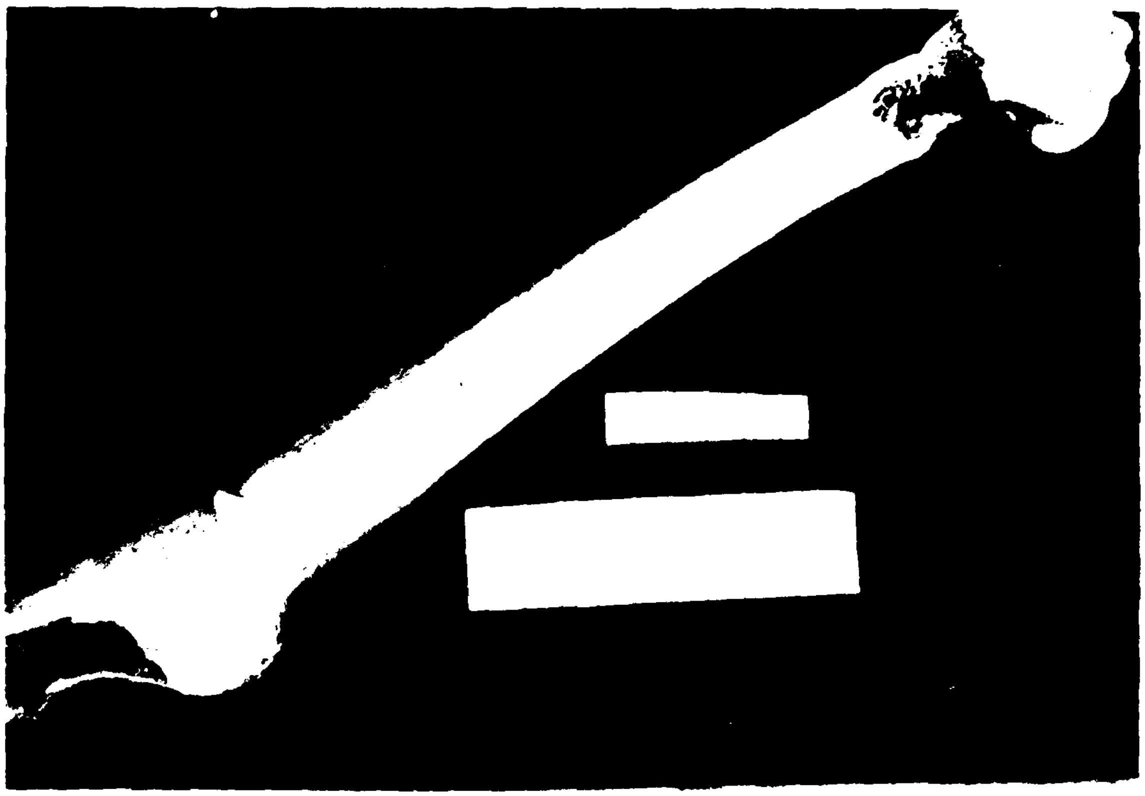
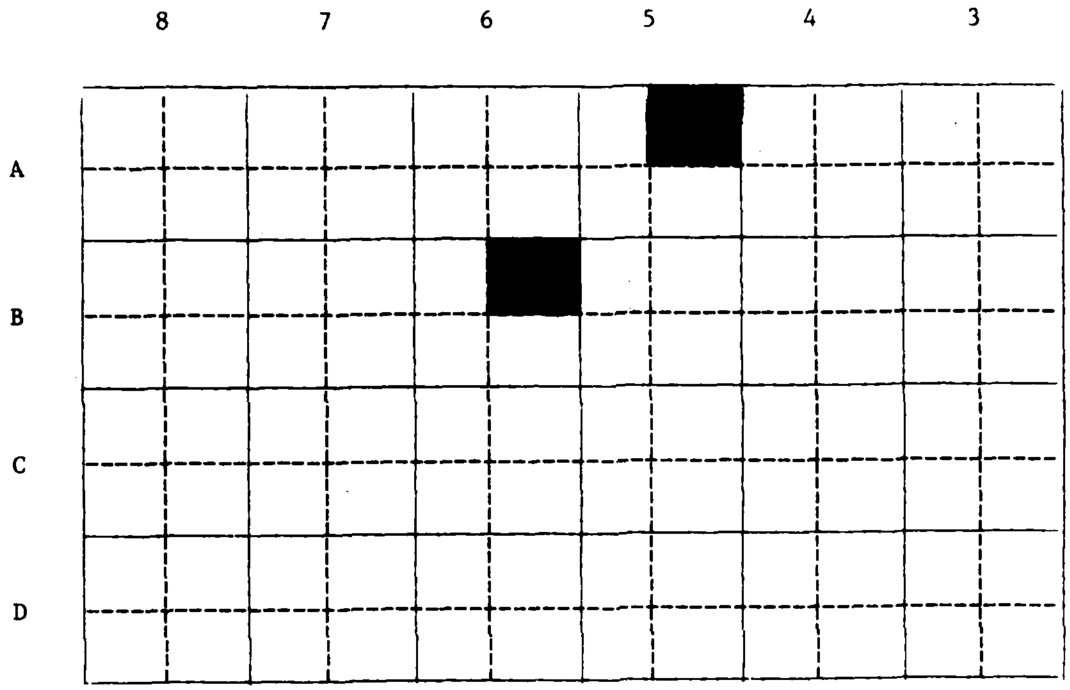


FIGURE 20. Grid Chart II. Crow Creek excavation Grid Lines.



one meter

Scale:

Location of bones having tumors. Humerus - 6B NE

Tibia - 5A NE

Division of the Armed Forces Institute of Pathology for analysis in an effort to identify the type(s) of neoplasm represented.

There was no evidence of metastatic neoplasm in any bone under study here. One probable metastatic neoplastic implant has been seen in the frontal area of the skull of a 35-42 year old Arikara male (39CO32, F-101, B-5). No evidence of the effect of cancer upon bone has been found to date in other pre-Contact South Dakota skeletal material.

Benign tumors

All benign bone tumors were found in adults. Because they are quite similar structurally and behaviorally, osteomas and exostoses are included in the same general classification. Other tumors found in this survey have been categorized as osteoid osteoma, bone spur, heterotopic bone and myositis ossificans, and cyst-like lesions.

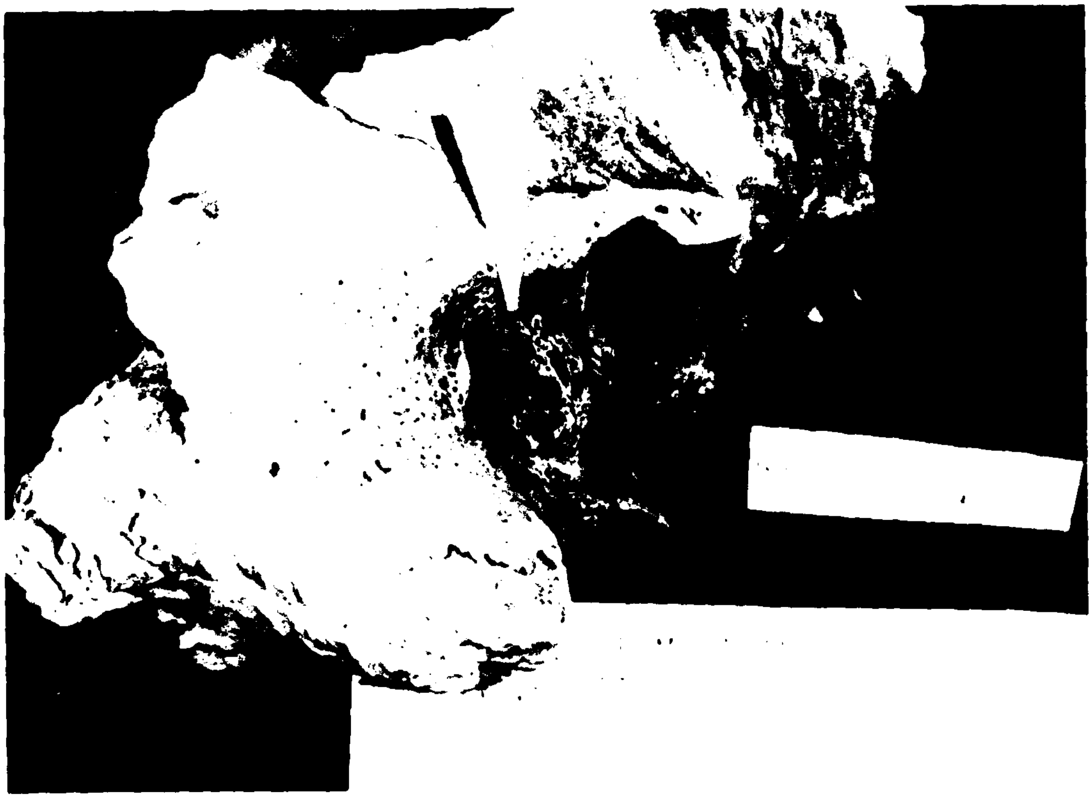
Osteomas

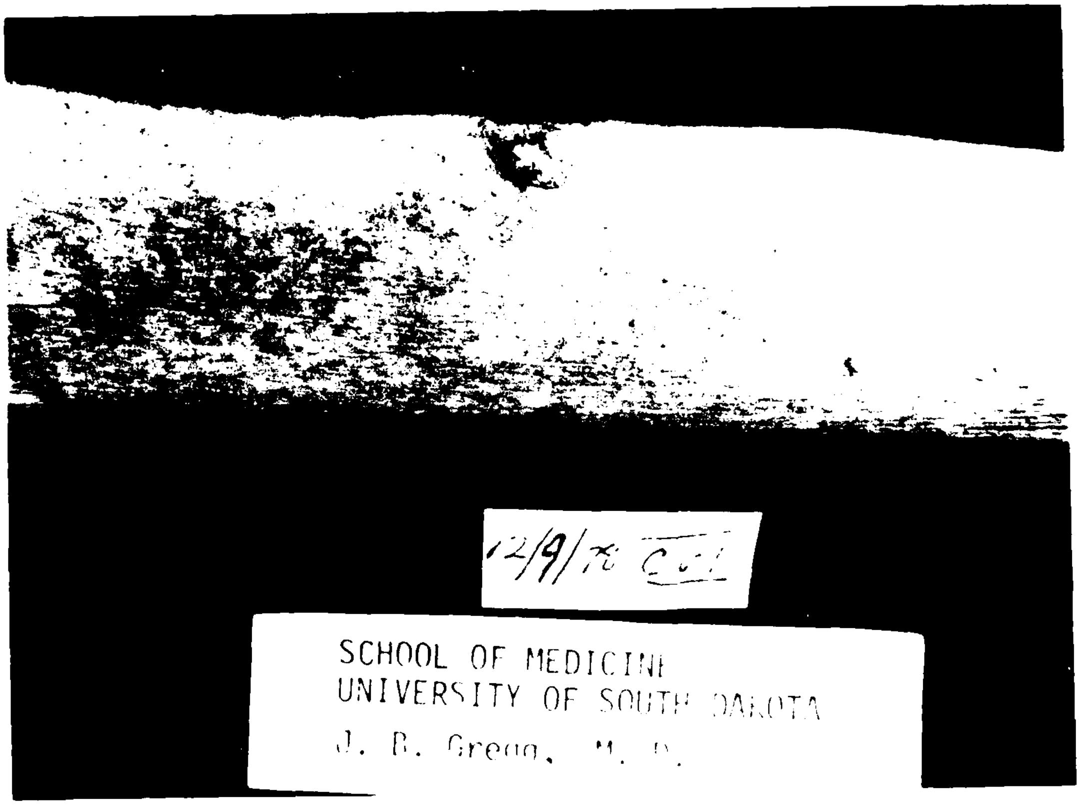
A total of seven osteomas were found in various tubular and flat bones; all were small. There were three torus palatinus defor-mitites, one large and two small. Because of the fragmented condi-tion of so many of the palates, it was not possible to obtain better information as to the frequency with which these tumors occurred. Exostoses were found in the external auditory canals of 32 skulls. The majority were medium to large in size and they were mostly of linear configuration. In view of the fact that the temporal bone count has provided the best criteria for estimating the total number of individuals whose skeletons were exhumed from the Crow Creek site, an assessment of the frequency of occurrence of exostoses in the external ear canals of the total population can be made. There were 963 temporal bones (right - 486, left - 477). There were exostoses within the external auditory canals of 45 (4.6 percent). This finding is almost identical with the results obtained from the study of other skeletal populations from the upper Missouri River Basin and elsewhere (Gregg and Bass 1970; Gregg and McGrew 1970; Gregg, unpublished data).

The right external auditory canal of one temporal bone was completely occluded by a spongy exostosis to the extent that the involved individual would probably have had considerable trouble hearing in that ear (Plate 37). The fact that only one such tumor was found would suggest that it was unilateral. One similar but less obstructive spongy exostosis in an Arikara skull from South Dakota was reported by Gregg and Bass (1970). Milder degrees of similar spongy change in the bone of the tympanic ring have been seen in specimens from South Dakota on several occasions in the past (Gregg, unpublished data).

Osteoid osteoma

Two such tumors were found in adult bones, one in the midportion of the anterior surface of a tibia (Plate 38), and the other in the proximal portion of a humerus (Plate 39). Both bones were unarticulated, but they were located within one meter of each other in the common grave. These tumors appear to have been inactive at the time of death. Morse (1969) discussed similar lesions but did not report





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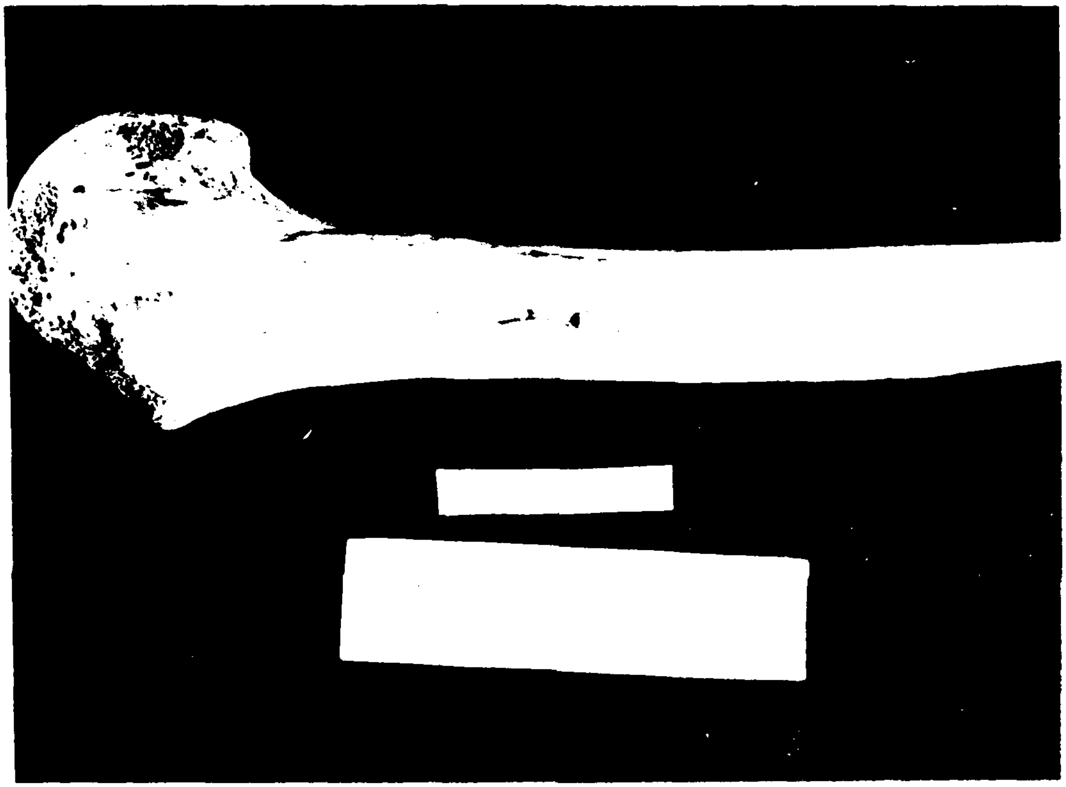

any instances from his research. Steinbock (1976) also noted three reports of similar lesions by other authors, two from Great Britain and one from Czechoslovakia. No similar lesions have been observed to date in the other skeletal material from North and South Dakota.

