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A Biological Investigation of Skeletal Remains from the Mouse Creek Phase and a Comparison with Two Late Mississippian Skeletal Populations from Middle and East Tennessee

Donna Markland Boyd
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Donna Markland Boyd entitled "A Biological Investigation of Skeletal Remains from the Mouse Creek Phase and a Comparison with Two Late Mississippian Skeletal Populations from Middle and East Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

Fred H. Smith, Major Professor

We have read this thesis and recommend its acceptance:

Gerald F. Schroedl, Richard Jantz, William Bass

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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A BIOLOGICAL INVESTIGATION OF SKELETAL REMAINS FROM THE MOUSE CREEK PHASE AND A COMPARISON WITH TWO LATE MISSISSIPPIAN SKELETAL POPULATIONS FROM MIDDLE AND EAST TENNESSEE

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

Donna Catherine Markland Boyd

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DEDICATION

To Little Marigold, with love.

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to these data. Future use by others of raw data presented in this study must receive prior approval from the Museum and should include proper acknowledgment of their original source and the exercise of discretion and professional ethics in their interpretation and accessibility.

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No words can express the debt and love owed to my mother, Mrs. Mary G. Hurd, sister, Mary Ellen Markland, grandmother, Mrs. Elizabeth Hensley, and husband, Mr. Clifford Boyd, Jr.

ABSTRACT

This study examines the biological characteristics of the Late Mississippian Mouse Creek Phase skeletal series of Ledford Island, Rymer and Mouse Creek and relates them to other Late Mississippian skeletal populations (the Toqua and Averbuch samples) by using a comparative and holistic approach. The purpose of the study is to assess the biological relationships between these populations, based on the multidimensional biological variables of paleodemography, stature, paleopathology and craniometrics.

No evidence of significant Mouse Creek Phase demographic stress was found. All of the Mouse Creek Phase site populations exhibited low mortality, probability of death, and crude mortality rates and high survivorship and life expectancy values. In contrast, the Toqua and Averbuch populations manifested substantially greater degrees of demographic stress.

Stature estimates based on maximum femur mean lengths from all of the Mouse Creek Phase sites compared favorably to those recorded for other low-stressed Amerindian populations. No evidence of significantly reduced stature possibly indicative of environmental (nutritional) stress was found. In the comparative analysis, Averbuch and Mouse Creek Phase females differed significantly from each other and from all other sex and site groups.

Pathology class incidence was low across all of the Mouse Creek Phase sites, with Ledford Island exhibiting the lowest

(age-related) and Rymer the highest (infectious disease- and trauma-related) incidences. Pathology class incidences for all the Mouse Creek Phase sites were not nearly as high as expected for young subadults. Porotic hyperostosis/cribra orbitalia frequencies were significantly higher at Toqua than at Averbuch or the Mouse Creek Phase sites. Differential utilization of maize across the three populations or the erroneous association of these disease states necessarily with maize utilization were offered as possible explanations for the observed differences. A similar result in the periostitis frequency comparison was explained in terms of the greater length of occupation, more dense settlement distribution, and more central location of the Toqua site, resulting in higher possibilities of bacterial infection.

Finally, genetic relationships between these populations were explored via a canonical discriminant analysis of selected Toqua, Averbuch and Mouse Creek Phase site crania using eight craniofacial measurements. Biological relatedness was suggested between many of the Mouse Creek crania and the Toqua crania. Mouse Creek Phase and Toqua male crania showed similarities to each other, while crania from Mouse Creek Phase, Toqua and Averbuch females exhibited distinct differences. No evidence was found suggesting a close Mouse Creek Phase-Averbuch cranial association. These results, in combination with available archaeological data, strongly question the Mouse Creek-Middle Cumberland connection established by Lewis and Kneberg.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

TABLE | PAGE

TABLE PAGE

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

FIGURE PAGE

FIGURE PAGE

CHAPTER I

STATEMENT OF PURPOSE

The intent of this thesis is to examine from a biological perspective the skeletal remains from three Mouse Creek Phase sites in Southeast Tennessee, and to compare (using the interrelated biological dimensions of demography, stature, paleopathology and craniometrics) the results of this analysis to other Late Mississippian skeletal populations from the Toqua and Averbuch sites. This is done to assess the biological relationships between the Mouse Creek, Dallas and Middle Cumberland cultures, with the Toqua and Averbuch skeletal series selected as examples of the latter two cultures, respectively. While the Toqua and Averbuch skeletal samples may not be representative of the entire Dallas and Middle Cumberland populations, they represent the largest and most complete skeletal series available for these cultures.

Limited descriptions of the Mouse Creek Phase populations were compiled by Lewis and Kneberg (n.d.b., 1946, 1955, 1958), Lewis (1943) and Kneberg (1952), as well as Berryman (1975); however, no thorough examination of the skeletal remains recovered from the Mouse Creek Phase sites has been conducted. The primary goal of this study is to define the heretofore unknown biological variability of the Mouse Creek Phase individuals. Information regarding vital statistical data of mortality, longevity, fecundity and survivorship is gleaned through a paleodemographic analysis using age and sex

distributions obtained for each individual population. An examination of long bone length as it relates to stature also is conducted. Indications of stress in the populations, as evidenced by significantly reduced statute estimates, are emphasized. Further health/disease state indicators are explored in the paleopathological analysis and are integrated with the previous paleodemographic and stature analyses in order to arrive at an overall picture of the health status of the Mouse Creek Phase populations.

The second, but no less important, goal of this study is the comparison of the Mouse Creek Phase data to those from the contemporary populations of Averbuch and Toqua. Most of the skeletal data from these populations has been outlined by Berryman (1981, 1984a, 1984b) and Parham (1982), respectively. The purpose of the present study is to explain the biological variability observed across the three cultures in terms of each population's unique interaction with the Late Mississippian environment.

One means of measuring this interaction is through a multivariate study of crania from the Mouse Creek Phase, Averbuch and Toqua sites based on selected craniofacial measurements. This is conducted in order to more fully examine the biological relationships between the Mouse Creek, Middle Cumberland and Dallas cultures. Archaeological information concerning origins and affiliations of the cultures is integrated with the statistical study.