Bone spurs

Seven tubular bones, four of them tibiae, showed spur formation. All were benign and the majority could easily have been of traumatic origin.

Heterotopic bone and myositis ossificans

Metaplastic bone formation was observed on 14 occasions in the Crow Creek skeletons, all in adults. The nine instances in which it was found in the tibiae and fibulae were probably the result of old sprain-type injuries. The abnormality found in a male pubic symphysis probably followed injury and calcification within a hematoma. The lesions in the humeri and innominates were also probably post-traumatic (Plates 40,41).

Cyst-like lesions

In dried bone, lesions which contained solid tissue during life quite often appear as cystic areas. Some of those found here were probably cartilage or fibrous tissue cell rests during life. Others may have followed injury to bone or joint surfaces (Plates 42,43). Only one true cystic process was found, in the mid-parietal area of an adult skull (Plates 44,45). The reaction in the surrounding bone suggested that it was of traumatic origin. Possibly it began as an extra-cranial sub-periosteal hematoma which was followed by


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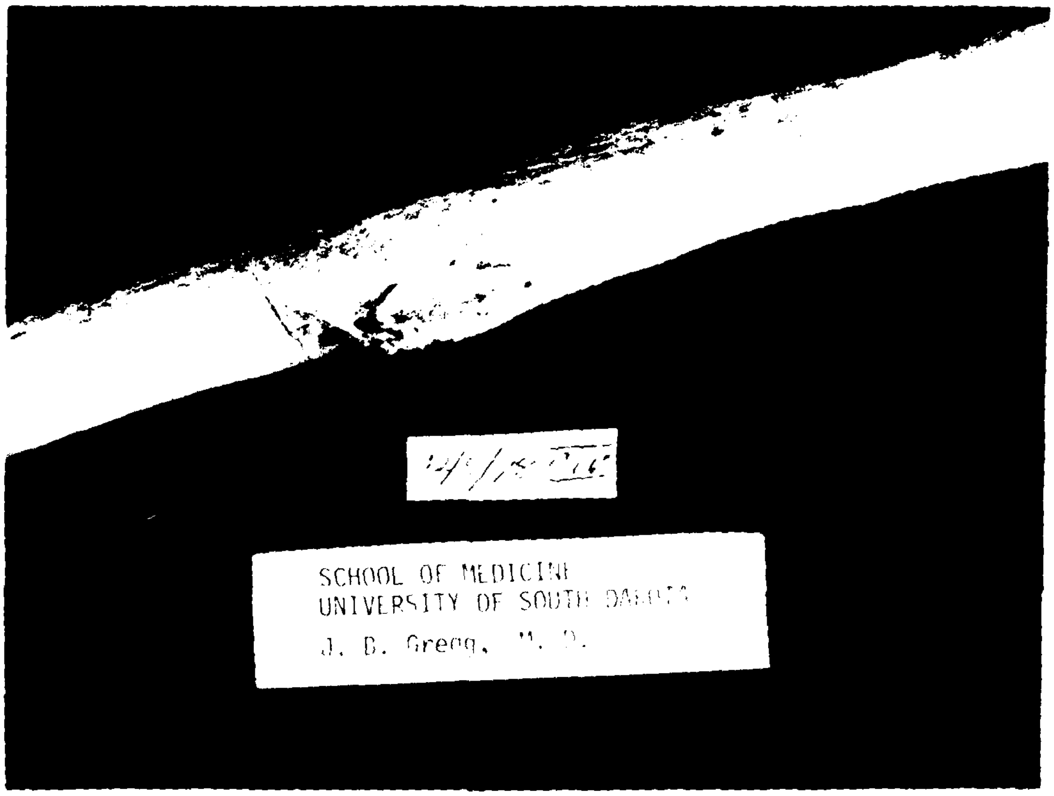
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PLATE [illegible]. Lytic lesion sternal end adult clavicle.

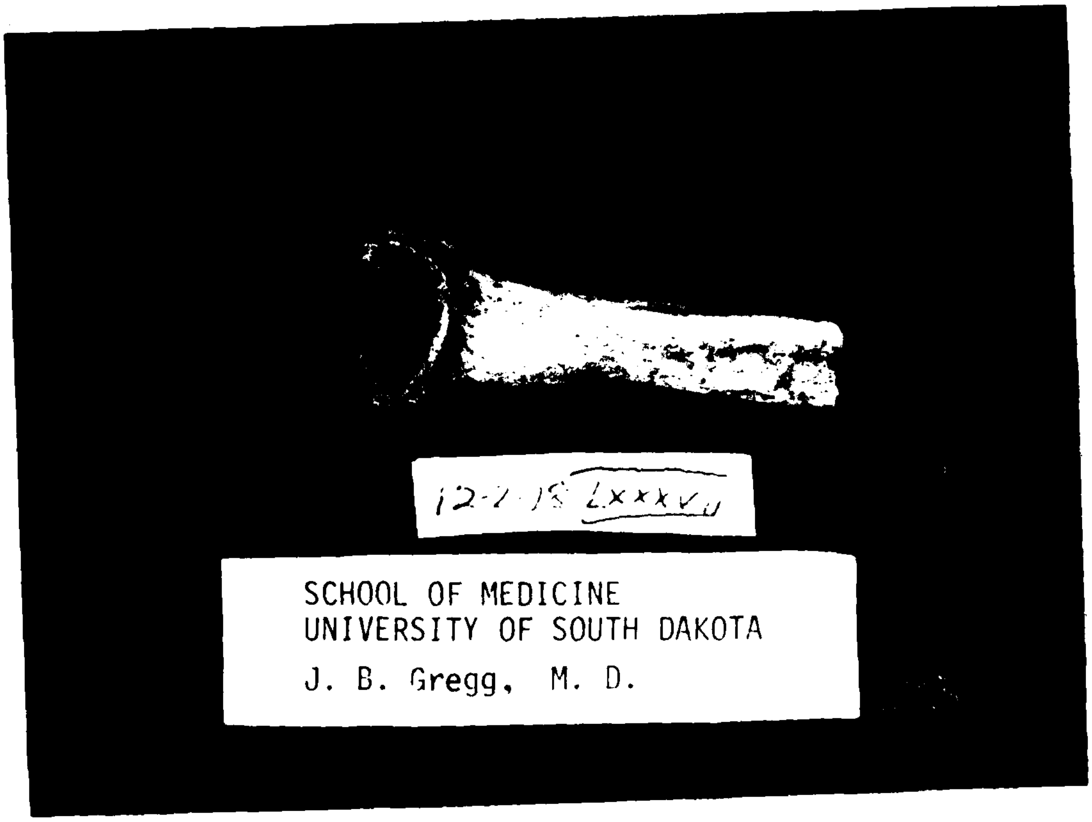
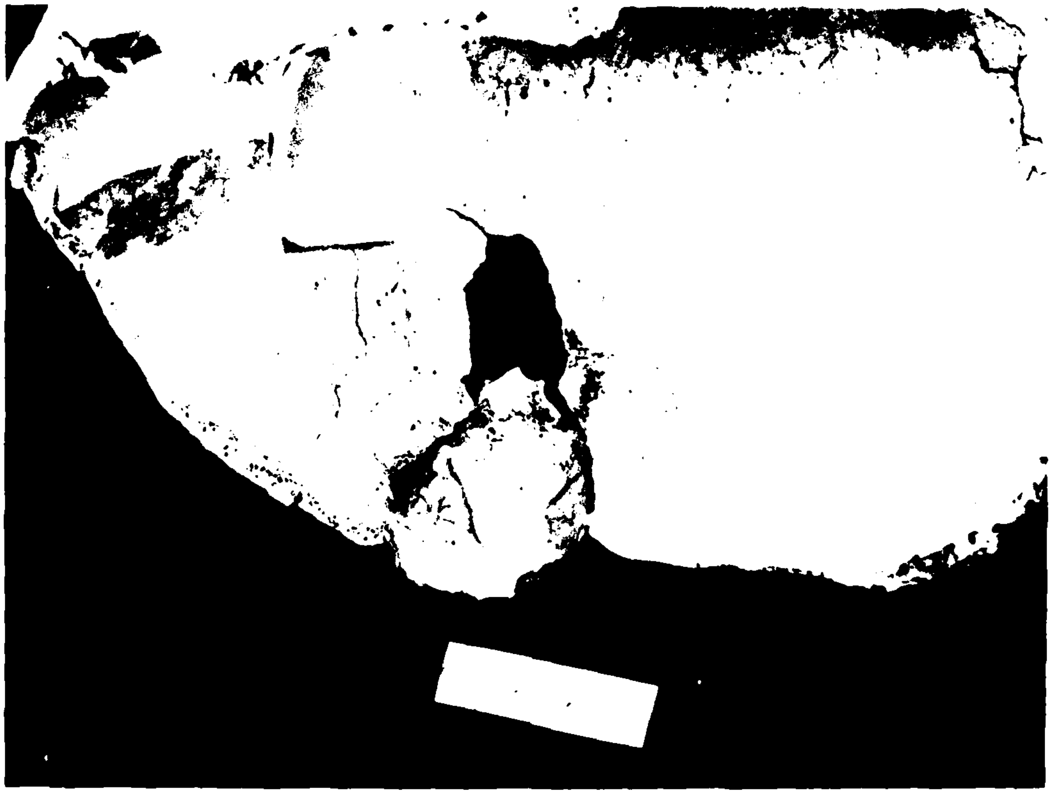


PLATE 55. Cystic lesion in area of insertion of biceps muscle tendon into radius.

PLATE [illegible]. Lateral surface, right parietal area, adult skull, showing cystic lesion with mild old bone [illegible], anteriorly and posteriorly. Note bone reaction superiorly indicating extension of inflammatory [illegible] to superior temporal line.

F[illegible] Medial surface of [illegible] Plate [illegible]
Note minimal bone reaction.



localized necrosis and liquifaction of the bone of the calvarium. There was nothing to indicate osteomyelitis in the surrounding bone. By virtue of being well healed and with the minimal amount of reaction on the medial surface of the bone, it is most likely that the injury had occurred quite some time prior to the death of the individual and probably had not produced much functional disturbance.

In Brothwell and Sandison (1967:328) there is an illustrated discussion of intro-diploic epidermoid cysts within the clavarium. Morse (1969:116-117) illustrated and discussed briefly a possible bone cyst in the frontal area of a Dickson Mound (F34) skull. Such cysts would have to be considered in the differential diagnosis of the cranial cyst noted above.

NUTRITIONAL AND METABOLIC DISTURBANCES IN BONE (Table 44)

Anemia

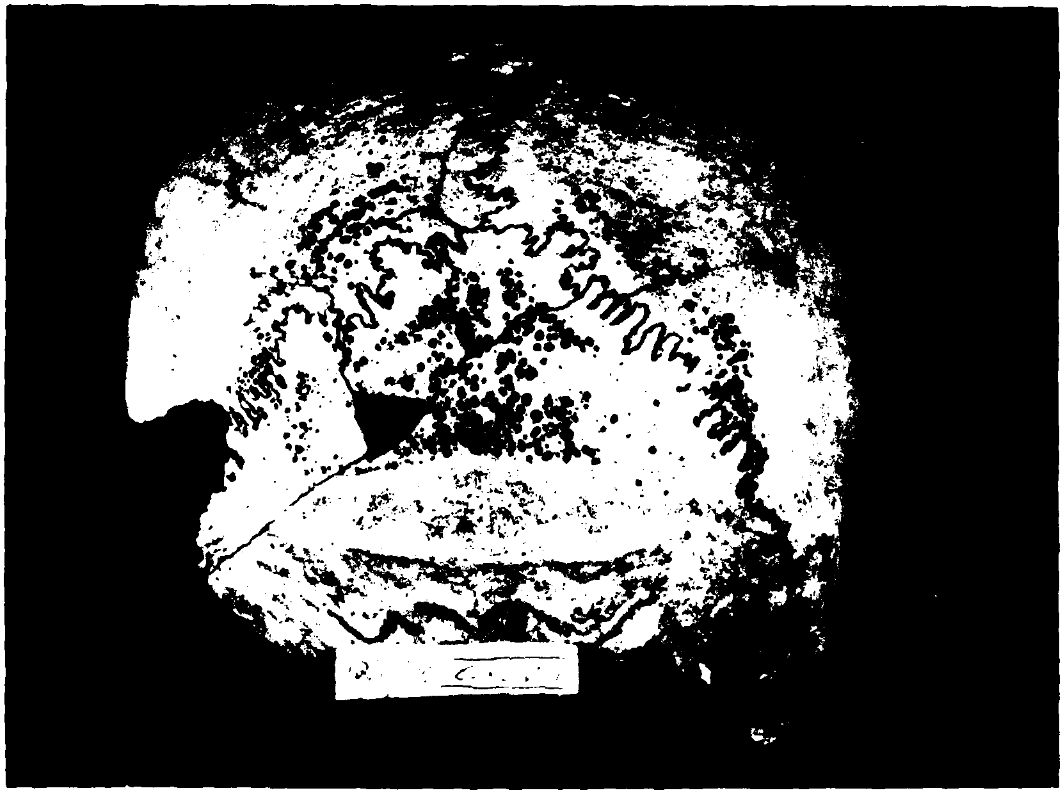
Evidence of anemia possibly due to iron deficiency as manifested by cribra orbitalis, porotic hyperostosis, or a combination of the two in the same individual, was found in 28 instances. Almost all were in skulls of children. In four skulls there was sufficient anatomic continiuty to establish that both processes had been existent in the same individual (Plates 46,47,48). Because of the fragmentary condition of the orbital portions of many skulls, the skewed age distribution of the Crow Creek skeletal population, and the fact that bone changes associated with cribra orbitalis are found primarily in children, it was not possible to determine with any accuracy the frequency of occurrence of this abnormality. Previously in other

TABLE 44. Bone changes commensurate with nutritional and metabolic disturbances.

Iron deficiency anemia		
Cribra orbitalis, isolated		18
adult	1	
child	17	
Cribra orbitalis associated with other lesions		4
C.O. plus mastoid involvement	1	
C.O. plus parietal involvement	1	
C.O. plus frontal involvement	1	
C.O. plus occipital involvement	1	
Porotic hyperostosis		6
Occipital	5	
Parietal	1	
Inflammatory periosteal reaction at the ends of long bones, children and juveniles (see Table 42).		
Dental disease (instances, not individual teeth)		
Tooth wear and attrition		136
Mild	37	
Moderate	71	
Severe	28	
Dental abscesses		17
Antral-oral fistulae		4
Abscess posterior surface maxilla		1
Marked hypertropic change in bone		1
Distal tibia	1	

PLATE 46. Cribra orbitalia lesion [illegible] suggesting previous activity.

PLATE 47. Superior orbital ... [illegible] ... cribra orbitalia in calls' ... [illegible]



South Dakota skeletons there has been some evidence of mild cribra orbitalis and porotic hyperostosis but no severe cases of these abnormalities. Morse (1969:2,28) wrote that cribra orbitalis and porotic hyperostosis are "frequent whenever one examines a large collection of excavated skeletons." El-Najjar et al. (1976) and Cybulski (1977) have also reported regarding this condition.

Periostitis of nutritional origin

As has been previously discussed in the section on inflammatory disease of the periosteum, many long bones of children and juveniles showed evidence of intense periosteal reaction in the shafts near the epiphyseal plates. This was most noticeable in the proximal tibiae, the distal femora, the proximal femora, and the proximal humeri. There was marked variability in the intensity of the reaction among the individual bones and among bones which came from children who were the same age. An infectious origin for these changes might be hypothesized. However, a nutritional or metabolic cause would seem more likely.

Dental disease

In 157 instances there was evidence of moderate to severe dental disease. This was manifested by tooth wear of variable degree, caries, abscesses of dental origin, loss of teeth, and antral-oral fistulae (Plates 49,50,51). Communications between the oral cavity and maxillary sinus of dental origin have been discussed previously under "Sinusitis" in the section, Inflammatory and Infectious Diseases.

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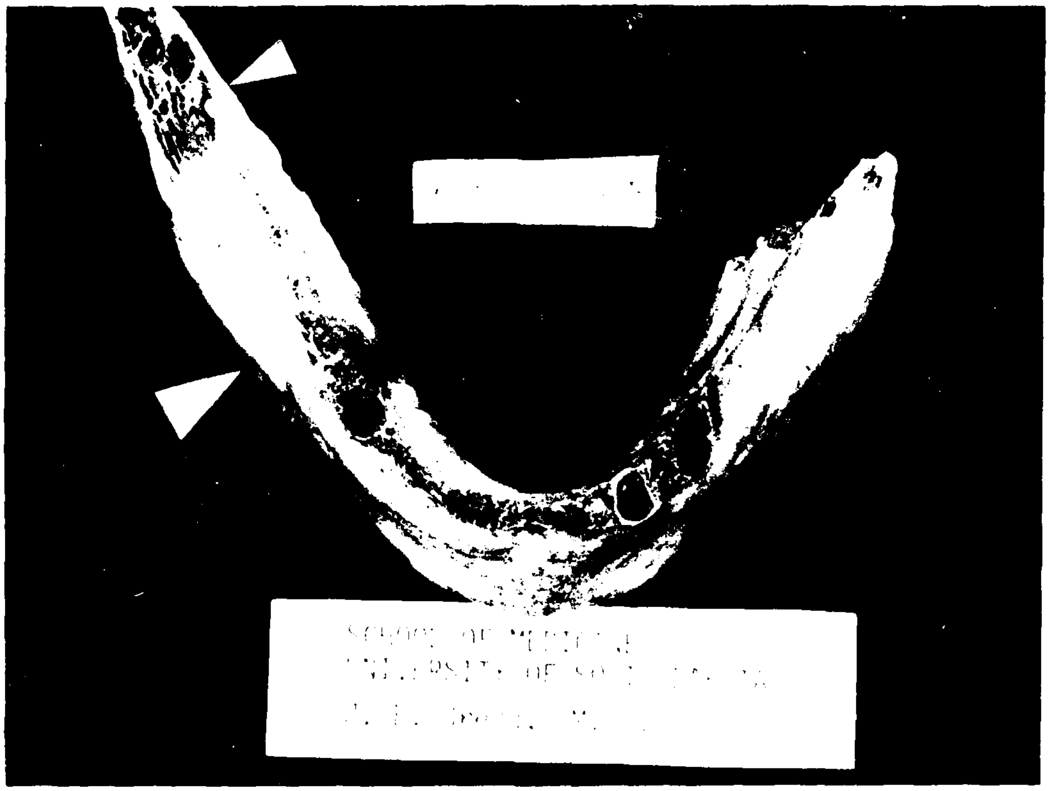

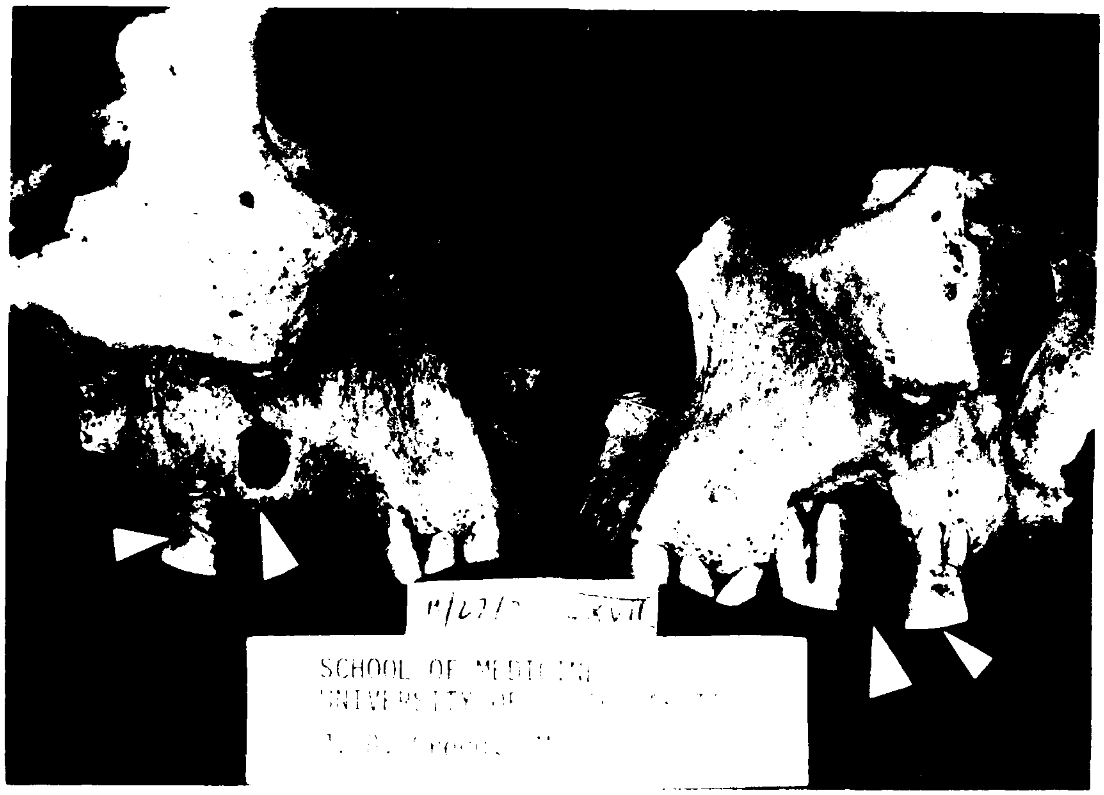
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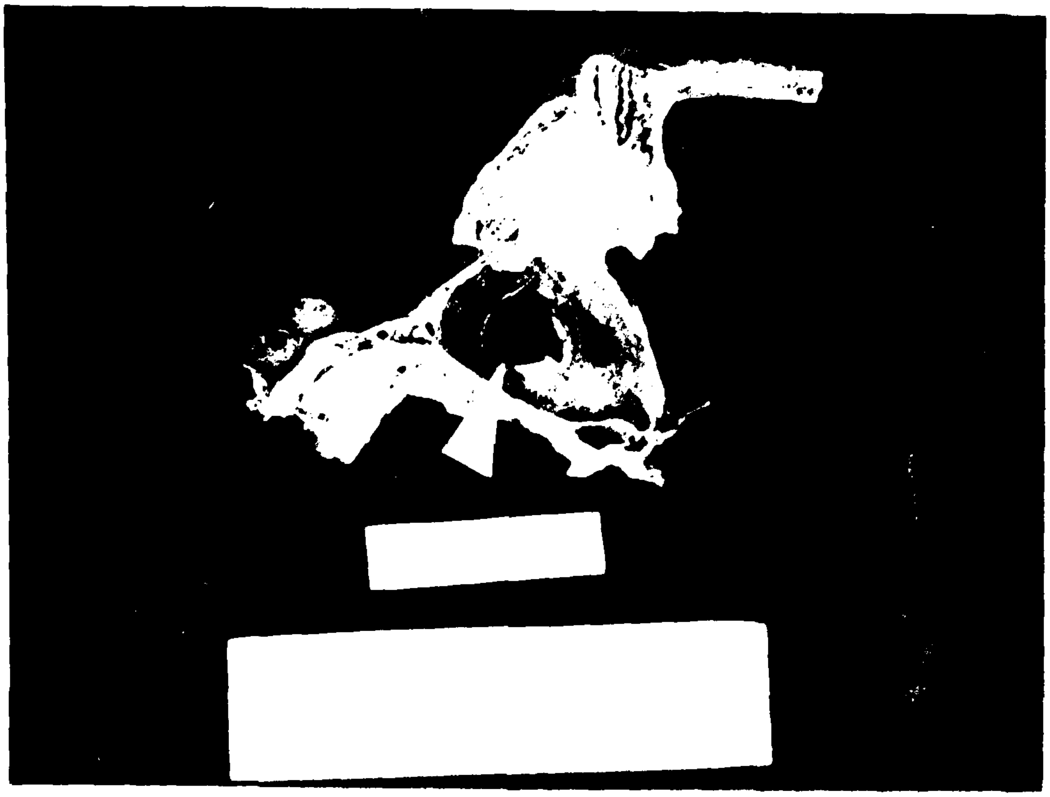


Isolated hypertrophy of bone

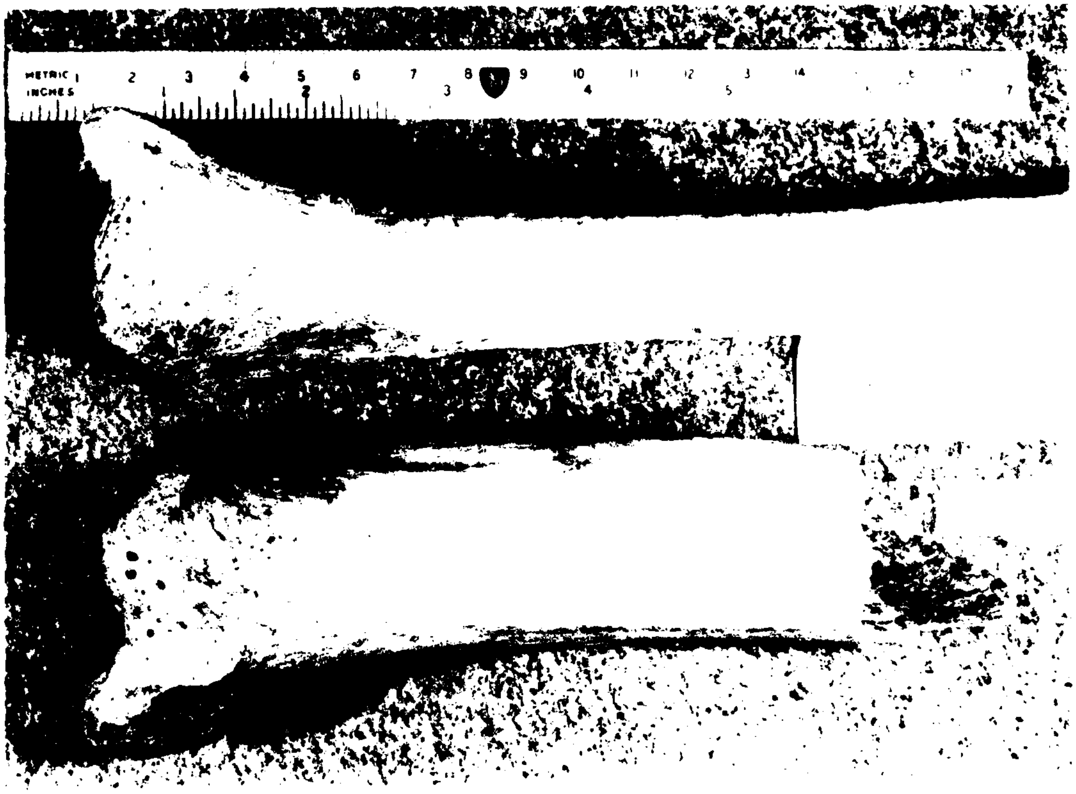
In one instance there was an isolated fragment of the distal portion of an adult tibia within which there was marked hypertrophy of the cortex and generalized enlargement of the entire remaining part of the bone (Plate 52). The bone fragment was definitely human. The remainder of this bone was missing and there were no other bones which showed this reaction. The pathology represented here remains unknown.

Temporal bone abnormalities

Within the temporal bones there was no evidence of fixation of the stapes footplate by otosclerosis. Previous studies (Birkby and Gregg 1975; Gregg 1965, 1978d; Gregg et al. 1965; Holzhueter 1964; Holzhueter et al. 1965; Steele, et al. 1965) for the effects of otosclerosis in the temporal bones from Indian burials in North and South Dakota have not shown any evidence of this disease process. The Crow Creek results are therefore in accordance with the results from these previous studies. This is further supported by the current evidence that otosclerosis is a process which is found primarily in, but not limited to, caucasoids and which may be linked to faulty metabolism of fluorine.

No other findings which would indicate the presence of nutritional disease or metabolic disturbances were noted in these skeletons. X-rays have been taken of the long bones from the Crow Creek skeletons for the purposes of measuring coritcal bone thickness and to evaluate the transverse lines in the long bones. These studies may provide

PLATE 52. Distal adult tibia (below) with normal for comparison above showing generalized widening of the bone and thickening of the cortex, cause undertermined. No other fragments of the lower bone were found for analysis.



some indication of the metabolic status of these people, and they will be reported later.

DEGENERATIVE CHANGES IN BONE (Table 45)

Osteoporosis

Decreased bone density (osteoporosis) is extremely common in the United States today, being more prevalent in the elderly, and especially frequent in post-menopausal females. Osteoporosis is also common in prehistoric and protohistoric skeletons exhumed from North and South Dakota. Unfortunately, osteoporosis is difficult to quantitate in old bones. Too often soil conditions so affect the bones that chemical leaching may be mistaken for a pathological condition. However, the soil conditons in a given locale are usually quite constant. Bones from a common cemetery or a common grave can usually be compared, and a rough idea of the average bone density can be made by an estimation of the bone weight, compactness, fragility, or cortical thickness. This means of determining density differences between individual bones was used in this study. Individual bones and groups of bones from the Crow Creek site, some articulated and some not, showed very definite differences in weight and structure and estimates were made of osteoporotic changes. Probably the most common loci for osteoporosis were in the vertebrae, the ribs, the pelvis, and in the skull.

To categorize, and for purposes of quantitation, in the 79 instances where osteoporosis was suspected, the changes in bone were classified according to the degree of severity and listed

TABLE 45. Degenerative changes in bone.

	VERY MILD	MILD	MODERATE	SEVERE	INSTANCES
Osteoporosis --					79
Mandible			1		
Multiple bones, vertebrae, long bones, ribs		7	1		
Vertebrae, T & L	1	7	7		
Vertebrae, L		5	4	1	
Tibia, & fibula		6	1	1	
Radius & ulna		1			
Vertebrae collapse,					
thoracic		1	2		
lumbar (2,3,4)			1		
Skull, generalized		11	6	2	
frontal			1		
parietal	2	10			
Vertebral lipping --					125
Cervical		1	4		
Thoracic	1	4	1		
Lumbar	14	42	41	11	
Generalized		5	1		
Hypertropic changes in joints and bones --					50
Temporomandibular		5	1	2	
Shoulder		2			
Elbow		1			
Wrist		1			
Hip		4			
Knee		16	2	1	
Foot		5		1	
Sacro-iliac		1	2		
Pubic symphysis		2	2		
Iliac crest			1		
Ischial tuberosity			1		

according to the bone(s) involved. Indications of osteoporosis utilized were: 1) definite decrease in cortical thickness (Plates 53,54), 2) pathological changes which are secondary to osteoporosis, such as compression fractures in osteoporotic vertebrae (Plate 55), 3) changes in the skull which are associated with this process (Plate 56), and 4) definite decrease in bone mass without evidence of the weathering effect, as manifested by lesser weight when compared to bones from skeletons of the same age and sex and which were excavated from the same portion of the common grave. This latter criterion for osteoporosis was difficult to quantitate and required a largely judgmental analysis. None of the usual texts pertaining to paleopathology contain any method for measuring osteoporosis in isolated bones or bone groups quantitatively.

Because the skeletons were not in anatomic continuity it was not possible to determine the total number of individuals who were affected by osteoporosis. However, the wide distribution of bones having these changes throughout the common grave would indicate that a significant number of those who lived at Crow Creek were affected by osteoporosis. Erickson (1976) and Perzigan (1973) have discussed osteoporosis in other Indian populations.

<u>Vertebral lipping</u>

Degenerative changes were found in all portions of the spine but were more obvious in the lumbar area (Plate 57). The findings

were both generalized and restricted to individual vertebrae or groups of vertebrae, but nothing was found which suggested ankylosing spondylitis. Classical Marie-Strumple disease has been identified in a skeleton from a South Dakota Indian burial on one occasion (Bass, et al. 1974). Because of the discontinuity of the skeletons, it was not possible to quantitate the frequencies of the arthritic changes. However, vertebral osteophytosis appears to have been common in the people of Crow Creek.