Thus, this study relies on the traditional anthropological comparative and holistic approaches. It is <u>comparative</u> in its

attempt to discern biological similarities and differences in Mouse Creek Phase, Toqua and Averbuch individuals. It is holistic in its use and intercorrelation of archaeology and skeletal biology in outlining and explaining the observed variability across these groups.

CHAPTER II

ARCHAEOLOGICAL SETTINGS

I. INTRODUCTION

Precedent to the biological analysis of the populations in question is a consideration of their archaeological background and setting. This includes a brief discussion of the archaeological manifestations of the cultures represented, as well as descriptions and histories of investigations of the individual sites.

II. CULTURE AND SITE DESCRIPTIONS

The Mouse Creek Phase

The Mouse Creek Phase represents a Late Mississippian complex in eastern Tennessee. It was originally defined by Lewis and Kneberg (n.d.b., 1941) as a "Focus" on the basis of their investigations in the Chickamauga Basin in southeastern Tennessee in the late 1930s. It was later redefined as a "Phase" by Faulkner in 1972. The term "Mouse Creek" is derived from the names of two streams, North and South Mouse Creek, which flowed into the Hiwassee River in the Chickamauga Basin area. All of the originally defined Mouse Creek manifestations were located along the Hiwassee River, except for the northernmost Hampton site (in the Watts Bar Basin), situated along the main Tennessee River (Lewis and Kneberg 1941:7). A more recently discovered Mouse Creek component at the Moccasin Bend site

also lies along the Tennessee River (Quentin Bass, personal communication 1984).

Lewis and Kneberg (1941:7) define the Phase in the following manner:

> The [Phase] is characterized by large sedentary communities located on the fertile bottom lands or on large islands. The subsistence basis was predominantly agricultural, although hunting and the gathering of wild plant foods were important supplements. The corn grown showed six, eight, ten and twelve rows of kernals, the larger number of rows being characteristic of the corn raised in the later period of aboriginal occupation of the Chickamauga Basin. Beans and squash were also cultivated. The bones of deer, rabbit, squirrel, wild turkey, turtle and fish were abundant in the refuse of Mouse Creek communities.

Temporal boundaries for the Phase can only be estimated. Small numbers of European trade items in a few of the burials (especially at Hampton), as well as the excellent conditions of uncarbonized pine wall posts (still containing resin) in many of the Mouse Creek structures led Lewis and Kneberg (1941:7) to interpret the Mouse Creek Phase as a relatively late (protohistoric) occupation. They also proposed a relatively brief time span for the Phase--between A.D. 1540 and 1714. They reasoned that since <u>no</u> important towns or settlements were noted along the Hiwassee by De Soto in 1540 (Lewis and Kneberg 1941:11), Mouse Creek must have postdated De Soto's exploration. Also, assuming that Mouse Creek represented historic Yuchi, Lewis and Kneberg based the terminal date for the Phase on the destruction of the last Yuchi town. In addition, the archaeological configurations of the Mouse Creek Phase sites suggest

they were occupied only for a brief amount of time. Garrow (1975:83) has suggested a tentative date restriction to the 16th century based on the supposed relatedness of the King site in northwest Georgia to the Phase (see also Blakely 1984). A recent radiocarbon date of 450 +/- 50 years: A.D. 1500 (A 3342) was obtained for one of the Mouse Creek sites (Ledford Island). The corresponding dendro-calibrated date range (Damon et al. 1974) of A.D. 1420-1470 indicates a similar, although somewhat earlier time period.

Because of the restricted distribution of the Mouse Creek Phase sites mainly along the Hiwassee River, Lewis and Kneberg (1941) and Kneberg (1952:198) differentiated the Phase from the more prominent Dallas manifestations. The Mouse Creek culture was seen as consisting of small enclaves of people living contemporaneously with but peripheral to the larger Dallas populations. Lewis and Kneberg (1941) based these distinctions primarily on significant variability in trait lists of the following four archaeological categories: (1) Community plan--Mouse Creek settlement pattern was described (Lewis and Kneberg 1941:7) as consisting of closely grouped dwellings of an orderly arrangement, occasionally surrounding an open courtyard. All of this was enveloped in a palisade. In contrast to this "open court" plan, the Dallas community structure was defined as the "compact, stockaded village type with the dwelling houses adjacent to a prominently located community center" (Lewis and Kneberg 1941:12). Lewis and Kneberg also cited the absence of Mouse Creek mounds as a basis for the Mouse Creek-Dallas

differentiation and also perhaps further evidence of the short time span of Mouse Creek occupation. However, this interpretation has since been questioned. Garrow (1975:77) believes that this mound dearth reflects simply the "frontier position" of the Mouse Creek villages, and should not be considered a definitive Mouse Creek trait; (2) Architecture--Mouse Creek house type consisted of substructure floors--"The floor level was excavated into the ground to depths averaging one and a half feet" (Lewis and Kneberg 1941:7). Also, entrances to these structures were of the exterior vestibule type--". . . the walls were evidenced by narrow trenches. It seems probable that either small saplings or canes were set contiguously in the trenches and plastered on the outside" (Lewis and Kneberg 1941:8). Dallas structures generally exhibited neither substructure floors nor exterior vestibule entrances, according to Lewis and Kneberg (1941:8). However, more recent research (Polhemus 1984) has shown that many Dallas structures do possess vestibule entrances; (3) Mortuary Pattern--Mouse Creek dead were commonly interred near dwellings in "well made oblong pits with vertical sides and flat bottoms" (Lewis and Kneberg 1941:8) often with log, bark, or pottery (especially with infants) coverings. Limestone capstones were noted in a few instances. The majority of the individuals exhibited an extended mode of burial (Lewis and Kneberg 1941:8; Kneberg 1951:198), although a few flexed and semi-flexed skeletons were observed. Numerous multiple interments were recorded (although much of this has since been ascribed merely to reuse of burial pits). Grave

acoutrements were noted as being few and mainly utilitarian. In contrast, Dallas burials were for the most part flexed or partly-flexed. Multiple inhumations were less common, while more ceremonial grave goods were included; (4) Ceramic industry--Mouse Creek pottery was described as being "tempered with crushed mussel shell and was generally a rather coarse ware" (Lewis and Kneberg 1941:8). This category shows the most similarity between Mouse Creek and Dallas in that most of the Mouse Creek ceramic types are related to Dallas (perhaps even Dallas derived), only less elaborate. However, the absence of any significant amount of cord-marking on Mouse Creek Phase ceramics (Lewis and Kneberg 1941; William Baden, personal communication 1984) is a notable difference.

Based on the above differences, Lewis and Kneberg (n.d.b., 1941, 1946, 1958), Lewis (1943) and Kneberg (1952) hypothesized that the Mouse Creek Phase individuals represented a distinct, intrusive ethnic group--the Yuchi, having origins in the Middle Cumberland culture in Middle Tennessee. Kneberg (1952:198) speculated that the Yuchi possibly acted as a "buffer" between the Dallas and the encroaching Cherokees. An end to this arrangement was met in 1714, when two revenge-seeking local traders instigated the destruction of the last Yuchi town of Chestowa by the Cherokee. The remaining Yuchis abandoned the region and were incorporated with the Creeks (Bauxar 1957a, 1957b; Lewis and Kneberg 1946:12).

While a multivariate analysis of crania from Mouse Creek, Dallas and Middle Cumberland cultures by Berryman (1975, 1980)

generally supported this Middle Cumberland connection, other researchers are more dubious. For example, Mason (1963:550-551) has questioned the association between Mouse Creek and Yuchi since it was based only on Swanton's tenuous identification of the Yuchi with the Chisca, a Mouse Creek affiliate. This, in turn, was based upon geographical inferences made during the historic period. Instead, Mason has noted the closer association of Mouse Creek with the Dallas culture as a result of her comparison of an Alabama Yuchi site with Mouse Creek. Garrow (1975) believes that Mouse Creek is affiliated with certain sites (specifically the King site, Carter's Dam site, Bell Field and Little Egypt sites) in northwest Georgia and that these sites are, in fact, more representative of the Mouse Creek Phase than are the sites in southeastern Tennessee. An analysis of Mouse Creek Phase archaeological and social dimensions based on the Tennessee material is currently being conducted. This research should help clarify uncertainties concerning the origin and affiliation of the Mouse Creek Phase.

The Mouse Creek Phase Sites

The construction of the Chickamauga Dam and Reservoir by the Tennessee Valley Authority through the Works Progress Administration precipitated the excavation of thirteen sites in the Chickamauga Basin under the direction of T.M.N. Lewis and M. Kneberg from 1936-1939. Of these sites, four exhibited Mouse Creek Phase components. Three of the sites, all located near the confluence of

North and South Mouse Creeks with the Hiwassee River (Figure 1), became the "type" sites for the Mouse Creek Phase--the Ledford Island site (16BY13), the Rymer site (15BY11) and the Mouse Creek site (3MN3 and 4MN3). These three sites are utilized in this analysis, since they exhibit the best preserved and largest Mouse Creek Phase skeletal samples (Total n=799). A fourth Mouse Creek skeletal series from the site of Ocoee was not included in this study due to poor preservation and small sample size. The following site descriptions are based on the well documented field reports of Charles Fairbanks, George Lidberg and Stuart Neitzel (Fairbanks 1937; Fairbanks and Lidberg 1938; Neitzel and Fairbanks 1938), as well as Lewis and Kneberg (n.d.a., n.d.b.).

Ledford Island (16BY13). The Ledford Island site was located near the southern head of an island situated in the Hiwassee River approximately one and one-half miles downstream from the North Mouse Creek mouth in Bradley County (Figure 2). The 234 acre island was very level with rich soil and had been intensively cultivated for some time. Although exposed to flooding each year, the portion of the island containing the site was not usually affected by the annual inundations of the Hiwassee River. Excavations were conducted from May 1938 to March 1939 and unearthed at least 20 village (habitation and community) structures surrounding a probable open courtyard which was for the most part free of structures, burials or midden accumulation (Figure 3). Only about 1.75 (11.62%) of the estimated