Hypertropic changes in joints and adjacent bone

The knee was the most common locus for degenerative disease (Plate 58), being involved in 19 instances. It was followed in frequency by the temporomandibular joint, eight instances (Plate 59). None of the joints involved by hypertropic osteoarthritis were fused; all were still mobile. Lumbar vertebral changes in a few instances probably caused some limitation of motion. Because almost all of the hands and the majority of the feet were missing, it was not possible to evaluate these structures for changes which might have indicated the effects of hypertropic or rheumatoid arthritis. In other Indian skeletal material from South Dakota, the effects of generalized degenerative arthritis were quite common, but rheumatoid type changes have not been observed during previous investigations (Gregg, unpublished data). In no instance in the Crow Creek skeletons was there found anything indicating joint changes which might be found as an accompaniment of neurological disease (Charcot joint). One possible

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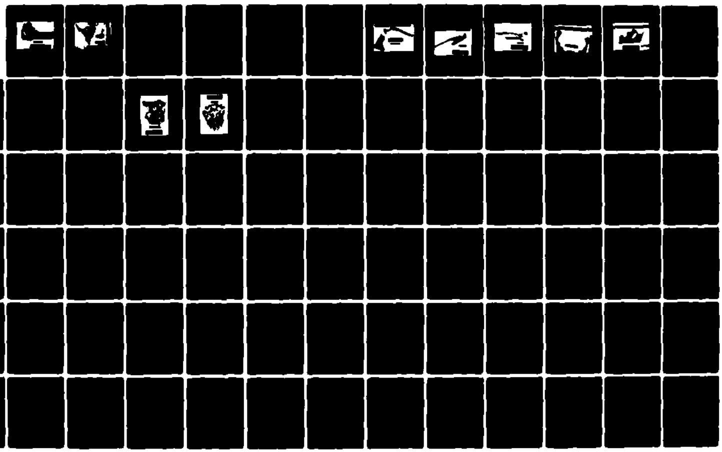

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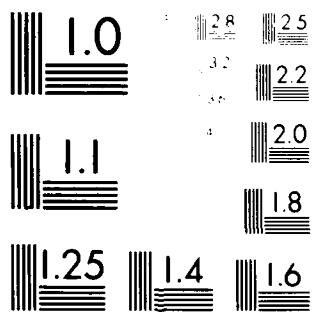
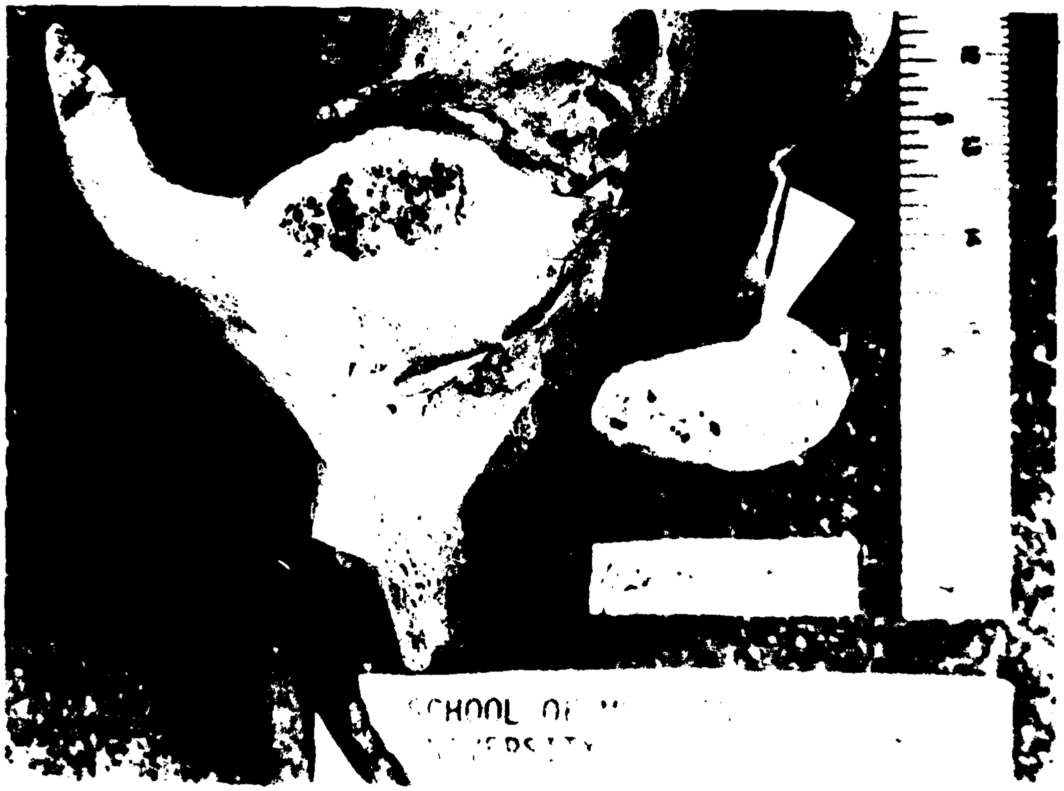


MICROCOPY RESOLUTION TEST CHART

PLATE [illegible]. Component of the temporomandibular joint showing degenerative changes in the joint surfaces of the mandibular head (right) and the [illegible] (left).



Charcot joint has been found in other Indian skeletal material (Gregg, unpublished data). The joint changes of arthritis are similar in frequency and appearance with the findings from other skeletal populations (Bowers 1966; Brothwell and Sandison 1967; Greene and Armelagos 1972; Hudson et al. 1975; Miles 1975; Morse 1969; Roney 1959; Steinbock 1976).

CONGENITAL AND DEVELOPMENTAL ANOMALIES IN BONE (Table 46)

Manifest deformities

Overt defects in skeletal formation or development were found in five instances. These defects were:

1. Probable congenital hip dislocation in a 6-10 year old child (Plate 60).
2. Fusion of the proximal portion of the radius and ulna, right side, adult (Plate 61).
3. Fusion of the proximal portion of the radius and ulna, left side, adult (Plate 62).
4. Asymmetrical development of the mandibular heads, adult (Plate 63).
5. Hypoplasia of the head and the body of a mandible in the area of the angle, unilateral, adult (Plate 64).

All of these anomalies would undoubtedly have been apparent during life because of the functional or cosmetic disturbance which they produced. However, they were not incompatible with life as it existed in the Crow Creek village at the time of death. On no occasion during this search for pathology was there found anything which would identify any disabling congential disease such as cleft palate, achondroplasia, hydrocephalus, or other overt anomaly. The fragmentary and disrupted condition of the skeletons, the absence of hands and feet, and the skewed age ratio of the population as compared to other

TABLE 46. Congenital and development anomalies in bone.

Cranial	Skulls	
Metopic suture	1	sub-adult
Premature closure of squamosal suture	1	sub-adult
Double articular facet, skull base with C-1 unilateral	1	adult
Anomalous styloid processes	1	adult
Mandible, bifid head	3	adult
Mandible, asymmetry of ascending rami	1	adult
Mandible, unilateral hypoplasia	1	adult
Accessory maxillary sinuses	1	adult
Dental pearls (instances)	8	adult
Anomalous dentition including absence of teeth, malposition of teeth, accessory teeth, fusion of teeth, etc.	11	adult & sub-adult
Fusion C-1 to base of skull	1	adult
Articulation of odontoid process with anterior foramen magnum (? platybasia)	1	adult
Paracondyloid processes	37	adult & sub-adult

	Small	Medium	Large
Right	1	12	
Left	1	10	1
Bilat	3	8	1

Spinal		
Bifid processes		13
Odontoid (sub-adult)	10	
Spinous		
C-2,3,4 (sub-adult)	1	
Thoracic, mid (adult)	1	
S-1 (adult)	1	
Vertebral fusion		9
Cervical		
C-2,3 (adult)	1	
C-3 & 4 & neural arch defect C-6 (adult)	1	
Mid-cervical (adult)	1	
Thoracic		
Mid-thoracic (adult)	5	
Mid-thoracic & neural arch defect L-5 (adult)	1	
Scoliosis (manifested by unilaterally asymmetrical vertebrae		7
Thoracic (adult)	3	
Lumbar (adult)	4	
Separate, partial, and absent neural arches		
Mixes defects (all in adults)		9
Partial C-3, S-2; separate L-5, S-1; absent S-4,5		
Separate L-5, S-1; absent S-2,3,4,5		
Separate L-5, S-1; absent S-4,5		
Separate S-1; absent S-2,3,4,5		

TABLE 46. (continued)

Separate S-1; absent S-2
Separate S-1; absent S-2
Separate S-1; absent S-2,4,5
Separate S-1; absent S-2,4,5
Separate S-1; absent S-3,4,5

Separate defects (all in adults) -------------------------- 95

		Absent	Partial	Separate
Cervical	C-1	1		
	C-3		1	
Lumbar	L-3			1
	L-4			1
	L-5			37
Lumbo-	L-5, S-1			3
sacral	L-5, S-1,2			1
Sacral	S-1		6	1
	S-1,2		8	
	S-1,2,3,4,5		2	
	S-1,4,5		5	
	S-1,5		2	
	S-2,3	1		
	S-2,3,4,5	1		
	S-3,4,5	12	1	
	S-4,5	11		

Vertebral assimilation with and without associated neural arch defects

		SEPARATE							ABSENT							PARTIAL
	ID	Lumbar		Sacral					Lumbar		Sacral					
ANOMALY	Number	4	5	1	2	3	4	5	4	5	1	2	3	4	5	
	CCCXXX		X	X												
Sacralization	(33)		X	X												
L-5 Total	CCCVII									X	X	X	X	X	X	
	CCCXV										X	X	X	X	X	
	CCCXVII		X	X												
	XVI															
	XXIII															
	CLXII													X	X	
	CCLXII															
	CXVIII		X	X												
	CXX															
	CLXXI	X	X													
	CCXVIII												X	X	X	
Sacralization	(25)															
L-5 Partial	(23)															
	CCLXVI		X	X												
	CCLXXII															
	CCC															
	CCCXXII	X	X	X												

TABLE 46. (continued)

	ID Number	4	5	1	2	3	4	5	4	5	1	2	3	4	5	
	LXVI											X		X	X	S-3
Lumbarization S-1 Total	LXXXV															
	CCXXVII			X	X										X	
	CCCVL			X	X									X	X	
	I															
	XXIX															
Lumbarization S-1 Partial	CXII			X												
	CXVI	X	X													
	CXXXIII			X	X											
	CLVI			X												
	CLXX			X	X	X										
	CXCVIII			X												
	CCI			X	X			X								
	CCXVI			X												
	CCXLIV															
	CCLVII			X												
	CCLXI										X	X			X	
	CCLXXI		X	X												
	CCLXXIII		X	X												
	CCXXV															
	CCLXXXIX															
	CCXCIX		X	X	X											
	CCCXXVII											X				S-1
	CCCXLII			X												
	CCCLXIII											X	X			
Totals		3	9	20	8	1		1		1	2	6	4	6	8	2

Total assimilations and associated defects-------------------------71

Other anomalies

Radius and ulna, fusion proximal portion ------------------- 2

Right 1

Left 1

Sternum -- 1

Humerus, absent medial epicondyle -------------------------- 1

Hip, dislocation, child, unilateral ------------------------ 1

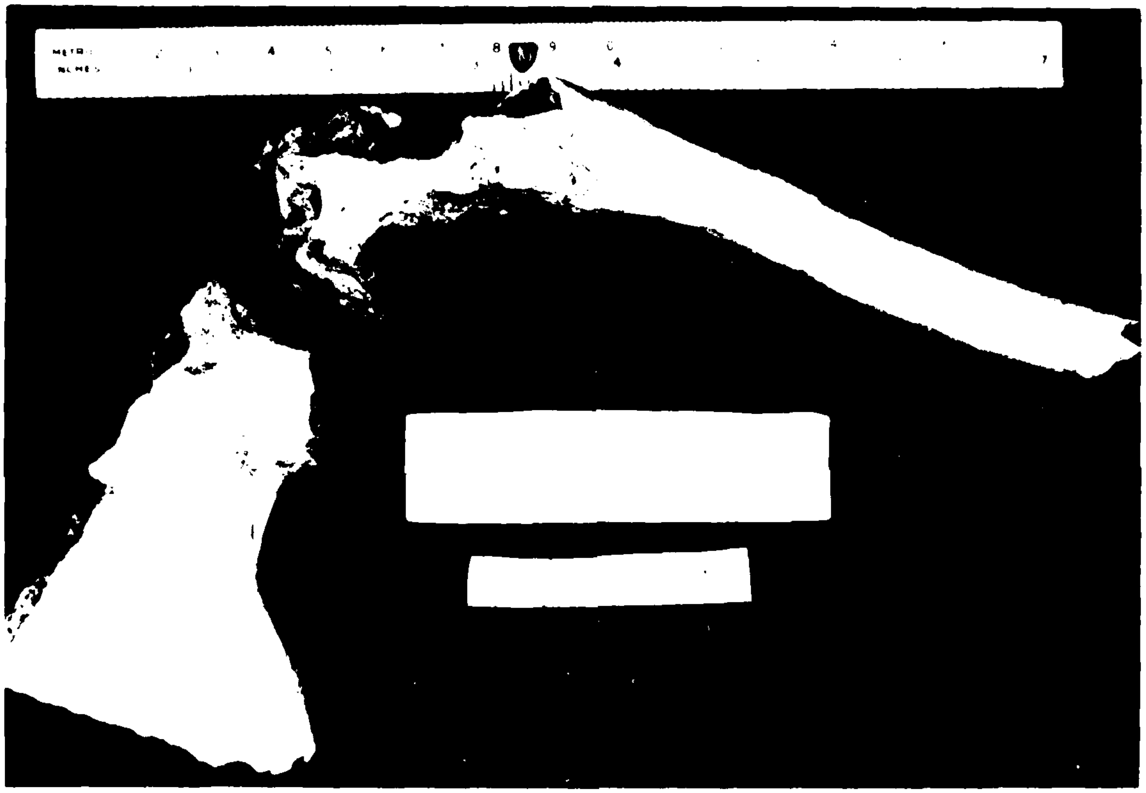
Femur, vascular deformity, distal portion ------------------ 1

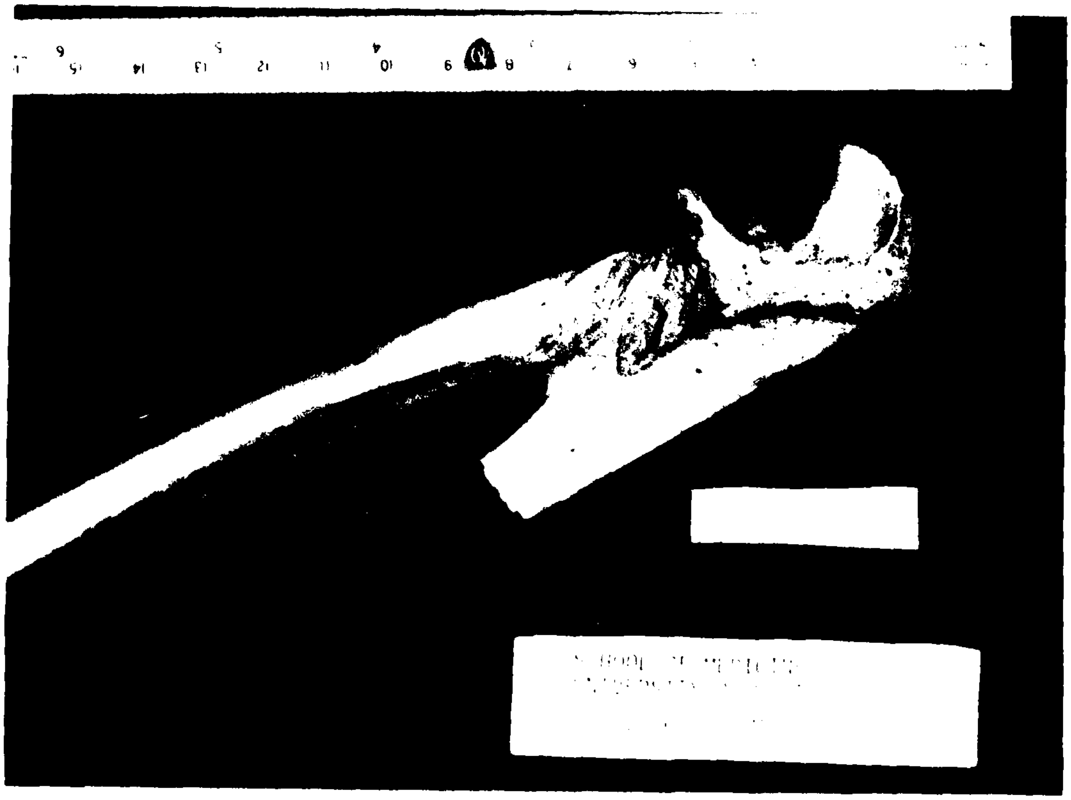
Fibula, nutrient foramen anomaly --------------------------- 1