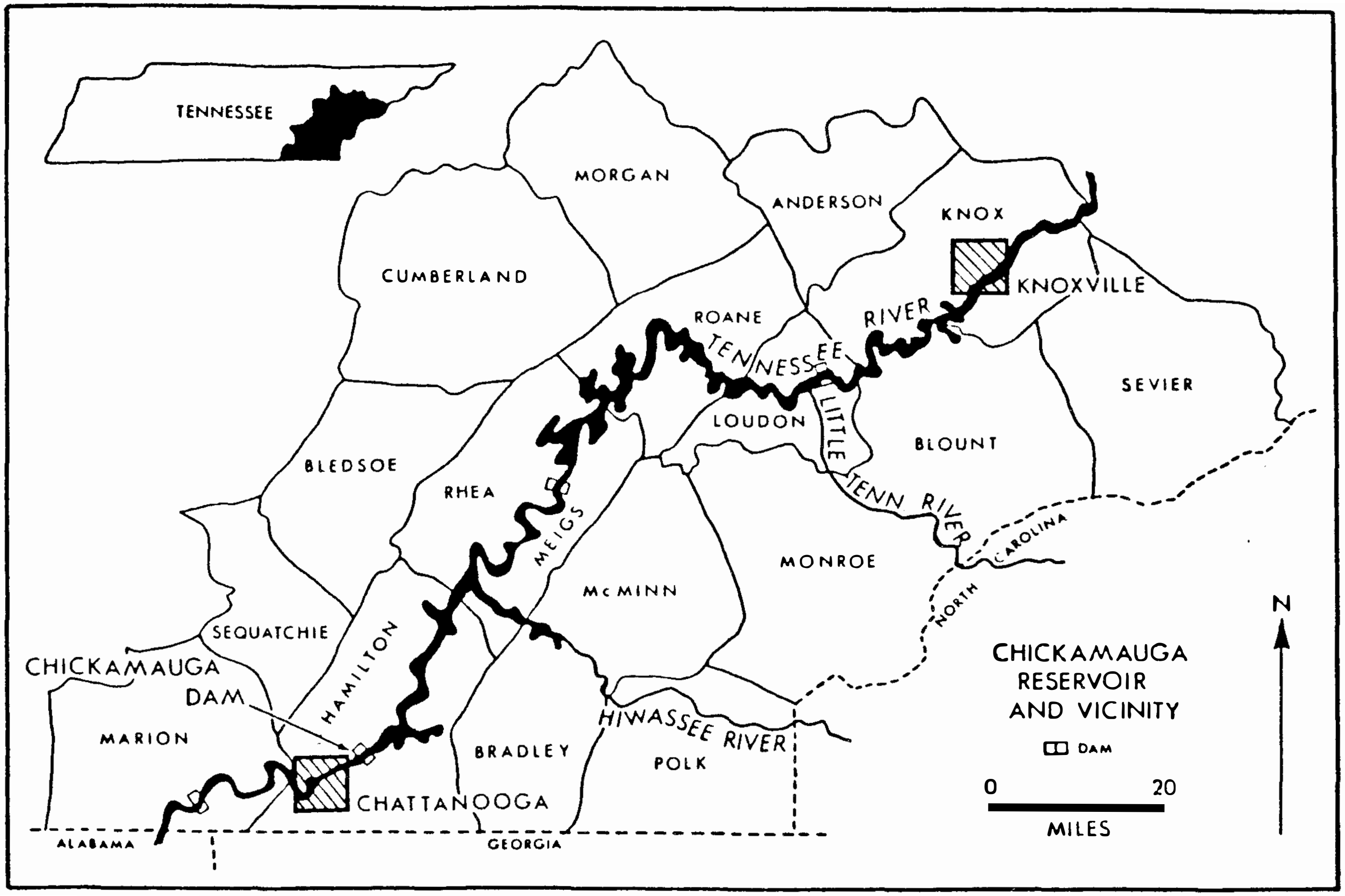


Figure 1. Location of the Chickamauga Dam and Reservoir in Southeastern Tennessee.

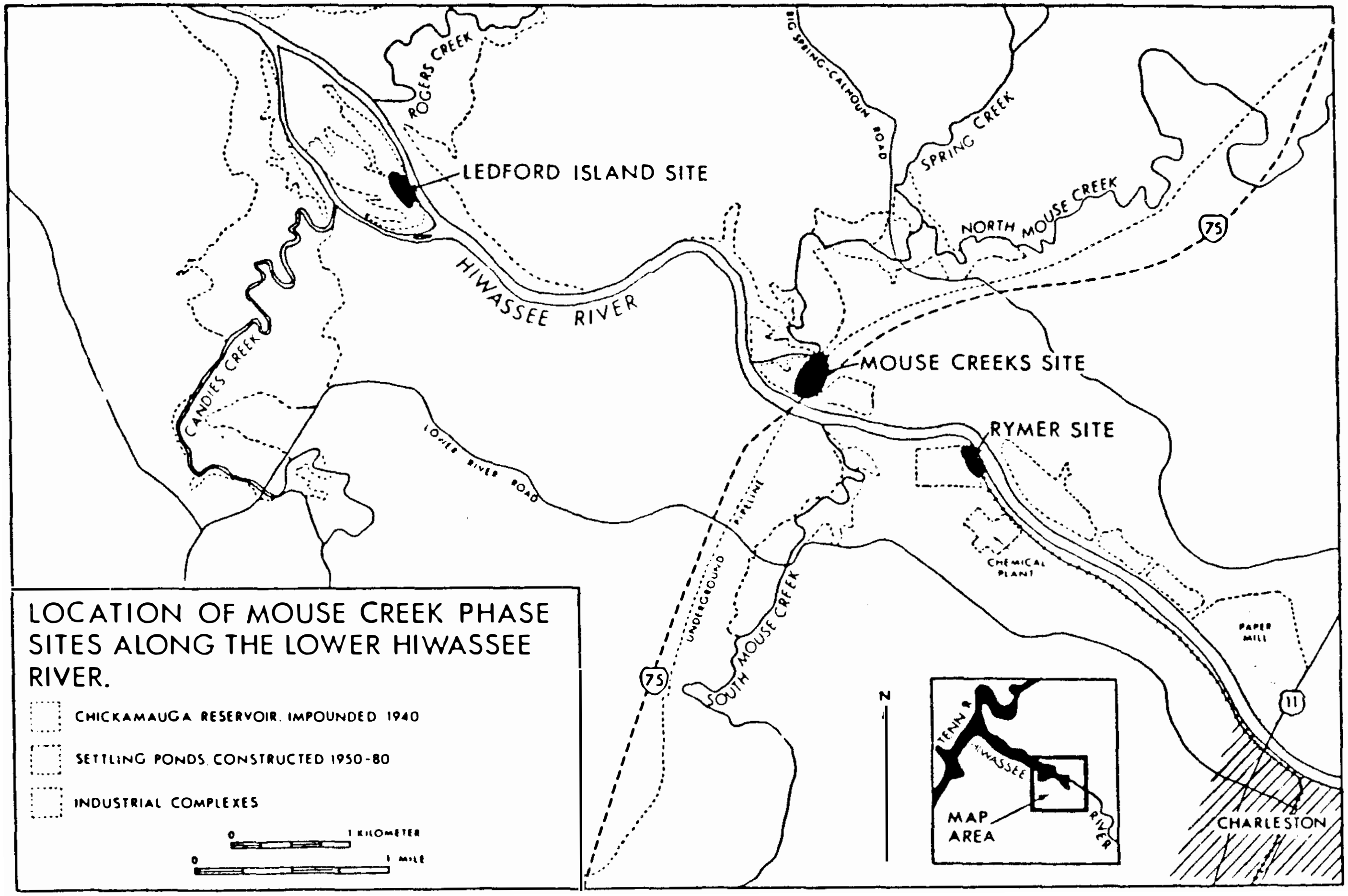


Figure 2. Location of the Mouse Creek Phase Sites Along the Lower Hiwassee River.

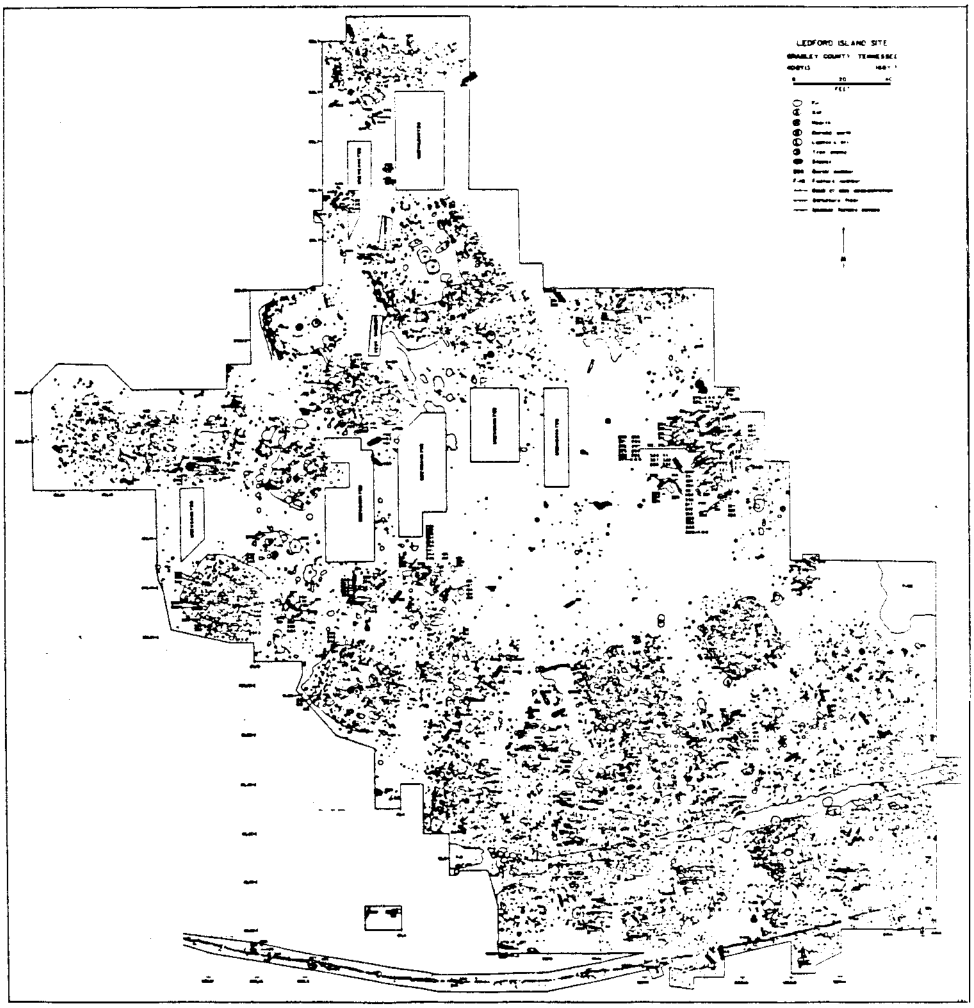


Figure 3. Generalized Excavation Plan of the Ledford Island Site.

15 acres of the total site area was excavated. A ditch 7 ft wide and 2 to 3 ft deep ran parallel with a palisade that surrounded much of the village. Two components were discerned at this site--an earlier and smaller Candy Creek (Middle Woodland) component which was overlain by the more extensive Mouse Creek Phase.

Burials were found scattered throughout the village area (excluding the courtyard), but Fairbanks and Lidberg (1938) reported that "in houses and around them were concentrations of burials that suggest cemeteries." A group of burials to the east of the site near the river bank numbering 73 of the total 462 was said to "unquestionably" represent a cemetery. Two stone box graves were present. Many sherd covered infant remains were found, always associated with house floors. Extended burials were most numerous; however, several flexed or semi-flexed individuals were noted. No temporal relationship could be established between these different burial modes.

Field reports indicate that Ledford Island was probably occupied for a longer period of time than the other Mouse Creek sites: more instances of superimposed multiple house patterns were found, with, in many cases, no clear pattern emerging from the postmolds. Circular cache pits were also common. A carbonized post which was recently parrafin-decontaminated and radiocarbon analyzed by L. Peters (personal communication 1984) yielded a date of A.D. 1420-1470.

Based on ethnohistoric evidence, Lewis and Kneberg (1946) believed that Ledford Island represents the Yuchi town of Amoye.

The site was not affected by the Chickamauga Reservoir inundation and remains intact today.

Rymer (15BY11). The Rymer site, located on the south bank of the Hiwassee River one mile above its confluence with South Mouse Creek in Bradley County (Figure 2), was the first Mouse Creek site excavated (August 1937-February 1938). Located on a high river terrace, this site area was also intensively cultivated. Two components were identified at the site--Component I was a small Late Woodland, Hamilton manifestation consisting primarily of three low burial mounds. One-half mile downstream was the much more extensive Mouse Creek village component. Approximately one acre (20.83%) of the estimated total site area of 4.8 acres was excavated (Figure 4). Approximately 34 structures (many of which had burned) and 168 burials were located. Fairbanks (1937:7) notes a distinct homogeneity of house, burial and material culture patterning. No indication of a cemetery was noted. In fact, there was a uniform, systematic orientation of structures with burials, suggesting that the dead were buried in close proximity to their respective houses.

Based on ethnographic inferences as well as archaeological data (presence of burned structures), Bauxar (1957b:408) has suggested that the Rymer site was the probable location of the previously mentioned Yuchi town of Chestowa (or Chestowee). The Rymer site is now the home of a chemical plant and associated settling pond (Peters 1981:4).