Rib, anomalous --- 1

Thoracic vertebra, defect, body, laterally ----------------- 1

Tibia, absent articular facet for fibula ------------------- 1





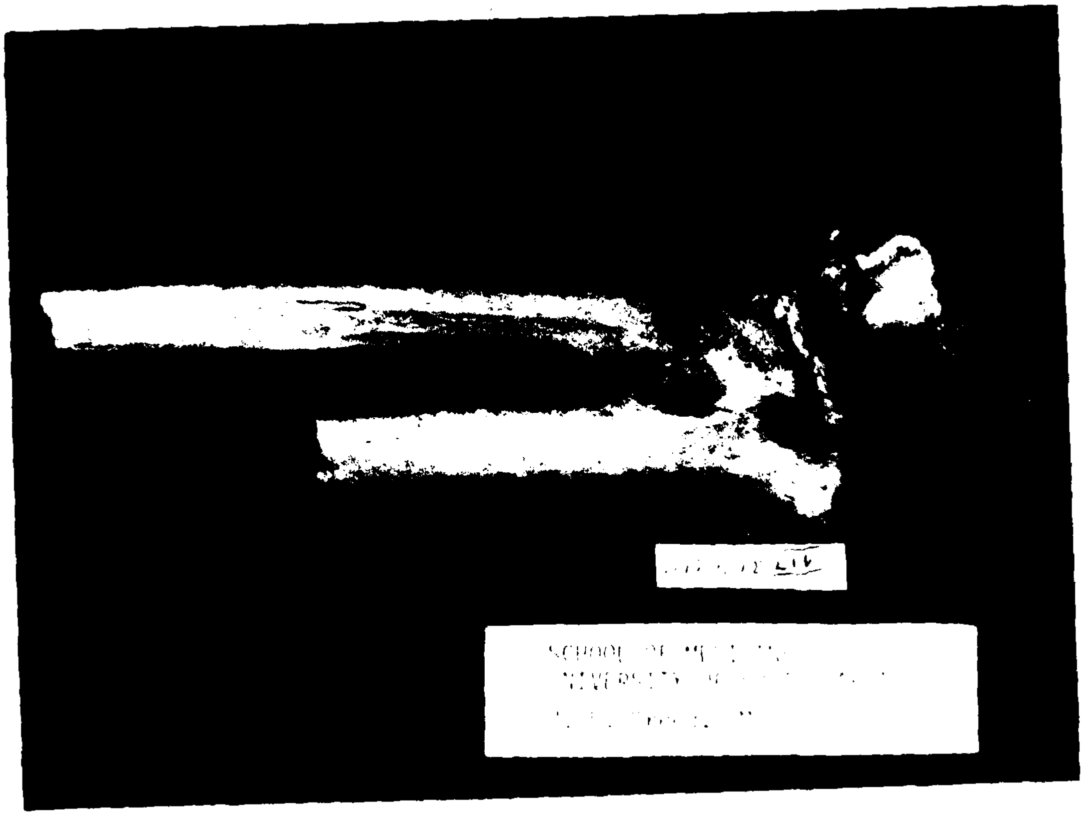


PLATE 6[illegible]. Hypoplasia of the left one half of the mandible and partial agenesis of the head.

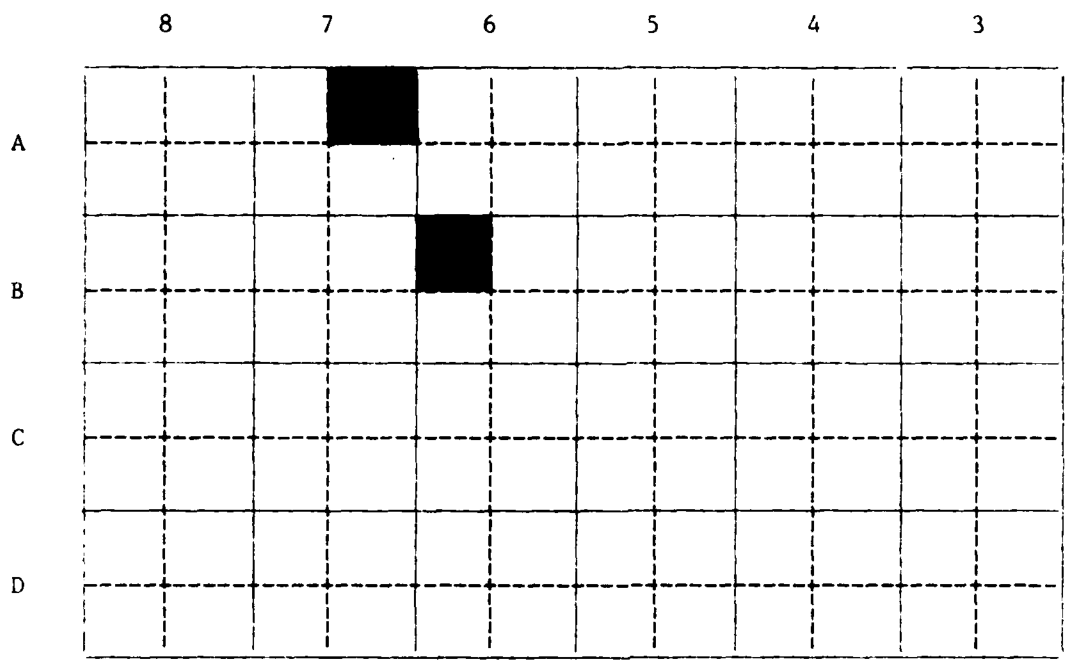
Arikara cemetery populations precluded the in-depth investigation into the incidence of congenital anomalies which had been planned.

The probable congenital hip dislocation would undoubtedly have produced a limp and difficult ambulation for the child. The fact that this child had survived in a primitive society for 6-10 years suggests that some form of life support measures had been utilized during life. Because this femur was not articulated with other than the rudimentary innominate, it was not possible to search for associated congenital anomalies or other abnormalities which might have accrued from the hip disability. Deitrick (1979) identified a probable congenital left hip dislocation deformity in a 18-21 year old male skeleton which came from the Rygh site in South Dakota (39CA4, F-301, B-6B). Concomitant with the femoral and acetabular deformities, she was able to find pathology in the left shoulder which was secondary to long term use of a crude crutch. Another severe dislocation deformity, possibly congenital in origin, in the right hip of an Arikara male skeleton which was more than 50 years of age came from the Sully site, South Dakota (39SL4, B-26A, #9363). Hypertropic changes in both shoulder joints, more so on the right, were also found in this skeleton. The fact that all three of these individuals had been able to survive for an extended interval in different communities along the upper Missouri River indicates that this deformity was not incompatible with life in these communities.

The left radius-ulna fusion (Box-47, Bag-2) excavation identification data was: 7A NE½, Upper Layer, Articulation 521, Bone Concentration "B." Only the fused radius and ulna were found in Bag-2. The right radius-ulna fusion (Box-152, Box-4) excavation identification data was: 6B NW, Bone Concentration "B." Within Bag-4 there were miscellaneous adult and child bones and fragments. The separation between the right and left radio-ulnar fusions was about .75 meter (FIG. 21). Both fusions were in adults but it was not possible to determine the exact age and sex of the bones. However, in both of the fusions the affected bones were approximately the same size, configuration, weight, density, and bone pattern. It is possible that they could have come from the same individual. Morse (1969:33) reported two cases, both on the left side, in which there was congenital fusion of the proximal portion of the radius and ulna. Both were from the Crable Site, Illinois. Ubelaker (1978: 84) reported two radius-ulna fusions in the proximal portion. One was found in the skeleton of an infant from Ossuary II, Maryland, and the other came from the Mobridge Site, South Dakota. He felt that these are a rare congential disorder.

The ascending ramus of the right side of the mandible in Plate 63 was approximately 2.0 cm longer than the left. When the mandible was articulated with the remainder of the skull (Skull #271), the dental alignment appeared to be quite good so there probably was little difficulty during life. One other specimen showing similar asymmetry has been seen in a South Dakota skeleton. No report of a similar anomaly has been found in the available literature of paleopathology.

FIGURE 21. Grid Chart III. Crow Creek excavation Grid Lines.



one meter
Scale:
Location of bones having radius-ulna fusion. Left - 7A NE
Right- 6B NW

The mandible seen in Plate 64 was an isolated specimen which was not articulated with a skull. On the left side of the mandible there was definite hypoplasia of the bone in the area of the angle, a very poorly developed mandibular head, and loss of the normal configuration on the affected side. There was a full complement of permanent dentition mandibular tooth sockets although the socket for the right central incisor appeared smaller and was displaced slightly to the right. Dental wear was approximately the same bilaterally on the teeth which remained, suggesting that the anomaly had not been accompanied by much difficulty in mastication. Because the skull was not available for inspection, it was not possible to determine whether this anomaly was a portion of a larger congenital defect such as hemifacial dysplasia. No skull which might articulate with this mandible was found during the search for pathology. No skull showed evidence of corresponding congenital deformity of the temporomandibular joint area, the external ear, or the zygomatic arch region. It is possible that the skull to which this mandible belonged may not have been recovered during this project. No report of this type of deformity has been found in the available paleopathology literature.

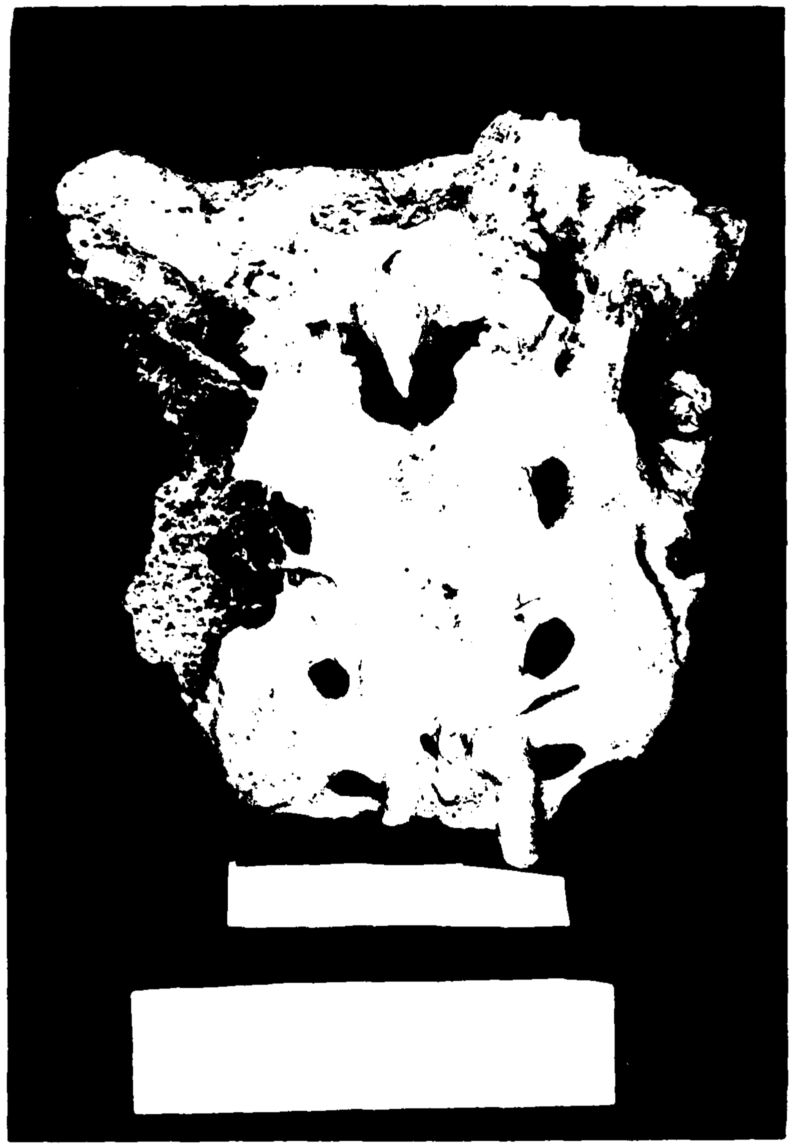
<u>Occult congenital or developmental defects</u>

Non-manifest congenital anomalies were frequent in the Crow Creek skeletons, just as they have been in other Arikara cemetery populations (Gregg 1967, 1978c and unpublished data; Gregg and Steele 1969; McGrew and Gregg 1971; Steele, et al. 1965). In the

Crow Creek skeletons, anomalies in the neural axis, especially in the lumbosacral area, were very common (Plate 65; see Table 46). These findings were in accordance with the results of other studies for neural arch defects (Adams and Niswander 1968, Austin et al. 1972; Bennett, 1972; Bowers 1969; Brothwell and Powers 1968; Carter and Evans 1973; Fahrni 1965; Frembach 1963; Gregg 1978d; Jarcho 1965; Katzenberg 1976; Kurtzke et al. 1972,1974; Lanier 1954; Ubelaker 1978). Although bifid, separate and absent neural arches, both single and multiple, were found very frequently in these skeletons, there was no indication of manifest spina bifida. Vertebral fusions were found in nine instances. Vertebral assimilation manifested by partial or complete lumbarization or sacralization, with or without associated neural arch deformities elsewhere, was found in 44 instances (Plate 66). The first cervical vertebra was fused to the base of one skull. Although Morse (1969:32) reports that fusion of the atlas to the occipital bone is rare, in previous studies of skeletons from North and South Dakota, both partial and complete fusion of the first cervical vertebra to the base of the skull have been quite common (Gregg 1978c). Paracondyloid processes were present in the base of the skull in 37 instances. Twelve were bilateral and 25 (13 right side and 12 left side) were unilateral. Some unilateral processes were found in disarticulated skulls. The frequency of occurrence of these processes is slightly lower than has been found in other Arikara cemetery populations (Gregg 1978c,d and unpublished data).

The possibility of scoliosis, manifested by unilaterally asym-

PLATE 6[illegible]. Adult sacrum showing partial neural arch deformity [illegible] and partial neural arch absence [illegible].



metrical vertebrae, was identified in six instances, all in adults, three times in the thoracic area and four times in the lumbar region. Because the vertebrae were disarticulated, it was not possible to determine how many of the anomalous vertebrae came from the same individual or how many individuals were represented by the affected vertebrae. Brothwell (1967:429-430) reported that one Bronze Age skeleton from Great Britain had probable scoliosis in the thoracic area.

An analysis of the anomalous dentition in the Crow Creek skeletons has been made elsewhere. The remainder of the congenital and developmental anomalies listed in Table 46 would have caused little or no difficulty during life and became apparent incidentally during the analysis of the skeletons.

Although many human skeletons from the upper Missouri Basin area have been available for study, to date there has been no published catalog or analysis of a large group for total paleopathology. Regarding the lack of an evaluation for the prevalence of congenital anomalies, Ubelaker (1978:84) has stated, "Congenital disorders comprise a variety of inherited abnormalities, most of which are rarely found in skeletal populations." In regard to manifest, disabling, life threatening processes, this statement is quite true. However, occult congenital and developmental processes which were not obvious during life and which did not interfere with function are very common in the skeletons from the upper Missouri River Basin. This compares well with the findings in the entire population of this country now.

In the United States today, one out of 15 live births has some form of congenital anomaly (Dr. Virginia Apgar, National Foundation, March of Dimes, personal communication). Most of these are innocuous and do not affect the individual's ability to exist and thrive.

There are five skulls from the upper Missouri River Basin Region of the United States which have findings compatible with hydrocephalus. Two of these are adults and three are children. The adults are in the "Sioux" collection at the United States Museum. One, labeled "Sioux Giant" (227 508) by Hrdlicka, has a skull volume of 1,865 cc (average measured male cranial capacity American Indian and Eskimo--1,460 cc, [Hambly 1947],and the other, labeled "Wahpeton-Macrocephaly" (243 369), contains 1,775 cc. Of the children's skulls, one, an Arikara aged 6-7 years (39SL4, F-421, B-119-E, #9926), had an interior volume of 1,425 cc while the skull of an average Arikara child of the same age contained 1,025 cc. The other child's skull (39HT2, Bag-1, F-2 in XU 1-2, 8-18-70, Bones from W. edge of pit #500) was from a 3-4 year old and was taken from the Hofer Mound near Freeman, South Dakota. It was probably of Middle Plains Woodland origin and had an interior capacity of 1,335 cc. Because hydrocephalus can have its origin in factors other than congenital, it is possible that these enlarged skulls were not inborn.

It has been postulated (Denig 1961; Gregg 1978c; Holzhueter 1964; Neel 1970; Tichauer 1963; Tretsvin 1963, 1965; Vogel 1970) that debilitating congenital or developmental anomalies are/were eliminated from primitive populations by natural selection, many times aided and abetted actively or passively by the people involved. This supposition is strengthened by the extreme paucity of human skeletal remains in which there are overt anomalies such as cleft palate, achondroplasia, manifest spina bifida, hydrochephalus, and disabling defects involving the hands and feet, which have been reported from North America.

The findings in regard to the frequency of occult congenital and developmental problems and the identification of the five manifest anomalies which are described herein should provide food for thought. The observation that occult congenital and developmental deformities are common in both the Crow Creek specimens and in other skeletal populations from North and South Dakota, while manifest abnormalities are few, would indicate that disabling congenital problems were probably eliminated from the community early in life and that the remains did not get into the common grave. Defectives which could survive with minimum life support measures did so.

SUMMARY AND CONCLUSIONS

The types and locations of pathologies and anomalies which were found in the skeletons of the Crow Creek victims were varied and numerous, but the majority were quite similar to those which have been found previously in comparable cemetery populations both in the upper Missouri River Basin and elsewhere. Because cemetery populations include the remains of individuals who lived and died over an extended interval in time, it is only possible to determine accurately the prevalence of diseases and anomalies which affected the people during their individual and communal life. At the inception of this project, it was envisioned that because the people of Crow Creek were a homogeneous group who lived as a community and all died at the same time, it might be possible to evaluate an entire community which was typical of its time for all recognizable diseases and abnormalities. Thereby, incidence patterns in health related problems might be determined. It soon became very painfully apparent, for reasons which have been discussed, that such was not possible, directly.

In the Crow Creek skeletons the temporal bone count is the single most accurate assay of the total number of individuals represented. Fortunately, in the past, several extensive studies of the temporal bones from the prehistoric and historic skeletons which came from North and South Dakota have been made using direct examination and X-rays. These have included an assay for the type of soil within the external auditory canals and its effects upon the preservation of the auditory ossicles, an investigation for stapes footplate fixation by otosclerosis, and an assessment for other diseases and abnormalities which might be of congenital, infectious, traumatic, metabolic, or neoplastic origin. Analysis of the temporal bones has provided one restricted but reasonably accurate source of information concerning the frequency of several types of pathology in the Crow Creek people. Careful comparison of these findings with those from the previous studies will allow increased insight into the occurence and manifestations of health problems affecting a limited portion of the skeletons, as they existed at this period in time and in this locale. Cautious extrapolation between the findings in the Crow Creek temporal bones and the findings from other portions of the skeletons allows limited insight into the manifestations of diseases elsewhere.

The incidence of external auditory canal exostoses in the Crow Creek skulls (4.6 percent) is almost identical with the findings in other skeletal populations from North and South Dakota which have been examined by this researcher. The types and locations of exostoses here were very similar to those seen in the other studies. One exception was a unilateral severely obstructive spongy exostosis. Stapes footplate fixation by otosclerosis has not been found previously in North and South Dakota skulls and was not found here. An anomalous styloid process, unlike anything which has been seen previously, was found in one Crow Creek skull. Gross examination of the development of the mastoid tips suggests that in many of these skulls the air cell system is poorly pneumatized, indicating otitis media during childhood. Definite confirmation of this must await interpretation of the mastoid X-rays. The auditory ossicles were preserved in approximately the same condition and number as in previous studies.

To summarize the findings in this survey of the Crow Creek skeletons for diseases, anomalies, and abnormalities, Table 47 has been prepared. In it are to be found a listing by pathological type of the commonalities and differences which have been observed between the Crow Creek and other skeletal populations. At the

TABLE 47. Commonalities and differences between the Crow Creek skeletons and other upper Missouri River Basin skeletons.

COMMONALITIES	DIFFERENCES
TRAUMATIC PROCESSES	
Healed fractures, mostly reasonably aligned, all skeletal populations Old, healed upper femur fractures with variable shortening and deformity in four other skeletons and one from Crow Creek Non-lethal scalpings sometime prior to death in several instances previously, two in Crow Creek Dislocations and epiphyseal injuries in Crow Creek and other burials, present but not frequent	Markedly depressed fracture, frontal region, well healed, one Crow Creek skull
INFLAMMATORY AND INFECTIOUS PROCESSES	
Osteomyelitis, present but not frequent Periosteal inflammatory response common but variable in location, type, and frequency a. post trauma sub-periosteal hematoma common b. periosteal reaction suggesting spirochetal infection c. inflammatory response at ends of long bones, especially femora, tibiae, children & sub-adults. Amount and severity of response variable Altered mastoid development suggesting otitis media during childhood Abscesses of dental origin, frequent Antral-oral fistulae, quite frequent Maxillary sinusitis type changes, quite frequent	No evidence of chronic granulomatosis in Crow Creek but definite evidence in other skeletons Inflammatory response at ends of long bones, children & subadults, more noticeable in many Crow Creek skeletons No evidence of gumma or Charcot joint in Crow Creek
TUMORS AND CYST-LIKE LESIONS	
Osteomas and exostoses common, incidence of exostoses in outer ear	Osteolytic tumor, distal Crow Creek tibia

TABLE 47. (continued)

TUMORS AND CYST-LIKE LESIONS (continued)

canals identical in Crow Creek and other studies	Osteolytic tumor, proximal Crow Creek humerus
Bone spurs common	Spongy exostosis completely occluding one Crow Creek external auditory canal
Heterotopic bone formation common	Osteoid osteoma in tibia and humerus, two Crow Creek skeletons
Small cyst-like lesions in bone common	Large cystic lesion, possibly post-trauma, parietal area, Crow Creek skull
No evidence of cancer primary in bone in Crow Creek or other skeletons	One possible metastatic cancer implant, right frontal area, Arikara male skull, from South Dakota. No other evidence of metastatic cancer in Crow Creek or other skeletons

NUTRITIONAL AND METABOLIC DISTURBANCES

Cribra orbitalis, mild to moderate, ? more evidence in Crow Creek No severe lesions in any skeletal group	
Periosteal inflammation, ends children's long bones, ? nutritional basis, more in Crow Creek skeletons	
Dental wear, caries, tooth loss, common all populations.	
Stapes footplate fixation by otosclerrosis not present in any pre- or proto-historic temporal bones	

DEGENERATIVE PROCESSES

Osteoporosis, primarily in vertebrae, ribs, innominates,skulls, frequent in all skeletal populations	
Vertebral lipping, variable degree, common all skeletal populations	
Degenerative and hypertropic changes in joints common all skeletal populations. Commonest in knee, temporomandibular, ankle, hip joints	

TABLE 47. (continued)

CONGENITAL AND DEVELOPMENTAL ANOMALIES

Congenital hip dislocation in one Crow Creek and three other skeletons	Markedly dissimilar length ascending rami mandible, one Crow Creek specimen and one other South Dakota specimen
Congenital fusion proximal radius and ulna in three specimens, two from Crow Creek	Parital agenesis one-half of mandible, one Crow Creek specimen
Occult bone defects in neural axis, vertebral fusions; absent, separate, partial neural arches; vertebral assimilation, complete or partial; paracondyloid processes; isolated or in combinations, common	Possible scoliosis several Crow Creek vertebrae
Manifest, disabling congenital anomalies-achondroplasia, cleft palate, manifest spina bifida, etc., not found in any skeletons	Probably hydrocephalus four skulls. two adults, indicating compatibility with survival. None in Crow Creek skeletons

time of this writing no comprehensive analysis for total pathology within a large skeletal population from the upper Missouri River Basin is available. When such analysis of one or more skeletal populations becomes available for comparison, the Crow Creek skeletal data will become much more meaningful.

PROPOSED ENVIRONMENTAL RECONSTRUCTION FOR THE CROW CREEK SITE THROUGH STABLE CARBON ISOTOPES

Analysis of the stable carbon composition of soils and food refuse, both modern and archeological, will provide a source of paleoenvironmental information for studies of how the Wolf Creek people adapted to their environment. Knowledge of such adaptations may lead to an understanding of the Wolf Creek people's history, a history which ended prematurely.

Nearly 99 percent of the earth's carbon is composed of the stable isotope ^{12}C. Approximately 1.1 percent occurs in the other stable form of ^{13}C and 10^{-12}% in the more familiar unstable isotope ^{14}C (Hammond 1972; B. Smith 1972). The distribution of ^{13}C in nature is variable but predictable.

The carbon content of plants initially reflects the $^{13}C/^{12}C$ ratio of its carbon source. For terrestrial plants, the carbon source is atmospheric with a $\delta^{13}C$ value (the ratio of ^{13}C to ^{12}C compared to the adopted carbonate standard, always negative, expressed in thousandths) of approximately -7‰. Aquatic plants depend on either the atmospheric CO_2 pool or the aquatic bicarbonate or carbon dioxide pools. Bicarbonate is enriched in ^{13}C more so than CO_2 and therefore has a high (less negative) $^{13}C/^{12}C$ ratio.

However, during photosynthesis, plants preferentially take up ^{12}C over ^{13}C from their immediate environments in order to metabolize energy through three major pathways: C_3 (Calvin), C_4 (Hatch-Slack), and CAM (Crassulacean Acid Metabolism) (Throughton 1972). Most non-desert plants have the Calvin or C_3 pathway with a 3-carbon structure. Some plants, C_4 with a 4-carbon structure, have an additional system which uses separate cells to segregate the two metabolic pathways(Bender 1971; Black 1973; Hatch and Slack 1970; Lerman and Troughton 1975). Like the C_4 plants, CAM plants use two metabolic pathways, but only one cell type is present. Metabolic processing is temporally separated, switching between night and day (Black 1973; Lerhman and Troughton 1975; Lerman and Queiroz 1974).

Plant $\delta^{13}C$ values can theoretically range from 0 to -38%o (B. Smith 1972) but there is a distinct bimodal distribution of real values associated with the metabolic pathways. Plants can therefore be grouped on the basis of their $\delta^{13}C$ values alone. C_4 plants discriminate less against ^{13}C than do C_3 plants and therefore have higher $^{13}C/^{12}C$ ratios. The mode for C_4plants is -12%o; for C_3 plants it is -28%o. CAM plants are intermediate in value, depending on their growth conditions (Lerman and Queiroz 1974).

The major photosynthetic groupings of plants have environmental correlates. C_4 plants tend to be tropical and are uncommon in northern temperate environments, especially where the normal July minimum temperature falls below $10^{o}C$ (Teeri and Stowe 1976). Most CAM plants are succulents. Additionally, within each grouping, $\delta^{13}C$ values may vary slightly due to micro-environmental conditions. From what is known of the environmental characteristics of the three major photosynthetic groups (Black 1973), the presence/absence or relative proportion of C_3, C_4, and CAM plants and their $\delta^{13}C$ composition can indicate climate. Unlike the unstable ^{14}C, the ratio of ^{13}C to ^{12}C after death will not intrinsically fractionate (change in ratio). Analysis of food remains and soil humus can therefore reflect the living environment.

Geochemists, pedologists, and plant physiologists have learned much of the environmental effects on $\delta^{13}C$ composition which will lead to environmental reconstruction (Farmer and Baxter 1974; Lerman and Long 1978; Lerman and Queiroz 1974; Lerman and Troughton 1975; Mazany 1978; Osmond, et al. 1973; Smith 1972; Stout and O'Brien 1972; Teeri and Stowe 1976; Troughton 1972; Troughton et al. 1974). For example, microatmospheric $\delta^{13}C$ values, reflected in local plant remains, can be depleted because of the release of carbon through forest litter and decomposition. This amount of litter and rate of decomposition are affected by the density of growth and climate. Clearing of large tracts of land for horticulture should also alter the carbon isotope atmospheric ratios. Temperature affects aquatic $\delta^{13}C$ values. Temperature also affects the rate of photosynthesis in terrestrial plants and thus affects the $\delta^{13}C$ value, with greater temperature reflected in more negative values within the C_3 mode. The $\delta^{13}C$ values of CAM plants have been shown to vary due to variations in the photoperiod, thermoperiod, illumination, and temperature; water stress; and salinity. Soil $\delta^{13}C$ values will be affected by the type of vegetation cover. Vegetation cover will, in turn, affect the relative biomass of different animal species and thus the resource potential for prehistoric exploitation.

An isotope-ratio mass spectrometer at the Laboratory of Isotope Geochemistry of the University of Arizona will be used over the next three years to obtain the carbon isotopic composition of plant and animal food remains from the 1954 and 1978 excavations at the Crow Creek site, soil samples from the fortification ditch, and modern plant and animal tissues from environments similar to the Crow Creek site. The modern samples will provide a broader range of prehistorically used foods to examine than the archeologically recovered remains. Comparisons between the modern and archeological samples will compensate for $\delta^{13}C$ variation due to any environmental changes between the prehistoric and modern time periods. Isotopic composition and the photosynthetic parameters for the C_3, C_4 and CAM plant groups will be evaluated for environmental indicators. Reconstruction of the prehistoric environment will be based on both isotopic and archeological analyses.

However, the environment within which the Wolf Creek people lived and died is more than the physical environment. For an understanding of the Wolf Creek adaptations, one must investigate their biological and social environments as well. It is possible to do this for the Wolf Creek by comparing the physical environmental reconstruction to the health status of the Wolf Creek people.

Studies of other populations (El-Najjar, et al. 1976; Lallo, et al. 1977; Mensforth, et al. 1978) have shown an increase in macroscopic infectious and nutritional lesions as the populations shifted from a gathered diet to one of increased reliance on cultivated crops. Horticulture modifies the environment by replacing the indigenous plant cover with cultigens, altering the animal composition of the habitat, and interrupting the normal water cycle. In addition, horticulture implies increased sedentism of the population with consequent environmental degradation. Sedentism usually implies an increased population density and a wider range of social contacts as well.

Environmental/health reconstructions for the Crow Creek people will be compared to those of other populations from different environments. These comparisons will be useful, even on the general, macroscopic level employed. Unfortunately, researchers were not permitted to obtain microscopic bone sections (a few mm thick) for a detailed study of the Crow Creek people. Inductively coupled plasma atomic emission spectroscopy (ICP-AES) of the bone sections would have possibly permitted the reconstruction of specific individuals or family units from the various bone elements recovered. Microscopic bone studies of modern Anglo and archeological Egyptian populations, for example, have revealed the initial changes in bone from malnutrition before severe malnutrition shows as gross lesions. Changes in bone thickness reveal the effect of child-bearing and lactation on the women in the populations (and gives some idea of the status of women in these groups). Growth changes in children and adolescents have led to an understanding of the role of proper nutrition in increasing life expectancy and the quality of life. Elemental analysis of bone sections for major, minor and trace metals has been used to reconstruct specific diets, e.g., for examination of the contribution of industrial society's diet to its current state of health. Prehistoric peoples had an organic, natural diet and did not suffer industrialized diseases. Modern man would do well to learn from his ancestors. The comparisons that can be made will result in a better understanding of how people in North America lived prior to European contact. The comparisons will also provide further insights into how humans cope biologically and culturally to change.

SUMMARY

The remains of at least 486 men, women, and children were recovered during archeological excavations conducted in the outer fortification ditch of the Crow Creek site (39BF11). The remains showed evidence of violent death and mutilations; the bodies were mutilated by scalping, dismemberment, and decapitation. Ceramics associated with the skeletal material were types which fit into the Campbell Creek and Talking Crow Ware groups. A single radiocarbon date run on charcoal collected from the bone bed matrix yielded a corrected date of A.D. 1325$\pm$62. Previous excavations in the village area demonstrated that many of the structures of the Wolf Creek component had been burned. These excavations also recovered some disarticulated human remains scattered in the village refuse. On the basis of available evidence from the two excavations, the suggestion can be made that the massacre victims were inhabitants of the Wolf Creek component village which is associated with the Initial Coalescent variant of the Coalescent tradition.