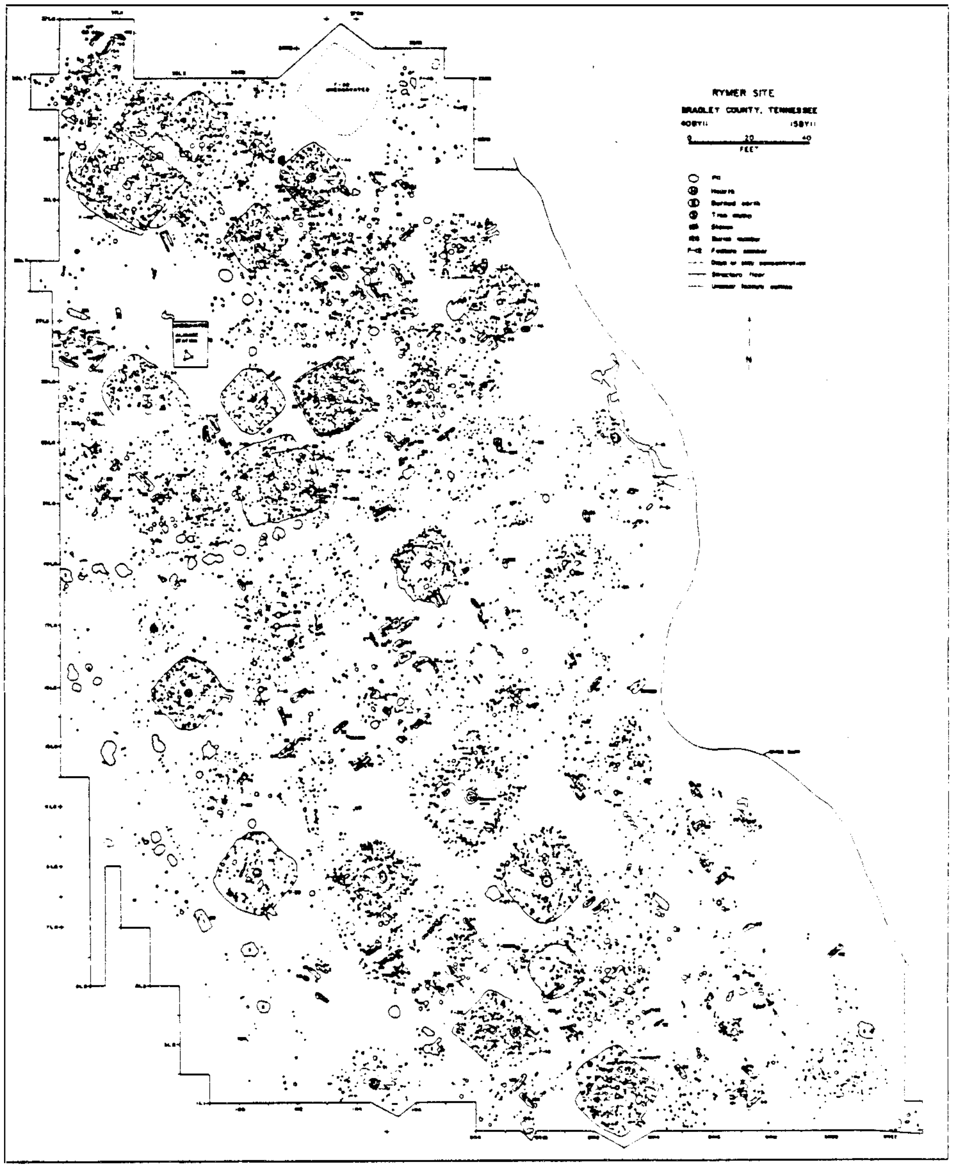


Figure 4. Generalized Excavation Plan of the Rymer Site.

Mouse Creek (3MN3 and 4MN3). The Mouse Creek site, located one mile downstream from Rymer on the north bank of the Hiwassee River (Figure 2) in McMinn County, consisted of two large village units (3MN3 and 4MN3), 1000 feet apart with no indication of cultural debris between them. However, many historic accounts note considerable flooding in this area with many skeletons and artifacts being washed away. Thus, although it is believed to be the largest of the three Mouse Creek Phase sites, an estimate of the total Mouse Creek site size is impossible. Three archaeological components were identified: Hamilton, Hiwassee Island and Mouse Creek. Approximately one acre of the southern unit (3MN3) was excavated with 82 burials, 15 structures, 2 palisade portions and numerous miscellaneous features being recovered (Figure 5). A basal portion of a Hamilton mound was also present. About 0.6 acre was excavated from the northern (4MN3) unit producing 87 burials, a palisade and 9 structures and numerous features (Figure 6).

These two sample units were combined in the following analyses. The Mouse Creek site was completely destroyed by the construction of Interstate Highway 75 and the excavation of a paper mill settling pond (Peters 1981:4).

The Dallas Phase

Like the Mouse Creek Phase, the Dallas Phase was originally defined by Lewis and Kneberg (1946:10) as: ". . . a Middle Mississippi culture that followed the Hiwassee Focus as the dominant