The Initial Coalescent - Central Plains intrusion into this area probably began in the late 13th century and by the early to mid-1300's was present in its developed form of large fortified villages. This early movement of Central Plains groups into the Big Bend region seems to make sense in terms of what is known about acculturation processes. That the Initial Coalescent material culture is an amalgamation of both Middle Missouri and Central Plains traits, which suddenly appear full blown at A.D. 1400 in South Dakota,

has long been noted. If the movement began to gradually occur in the middle to late 1200's on a small scale, it becomes possible to accept the appearance of the Initial Coalescent by the mid-1300's. This idea also allows for a period of peaceful interaction between Central Plains and Initial Middle Missouri groups. This peaceful interaction may have turned violent when a deteriorating environment in the south forced more and more Central Plains groups north into the Big Bend region.

This view has already been put forward by other authors. Kivett and Jensen (1976:64-67) have summarized a number of the early Initial Coalescent dates for the Big Bend region. For example, Component A at the Jiggs Thompson site shows Coalescent influences. Dates for the component are placed by the excavators at about A.D. 1350. Even earlier Central Plains influences are present in the 1200's at the Ketchin and Durkin sites. Jensen (Kivett and Jensen 1976:66) noted that a number of Arzberger collared rims were present at these sites which date to the first half of the 13th century. Although the evidence is not plentiful, there does appear to be some data available to support Central Plains influences in South Dakota as early as A.D. 1250.

In 1976, Kivett and Jensen envisioned this movement of Central Plains peoples into South Dakota as follows:

> Despite the short life span of the recognizable portion of the (Initial Coalescent) horizon, we feel confident that its influences were being felt in the Big Bend District and the upper Fort Randall District as early as A.D. 1250. At this point in time, the indigenous Middle Missourians apparently did not feel threatened, since they

> continued to live in sprawling unfortified villages. A century later the situation seems to have changed drastically with the Middle Missouri peoples now living in small scattered camps. It is also highly probable that there was an appreciable decrease in population. Part of this deterioration could have resulted from a shift to the less favorable Pacific I climate, but there is also evidence of increasing influences and perhaps overt pressures from the Initial Coalescent....In the Big Bend by the end of the 14th century, Initial Coalescent peoples were probably well entrenched in their large heavily fortified towns.

The data from the 1978 excavations at Crow Creek seem to reinforce the early dates for the movement of southern peoples into the Big Bend region.

Analysis of the skeletal material demonstrates that both sexes and all age groups were present, though some segments of the population appear to be under-represented. Craniometric analysis indicates that Crow Creek is most similar to samples from St. Helena and early Arikara sites.

To complement and supplement the work which has been done upon the archeology, cultural analysis, demography, and anthropological evaluation of the Crow Creek massacre village population, a study was also undertaken to investigate the diseases, anomalies, and abnormalities identifiable in bone which may have occurred in and affected these people during their lifetime. Many different diseases and anomalies have been recognized, some which have been reported previously in the literature of paleopathology and some which have not. The problems identified have been categorized as infectious and inflammatory, traumatic, tumors and cysts, metabolic and nutritional, degenerative, and congenital and developmental processes. Common and uncommon abnormalities found have been discussed and illustrated. Patterns of commonalities and differences in pathology between the findings in the Crow Creek massacre victims and other skeletal populations from the Upper Missouri River Basin have been outlined. Statistically significant information relating to the incidence of abnormalities in the temporal bones has been obtained during this study. Data concerning the prevalence of pathology in other portions of the skeletons has been forthcoming but incidence data cannot be obtained due to circumstances outlined herein.

RECOMMENDATIONS

The researchers believe that as much information as possible about the Crow Creek skeletal materials was gathered from this project considering the amount of time, funds and staff available. Much of the information gathered remains to be analyzed and many more projects can be done. A number of gnawing questions remain unanswered and cannot be answered without further analysis of the skeletons themselves and without more excavation at the site for accompanying cultural materials. Among the most important of these are:

1. What was the total population of the village?
2. Does more skeletal material lie in other segments of the fortification ditch?
3. What evidence in both the skeletons and cultural materials can be used to corroborate the nutritional deficiences apparent in some of the skeletons?

4. Does the nutritional deficiency relate to the cause of the warfare?

5. Was the massacre committed by Initial Middle Missouri populations or other Initial Coalescent populations competing for scarce resources?

Without considering the wishes of the Native American people living in the area, many archeologists would agree that the questions are important enough to keep the skeletal material out of the ground for a longer period of time and to remove the skeletons remaining in the ditch immediately adjacent to the 1978 excavation. Tests should also be conducted to determine whether more skeletal material exists at other locations on or near the site. Excavations of other lodges within the site may also provide information. There are, however, other considerations.

The primary consideration, of course, must be the wishes of Native American peoples. Attitudes towards bones have changed, with many groups now defining bones as sacred. Past attitudes towards bones may simply be inoperative now. Tribal animosities may now be submerged into Panindian concerns. Such is the case with the Crow Creek site. Anthropologists and archeologists have been taught to respect the concerns of the individuals with whom they deal, and the profession must place these concerns as being the most important.

Even though the massacred group has been firmly identified as Proto-Arikara, the Sioux, long time enemies of the Arikara, now are the most concerned about the treatment of the remains. Discussions with the Sioux indicate that they have several wishes about the ultimate disposition of the bones. They feel that the bones which remain in the ground should be removed and that all bones, after adequate study is done, be reburied on the site. The wish that the rest of the skeletal material be removed is based on the idea that all the massacred individuals were members of families and that these families should not be broken up even in death. The wish that the bones be reburied on the site is based on the idea that the people should be buried where they lived and died.

These wishes are further complicated by concerns about the impact of more excavation and reburial on the archeological integrity of the site and its National Landmark--and possible National Monument--status. There is relative certainty that further excavation will damage the site. Such excavations and accompanying analyses will also be costly.

A number of compromises may be possible and they may be considered to be the recommendations of this report. The remaining skeletal materials should be removed. Efforts should be made to determine if other concentrations of bones lie in other segments of the fortification ditch. This can be accomplished by soil cores taken at regular intervals. Soil cores should do minimal damage to the site. If other concentrations are found, decisions can be made at that time about further excavations. All new skeletal material should undergo analyses comparable to those described in this report. Reburial of the skeletal material should be done on the site.

Damage can be minimized by reburying the materials in one of Kivett's units. Reexcavation of that unit should be monitored carefully because additional artifactual materials will undoubtedly be encountered. Ultimately, the reburial container might be covered with earth in a form to resemble an earthlodge to blend in with other interpretive devices at the site should these eventually be built.

The final recommendation of this report goes beyond the issue of skeletal material at Crow Creek. The time has come that serious consideration be given to uniform treatment of human skeletal remains discovered on federal property. In South Dakota, the discovery of human skeletal remains along the Missouri River is a relatively common occurrence, but the treatment and ultimate dispostion of the bones has been extremely variable. Native American peoples nationally have shown very great concern about the issue. Some states have passed laws to handle the situation. Federal legislation should be passed so that any time human bones are found on federal property consistent treatment of the bones is ensured. Qualified archeologists should excavate the remains, qualified physical anthropologists/osteologists should examine the remains, and the bones should be reburied according to standards established by agreement of federal agencies and the living descendants of the people concerned. The legislation developed in the state of Iowa would seem an especially good model (Anderson, et al. 1977).

The Crow Creek people will not remain silent in death. There is much they can teach, although it will be difficult to learn.

Anthropologists have a tremendous responsibility to understand human action (Reynolds 1976). The people of Crow Creek lived dynamically. They died violently. Anthropologists' highest obligation is to salvage meaning from their destruction in order that those who live and die, then and now, do so with recognition. To create value in one's own life, one must respect the value of the past. Anthropologists must record and understand the stories of those who lived before so that all may learn from them. Scientific skill and imagination can transform the "debris" of the past into a resource for the present. All may then share the human goals and frailties of those many seasons gone.

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American Antiquity	AA
American Journal of Physical Anthropology	AJPA
Annals of Otology, Rhinology and Laryngology	AORL
Bulletin of the History of Medicine	BHM
Bureau of American Ethnology	BAE
Cleft Palate Journal	CPJ
Eugenics Quarterly	EQ
Family Physician	FP
Genetic Research	GR
Human Biology	HB
International Surgery	IS
Journal of the American Medical Association	JAMA
Journal of Anatomy	JA
Journal of Bone and Joint Surgery	JBJS
Journal of Dental Research	JDR
Journal of Laryngology and Otology	JLO
Medical Anthropology	MA
Medical College of Virginia Quarterly	MCVQ
Morristown (Tennessee) Journal of Pathology	MJP
Nordic Medicine	NM

Paleopathology Newsletter	PN
Plains Anthropologist	PA
South Dakota Journal of Medicine	SDJM

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APPENDIX A

INVENTORY OF DATA COLLECTED FROM CROW CREEK SKELETAL MATERIAL. DATA ARE ON FILE AT THE UNIVERSITY OF SOUTH DAKOTA.

INVENTORY OF DATA COLLECTED FROM CROW CREEK SKELETAL MATERIAL. DATA ARE ON FILE AT THE UNIVERSITY OF SOUTH DAKOTA.

I. Number of Individuals

Skull number assigned by box/bag number
"Maximum" element inventory: procedure described, data sheets, some data coded and on computer cards
Minimum element count with rough ages for left and right temporals, humeri, ulnae, radii, femora, tibiae, and fibulae

II. Demography

A. Age estimations
1. Subadults
Temporal aging procedures and data sheets
Dental and temporal ages compared for some individuals
Dental aging procedures described
Dental age estimations
Comparison of mandibular-maxillary age estimations from individuals
2. Adults
Pubis aging procedures described
Pubis ages on data sheets (using three methods/standards)
Age profile
Discussion of age estimations
Skull aging with procedures described and data sheets

B. Sex determination
Pubis sexing procedures described, data sheets, discussion
Skull sexing procedures described, data sheets, discussion

III. Cranial distances
A. Cranial measurements
Procedures described, original data on computer data sheets, and data on computer cards

B. Cranial observations
Procedures described, original data on computer data sheets, and data on computer cards

IV. Mutilations

Procedures described, mutilation inventory

V. Paleopathology

Paleopathology inventory
Cribra orbitalia and porotic hyperostosis: procedures described, preliminary report, data sheets

Vertebral neural arch defect inventory
Enamel hypoplasia: procedures described, data sheets
Scalping description of more complete skulls
Depressed fracture on more complete skulls
Gestation pits: procedures described, classified into stages
Linear lesions on postcranial bones: procedures described, data sheets, sketches of lesion locations and analysis

VI. Other Data Collected

Dental survey: procedures described, data sheets
List of strontium samples taken
Postcranial measurements: original data on computer data sheets, also on computer cards
Laboratory photographs (prints and negatives) and photographic inventory

RESPONSES TO REVIEWERS' COMMENTS

ON THE

CROW CREEK DRAFT REPORT

APPENDIX B

RESPONSES TO REVIEWERS' COMMENTS ON THE CROW CREEK DRAFT REPORT

GENERAL RESPONSE TO REVIEWERS: Larry J. Zimmerman
Principal Investigator

The authors of the Crow Creek report would like to thank the many individuals who took time to provide comments on the draft report. Many of their comments provided valuable and necessary information and criticism. Comments of a specific editorial nature were incorporated into the final report. Other comments of a substantive nature related to content were either changed in the text or are addressed in this appendix. Some comments simply cannot be addressed except on a more personal level outside this report.

Even though this report is the final document to be provided to the Corps of Engineers under Contract No. DACW45-78-C-0018, the title of the report will retain the word "preliminary". As noted in the document, information was gathered that will take many years to analyze. Presently, P. Willey is using the Crow Creek data for a dissertation at the University of Tennessee. M. Pamela Bumsted has received funding to continue her work on isotopic carbon and nutrition, Mark Swegle is continuing his work on nutrition and Steven Symes is examining X-rays of all long bones to study Harris lines. Larry Bradley and Larry Zimmerman are preparing a computer simulation to test the feasibility of hypotheses relating to nutritional deficiencies, land use, and population as causes of the massacre.

The data categories listed in Appendix A are not presented in detail but are presented so that investigators other than the authors may know what sort of problems exist to be studied. If individuals are interested in any aspect of the project, they are urged to contact any of the authors for more detail and/or permission to use the data. The firm hope, in fact, pledge, of the authors is that this is not a final report. This preliminary report will be the foundation of a larger, more widely disseminated scholarly report at some time in the future. We hope that other investigators will contribute to that volume.

Two of the reviewers commented that we had "dehumanized" the massacre and that "people" had been lost. That five hundred people died by massacre must be considered an immense tragedy. The task of anthropologists, at base, however, must be to provide an outside, "etic" view and remain objective about the subject matter where possible. In one sense, the skeletons are just bones, the ceramics are just a bunch of sherds, and the data generated from them are just data. At another level, of course, anthropology is intensely personal and the "etic" data can teach very "emic" lessons. As one reviewer aptly commented, "It is imperative that the results of this study be made available to the public. They are important, they are well done, and they are of interest. The present draft will serve well as the basis of a scholarly report. An abstracted version should be prepared and distributed as a popular account. There is a ready audience for this information. Dissemination will benefit both the profession and the Corps."

We quite agree with that reviewer. That there is a wide audience was apparent from the beginning of the project (and was in part responsible for many of the problems encountered by the investigators). Since the draft of this report was submitted in February of 1980, and during the more than six month review process, many popular accounts of the massacre have been published. The New York Times ran a syndicated story, the Baltimore Sun sent a Pulitzer Prize-winning science writer to South Dakota for a week to interview many individuals involved in the project. He did an in-depth story that covered three consecutive front pages and was widely syndicated. Smithsonian Magazine did a major article on the project. Weekly Reader carried the story to grade school children across the country and National Scholastic carried the story to high school history classes in its magazine Search. Two half-hour television specials, one for commerical, and one for public television have been aired.

A number of reviewers commented directly on various aspects of the excavation and analytical techniques used or not used for the operation. Responses to these criticisms are addressed in sections that follow. All readers simply must try to understand that this excavation was done under many very trying, very frustrating, conditions. As with every excavation, limitations of cost and time were restrictive. Cost estimates during negotiations were based on the basis of the excavation and analysis of 200 skeletons; there was simply no way of knowing that nearly 500 would be exhumed. Paramount in our considerations, however, was not the issue of time or money but consideration of Native American concerns about the bones.

As noted in the Summary, before the bones were removed at all, it was necessary to agree that the bones would be reburied. While keeping the bones out of the ground may have provided more information, and the scientists involved would certainly have preferred to have had a longer time for study, reburial was one of the prerequisites to have any access to the bones. As noted in the Summary, the wishes of scientists can now no longer be considered most important; there are spiritual and ethical obligations to those peoples studied.

All these considerations went into the excavation and analysis of the skeletal remains. While the authors are responsible for the actual analyses of the materials and this report, we feel little else could have been done about the conditions and trying "political" situations under which the operation was done.

RESPONSE TO REVIEWERS: P. Willey

All of the deadlines associated with this project have been very tight, and the deadline for having the re-edited version back to USD by October 1, 1980, fits well this generalization. As a consequence of this deadline, the changes made in the manuscript necessarily have been those easily and quickly made. Other suggestions were equally good, but because of time limitations could not be included in this draft. In addition to incorporating some of the suggestions in the body of the report, I would like to take this opportunity to respond to the reviewers. First, general comments will be made, then specific items will be addressed, and finally the progress of further Crow Creek osteological study will be presented.

GENERAL COMMENTS

I was pleased to see the quality of many of the reviewers' comments and pleased with the many well-reasoned suggestions. Their time and concern for making the report a better one is appreciated. It was surprising how divergent--even contradictory--some of them were, though.

In this section of the response, the time and money limitation, use of destructive techniques, and the "Bass School" of osteology are considered.

Limitations of Time and Money

Some of the reviews seem to imply that time and money were of little consequence in the excavation, preparation, data collection, and analysis of the bones. Wishing that the Crow Creek bones might have been permanently taken to a well-equipped laboratory and studied over a period of years by a team of osteologists, generating and testing hypotheses indefinitely, does not in anyway erase the reality we faced in conducting the study.

There was a considerable amount of uncertainty in August, 1978, whether or not we would be allowed to inspect the bones at all. It was only reluctantly that the Crow Creek Tribal Council agreed to allow the excavation and removal of the bones. It might be argued that the present-day Crow Creek Indian Reservation has no legal claim to the remains or what should happen to them. Perhaps this, or something similar, will eventually be argued in court. But it was very obvious to those involved that neither the Corps of Engineers nor the archeologists could change any decision made by the Tribal Council. Under these conditions, the Tribal Council, in a split vote, gave permission to excavate and remove the bones for a temporary period, a period which ended May 31, 1979. This date was set and irreversible.

Funding for the excavation, processing, and analysis was provided by the Corps of Engineers. As it was, our modest financial proposal was cut by 20 percent. Funding was a distinct and important issue. Our report very directly shows the influences of the limited time and money available for the study. Perhaps it would be worthwhile reviewing the time limitations.

Processing the human remains was completed by January 1, 1979. Willey and Swegle spent three and five months, respectively, repairing, inventorying, organizing and collecting data. We were aided by two part-time assistants, Jeff Buechler and Roger Williams, and various volunteers. Given these constraints, we believe an admirable job of maximizing the information collected was done. The majority of the osteological data presented here was organized, statistically manipulated, analyzed and written during the five month period from April to August, 1979, by Willey, between obligations to another employer.

As a consequence of these limitations, I hope the reviewers can understand why some techniques which might have been used were not and why the manuscript is in parts rough and why some of the data collected were not analyzed, let alone presented. Although little can be done to correct the lack of certain techniques, work has continued on the analysis and writing on a part-time basis. This is the subject of another part of this response.

Use of Destructive Techniques

Two reviewers suggest that additional, destructive techniques should have been used to analyze the skeletal material. Thin-sectioning for dental and osteon age estimations and pathological analysis was not performed because the equipment and technical assistance were not available at USD. The techniques are also time-consuming and expensive, but perhaps the most serious objection is that the techniques are destructive.

Permission was never received from either the Corps of Engineers or the Crow Creek Tribal Council for modifying the bones in this way. While the Corps probably would have approved of destructive techniques, the Tribal Council did not. Without their direct approval, an absolute minimum of destructive techniques was used in our portion of the analysis.

The "Bass School of Bone Analysis"

We strongly object to the criticism that only the "Bass school of bone analysis" was represented by the osteologists studying the Crow Creek remains. Admittedly, Willey has been associated with Bass for a long time, as has Gregg, but Gregg's training was totally divergent from Bass'. Osteological specialists were specifically made aware that the analysis was about to begin when the position for an osteological assistant was announced by a flier sent directly to 26 osteologists at 23 universities and institutions. During this period, advice was directly sought from a number of prominent osteologists. Others certainly knew of Crow Creek and their advice and interest would have been welcomed.

In addition, efforts were made to notify the community-at-large of the Crow Creek research. The fact that the excavation and analysis of the Crow Creek material was happening was made apparent by the popular media, including the Associated Press, the New York Times News Service, and various radio and television stations. That the analysis was about to begin was announced in two professional newsletters, Paleopathology Newsletter and Anthropology Newsletter.

Seven people expressed an interest in independently studying the Crow Creek material. All were encouraged, though we had no money to aid them and the time constraints of the contract could not be altered. Four of the seven did come to inspect the remains

(M.P. Bumsted, University of Massachusetts-Amherst; Suzanne Bennett, University of Wyoming; James Sartain, University of Iowa; and Richard McWilliams, University of Nebraska). Certainly an attempt was made to interest osteologists of all "schools"--not just the "Bass school"--to conduct independent research on the Crow Creek material.

In searching for an osteological assistant, no attempt was made to limit the applicants to the "Bass school." Altogether 12 people expressed an interest in the position: 3 from the University of Tennessee, 2 from the University of Wyoming, and 1 each from the universities of Alabama, Arizona, Indiana, Iowa, Michigan, Nebraska and South Carolina. The osteologist selected was Mark Swegle, whose background includes work with Jane Buikstra, Northwestern University, and Della Cook, Indiana University. Swegle had never before been associated with the "Bass school." Swegle's work was coordinated with Willey's but was in large part independent of his. Following completion of the basic data gathering listed in the contract, Swegle executed studies of his own interest.

Clearly there was no attempt to exclude osteologists outside the "Bass school", but in fact a concious effort was made to interest and include other "schools" in the study.

If there is a "Bass school of bone analysis", it is regional, but not restricted in topic, as exemplified by the students recently and currently working on theses and dissertations under Bass. Who else would one turn to for a long-term, continuing interest in the human osteology of the Northern Plains, other than the "Bass school?"

Bass has worked with Northern Plains skeletal material for the past 25 years. Consequently, he and the osteologists associated with him have on hand the comparative data from Northern Plains sites which will make the Crow Creek skeletons interpretable in the context of Northern Plains skeletal biology.

We agree that an ideal approach to the Crow Creek skeletons, especially considering their uniqueness, would have been to organize a team of osteological specialists, each emphasizing his own specialty. Specialists in paleodemography, various subdivisions of paleopathology, growth and development, metric and non-metric cranial, dental, and postcranial distance studies would have been especially welcomed. But, as pointed out above, the situation surrounding the Crow Creek material was not ideal.

SPECIFIC COMMENTS

To answer some of the more specific criticisms mentioned by the reviewers, I have chosen to discuss the excavation procedures, then consider the non-pathological osteological sections in the order they appear in the body of the report, namely; element count, paleodemography, morphological distance and mutilations.

Excavation Procedures

One of the reviewers suggests that screening was not performed. I am under the impression that dry screening was a standard part of excavation, or at least it was during the period I was at the site, through August 26, 1978 (see EXCAVATION PROCEDURES section of report).

One reviewer states that because screening was not performed, the lack of fly puparia and beetle parts cannot be assumed to mean they were absent from the deposit. The reviewer cites two sources which used insect remains to indicate seasonality and exposure of the corpses (Gilbert and Bass 1967, Ubelaker and Willey 1978). Assuming the matrix at Crow Creek was not screened, it should be noted that none of the excavations in which the insect remains were found, reported by those authors cited, were screened. I find it highly likely that if insect remains had been associated with the human bones at Crow Creek they would have been noticed.

Element Count

One reviewer suggested that the articulations observed in the field should have been reported. Since the preliminary draft was written, the articulated units assigned in the field have been compared with the laboratory inventory and the units apparently noticed in the field but not assigned numbers have been inventoried. A tabularization, description, and discussion of the articulations will be presented in Willey's dissertation.

One of the assumptions made in estimating the village population at Crow Creek was questioned; namely, that all lodges were inhabited at the time of the raid. Not only is there reason to question this assumption, but the other assumption, that all lodges were counted and the habitation practices were the same as in the historic period, is questionable. Still, in spite of these tenuous assumptions, I feel that the exercise of estimating village size was worthwhile and the estimation is the most accurate possible at this time.

Paleodemography

Some of the reviewers questioned our methods, some our statistics and some of our results. These problems are considered in that order.

Methods: The need for X-raying the mandibles and maxillae of the subadults is clearly stated in the section on paleodemography. There is no reason to repeat those statements here.

While it is true that sex estimation of subadults is much improved in the last few years, it is still tenuous. Further, the Crow Creek material is not, contrary to what one reviewer has stated, an ideal sample for testing and developing new sex methods. The ideal sample for testing and developing new sex or age methods, for that matter, is one in which the actual biological age and biological sex are known (not just the osteological or dental age and sex) and in which the parts of the individuals are separated. None of these ideals are met in the Crow Creek material.

Statistics: The X^2 tests have been presented in a standard form, i.e., X^2 = ____, d.f. = ____, p< ____. While presenting contingency tables with expected and observed frequencies is sometimes done, it requires more manuscript space and was not considered worthwhile in these instances. Even the expanded version of this section will probably omit the contingency tables.

It is true that the Kolmogorov-Smirnov test is more appropriate for comparing two samples of ordinal level data than the X^2 which was used to compare the Crow Creek demographic profile with other samples.

The reason the Kolmogorov-Smirnov test is preferable is because it is a more robust test. The Kolmogorov-Smirnov test will be used in future versions of the manuscript. Nevertheless, if the only advantage of that test is its robustness, then little is to be gained over the X^2's, other than appropriateness, since the X^2's are all highly significant anyway.

Results: It is clear from the data that the Crow Creek demography is different from what one might expect, as one reviewer notes, but I can find no reference in the section CROW CREEK PALEODEMOGRAPHY as to it being <u>un</u>biased.

It is true that with the statistics used, females cannot be shown to be significantly absent from Crow Creek, a point made in the discussion on paleodemographic comparisons. Nevertheless, a closer reading of PALEODEMOGRAPHIC COMPARISONS will show that the discussion refers to the <u>Larson Village</u> sample, which does have significantly fewer females, not Crow Creek.

<u>Morphological Distance</u>

I truly regret that no dental casts were made, no dental measurements taken and no postcranial non-metrics observed. Dental casting would have taken additional time and personnel, which we lacked. Dental measurements were considered, but after inspecting a sample of the Crow Creek teeth, James Sartain, who had planned to gather that data, concluded that too many were cracked to conduct the study. As far as I know, postcranial non-metrics have never been shown to accurately display morphological distances.

Interobserver error was not tested on the cranial measurements or non-metric observations. Time simply did not permit it, though it could be tested on other material.

It is true that there are other non-parametric statistics more appropriate than the one used for the non-metric cranial observations, and they will be used in future drafts. Nevertheless, the uninterpretable results produced using Grewal's and Berry and Berry's techniques will unlikely be significantly altered using more sophisticated statistics.

One reviewer suggested that an assessment of the environmental variables should have been considered in the morphological distance discussion. Because morphology is generally considered to be the product of the genetic environment plus the non-genetic environment and the interaction of the two, the only way to adequately discuss the affects of the non-genetic environment on the distance analysis would be to have a twin study on hand. Such a study would compare monozygotic twins reared together and apart both in relatively rigorous environments. Since there apparently is no such study at the moment, it would have to be performed--a task clearly beyond the scope of this report! Consequently no such assessment of environmental variables was performed.

Mutilations

The point that illustrations are much needed, especially for this chapter, is well taken. Steps have been taken to correct the lack of illustrations.

I hope that our statements were not misconstrued, leaving the reader to believe that all the missing hands and feet were due to trophy-taking. As stated in the mutilation section and elsewhere in the report, there are a variety of explanations for the lack of hands and feet, only one of which is trophy-taking.

One reviewer suggested that the missing ends of the lower arm may have been due to "parry" fractures. While this is a distinct possibility, it can be tenatively checked using the data presented in Table 40. If some of the missing distal ends are lacking because of parry fractures, then we would expect the ulna (the bone more frequently involved in such fractures) to be more frequently broken than the radius. Inspecting the column "Snapped or Splintered", we find that in fact the distal radius is more frequently snapped or splintered than the ulna--the reverse of the expected. It should be stressed that this is a tenative assessment of this plausible explanation. Future drafts will consider the problem further.

PROGRESS OF THE CONTINUING CROW CREEK OSTEOLOGICAL STUDY

It is important to stress what has happened to the osteological data since the preliminary draft was written. In the year that has passed since the preliminary draft was submitted to USD, analysis and writing has continued on a part-time basis. Work is done between other obligations to another employer and in the evening.

In this manner, the method sections of the non-pathological chapters have been rewritten, tightening the prose, expanding the scope of the sections, more carefully detailing the methods used, and was submitted as Willey's dissertation proposal.

The proposal was delivered to his committee this past July, and with a few minor editorial changes, it was accepted. The revised method sections have not replaced the original ones in this draft because results and discussions would also need to be changed. The time allowed does not permit these changes.

In addition to the four chapters presented in this report, a fifth dealing with stature is to be added to the dissertation, anticipating the recommendation of one of the reviewers.

A sixth chapter will deal with the archeological context of the bones. The differences between the bones of Beds A and B are to be analyzed to determine the meaning of the superficial, overlying Bed A. The horizontal placement of the elements are to be studied to determine whether the elements were placed in the ditch randomly or nonrandomly. Statistical analysis of this data has just been performed. Lastly, the articulated units will be studied. The inventory of these units have been revised based both on field and laboratory observations and awaits statistical testing and analysis.

The life tables in the paleodemography chapter have all been recalculated. While no basic errors were present, the recalculated life tables should more accurately reflect the actual population structure of the Crow Creek villagers.

It should be clear that the analysis and write-up of the Crow Creek skeletons is not nearly complete but is continuing on a part-time basis. There are plans to present a much improved version as Willey's dissertation and to publish the work in a more accessible form. This preliminary draft is but a small beginning.

RESPONSE TO REVIEWERS: Mark Swegle

It was recognized from the beginning that the analysis of the human skeletal material from the Crow Creek site would be in some respects incomplete. Some of the restrictions surrounding this study were the limited amounts of time, money, and personnel to study the large amount of skeletal material. The remains of almost 500 people were available for study for only five months. Funding for only two full-time osteologists and two part-time assistants was provided during this period, though many others volunteered much time and help. Additionally, retention or destruction of the skeletal material was forbidden. This ruled out the use of techniques such as thin sectioning of bones and teeth, and the curation of these and other samples for further studies. The commingled nature of the bone deposit also restricted what could be done.

Given these restraints, it was decided to collect the most basic information first. Then could be considered what had been learned and then the remaining time could be spent in deciding what additional data should be collected. Inventory, minimum individual count, cranial and post-cranial reconstruction and measurement, age and sex determination, study of the mutilations, and a preliminary survey of the pathologies were considered to be the most important tasks to be completed. Against the background of what was known about Middle Missouri archeology and the Crow Creek site and with our interest in the factors which led up to the massacre, we decided to spend the remaining time, following the collection of basic data, studying some of the skeletal evidence for nutritional deficiencies and growth retardation. Data on cribia orbitalia and porotic hyperostosis were collected from all the crania, and all of the long bones were X-rayed so that the frequency and pattern of Harris lines in the population could be studied.

The work described above comprises the bulk of what was done with the skeletal remains. A more detailed listing of the data gathered is contained in Appendix A.

While we regret that it was impossible to do more and that the bones will not become available for future research, we were pleased to have had the opportunity to do as much as we did, and we hope that this work contributes to the understanding of South Dakota prehistory.

RESPONSE TO REVIEWERS: John B. Gregg

Most of the reviewers appear to have some concept of the severe difficulties which were encountered by those who participated in this project. As all are well aware, we were trying to run an uphill race while wearing hobbles on our feet and blindfolded. It is easy to overlook the fact that it was totally impossible to do here what would have been possible in a big city's well lighted and well heated laboratory, having adequate modern equipment and a sufficient time to complete all studies which might be dreamed up, with an adequate supply of funds to do all the various esoteric analyses.

There seemed to be some mis-interpretation of the use of the words "incidence" and "prevalence" in the discussion of osteopathology. The usage of these terms here was in accordance with their definition in Dorland's Medical Dictionary, Ed. 24. From previous studies there have been accumulated considerable data relating to certain diseases and anomalies as they were found in upper Missouri River Basin skeletons. Unfortunately, all that could be deduced from these data were indications of prevalence in the region (number of cases of a disease in existence at a certain time in a designated area). In a population such as Crow Creek one could hope to find some indication concerning incidence of abnormalities (rate of occurrance, such as the number of new cases of a specific disease occurring in a certain time), and thereby obtain much more significant information relating to the people and

and their health problems. Because the temporal bone count provided the most accurate estimate of the total number of individuals in the common grave and because there is much previous data relating to the temporals for comparison, an attempt to get information relating to the rate of occurrance of temporal bone abnormalities at Crow Creek was most important. If information could be obtained relating to approximate incidence of certain diseases and abnormalities in one portion of the Crow Creek skeletons, through cautious extrapolation it might be possible to estimate more accurately diseases elsewhere in the Crow Creek skeletons. Also, such carefully extrapolated data might be compared with that from other populations past and present. Because it was felt to be an insult to the reader's intelligence and to eliminate some redundancy in an already lengthy manuscript, a discussion relating to the meaning of the words, "incidence" and "prevalence" was omitted.

In the reviews of the project manuscript, some of the comments infer that assistance from sources other than "the Bass school of bone analysis" had not been sought. Such is not true. In the search for ideas as to how to best conduct the survey for osteopathology in the Crow Creek bones, contacts were made personally, by telephone, and by means of a short article and a note from the editor in the <u>Paleopathology Newsletter</u>, an international journal of Paleopathology. Very little response was received from these inquiries. Assistance was sought in the analysis of unusual bone tumors from the Armed Forces Institute of Pathology. A plea for assistance was made in a paper presented at the annual meeting of the International Academy of Pathology, held in San Francisco, on March 4, 1979. From this contact some helpful ideas were obtained.

It is my hope that these thoughts, my comments on the critique sheets, and other comments are helpful.

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