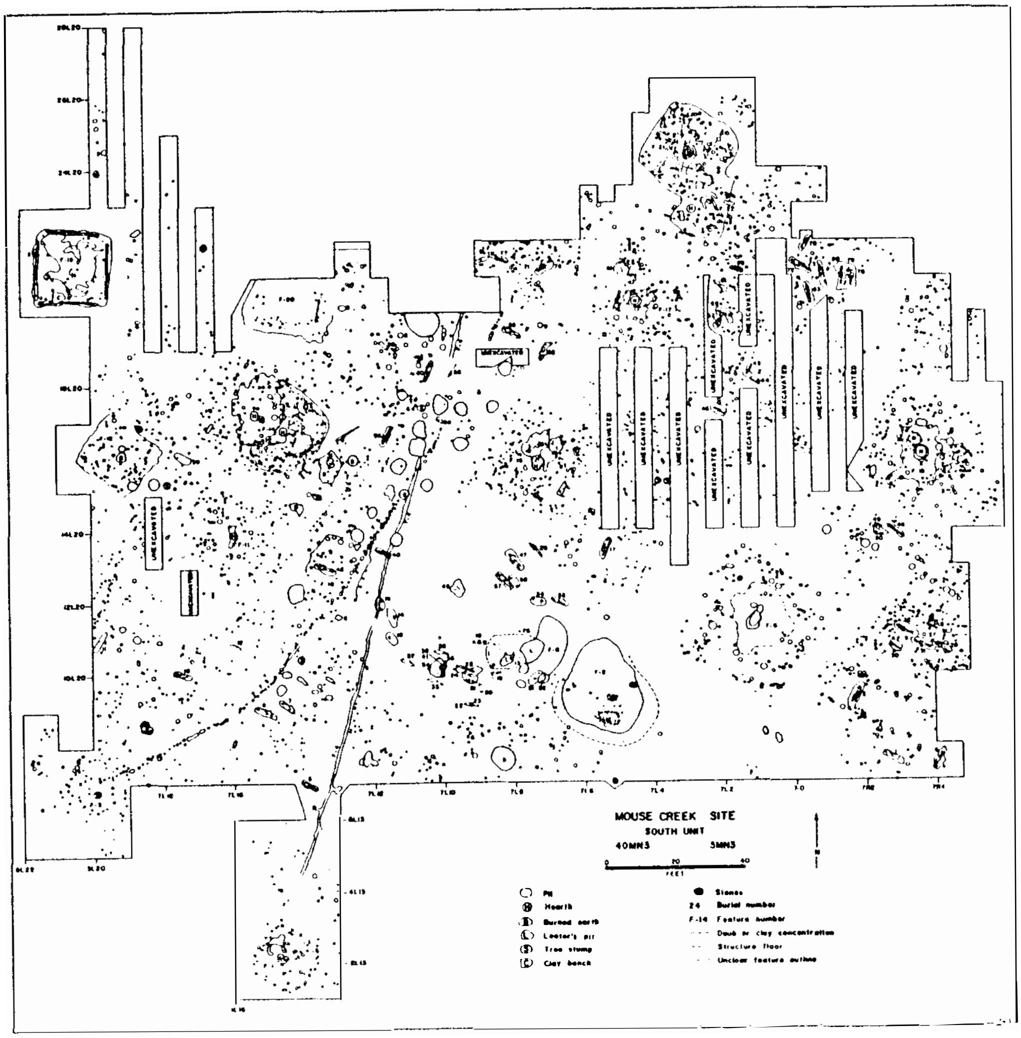


Figure 5. Generalized Excavation Plan of the Mouse Creek Site (South Area).

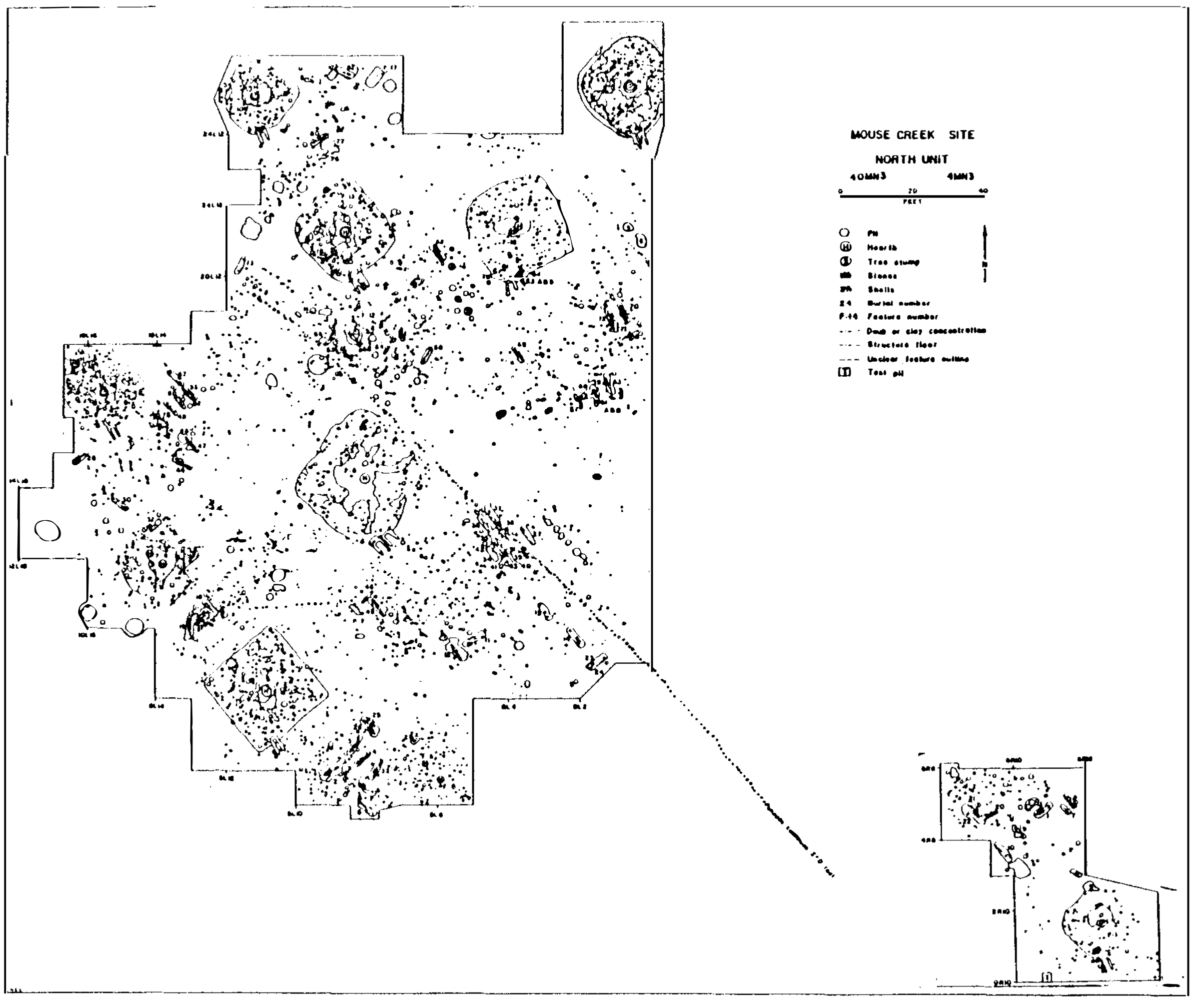


Figure 6. Generalized Excavation Plan of the Mouse Creek Site (North Area).

culture of the Eastern Tennessee Valley." They saw the Dallas people as being intrusive to the area, eventually merging with the Hiwassee Islanders. They based this hypothesis on the results of William S. Webb's (1938) investigation of 23 sites in the Norris Basin and subsequent differentiation of small (Hiwassee Island) versus large (Dallas) logged structures. The "replacement hypothesis" noted above is now generally disregarded by most researchers in light of evidence of cultural continuity between the Hiwassee Island and Dallas Phases in the eastern Tennessee region (Faulkner 1975).

Available temporal data in the form of a few radiocarbon dates designate a possible emergence of the Dallas Phase around A.D. 1250. Hatch (1976:130) and Parham (1982:4) suggest an ending date of possibly as late as A.D. 1600, with some manifestations lasting into the historic period.

One of the largest and most extensively documented and excavated representatives of the Dallas Phase is the Toqua site (40MR6). It is this site which will now be discussed in terms of history of investigation and overall site description.

Toqua (40MR6). The Toqua site was located on the south bank of the Little Tennessee River between river miles 23 and 25 in Monroe County, Tennessee (Polhemus 1984:1) (Figure 7). Situated on a second river terrace (Delcourt 1980) consisting of extensive bottomland well-suited for agriculture, it manifested essentially all periods of aboriginal occupation (Archaic through Historic Cherokee). Two

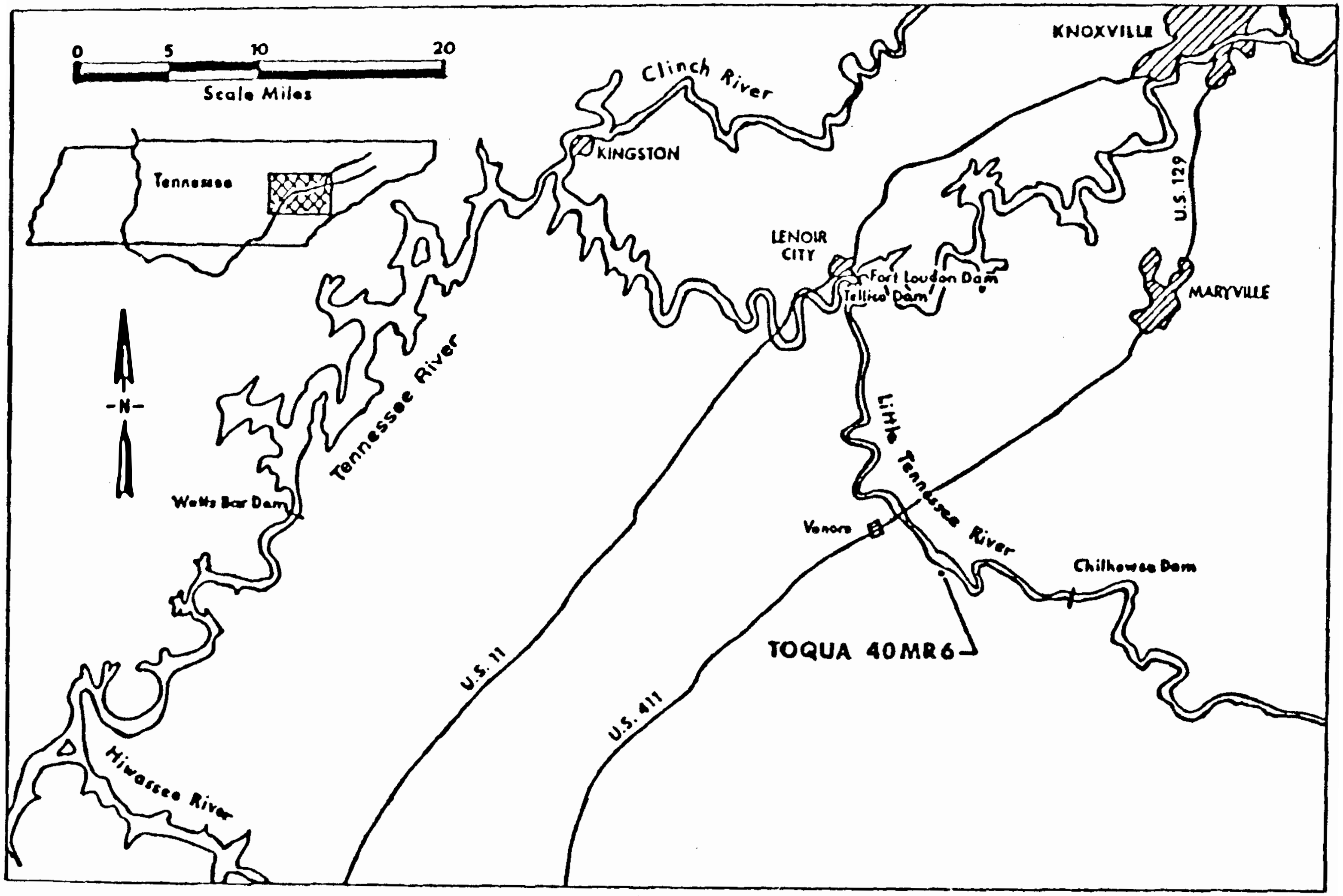


Figure 7. Location of the Toqua Site Along the Little Tennessee River (from Schroedl and Polhemus 1977).

Mississippian substructure mounds (Mound A--24 feet high; Mound B--at least 4 feet high) were present along with an estimated village area of 2000 x 600 feet.

In 1884, John W. Emmert, under the direction of Cyrus Thomas of the Bureau of American Ethnology, conducted the first documented investigation of the Toqua site. This work was commissioned as part of the attempt to disprove the Mound Builder theory--that a superior, unknown (non-Indian) race was responsible for mound construction in the east (Willey and Sabloff 1980:39-40). According to Polhemus (1984:13), "He [Emmert] utilized a combination of probing, auger testing, a central shaft, and shovel tests in addition to trenching to locate human burials." He removed 57 burials from the summit of Mound A (Toco Mound) and 14 from Mound B (Callaway). Testing was also conducted in the east village midden. Field observations (including grave lot and burial position) were recorded.

In the 1930s, George D. Barnes, with the help of hired hands, excavated large portions of the village area to the east of Mound A principally by means of a 500x8x5 foot trench. According to Polhemus (1984:14), "Barnes was a commercial collector who systematically mined the northwest quarter of the site for collectible artifacts." Skeletal material was peripheral to Barnes' goals and was subsequently discarded into the back fill. In addition, Barnes made minimal documentation of his work.

Plans to more fully excavate Toqua in the late 1930s through the WPA did not materialize, but this goal was finally realized

in 1975 as a result of TVA's purchase of the property in connection with the Tellico Dam Project. Work at Toqua was conducted by the University of Tennessee from March 1975 through March 1977, focusing on the Mississippian period occupation. Controlled surface collections were conducted. Excavations at Toqua focused on both Mound A (exhibiting nine construction phases) and B (consisting of two construction phases), as well as large portions of the Toqua village (approximately four acres total), wherein numerous structures, palisades and a plaza area were uncovered (Polhemus 1984) (Figure 8). Four major village plans were denoted (Schroedl and Polhemus 1977): the earliest consisted of widely spaced structures, while the remaining three exhibited a dramatic reduction of total habitation area and increase in (and perhaps doubling of) the density of the structures. This rebuilding perhaps corresponds to Polhemus' (1984:4) speculation concerning a fire destroying the original settlement and palisade. Polhemus (1984:4) also notes a final reduction in the Toqua site in the late 1600s-early 1700s corresponding to the Terminal Dallas Phase occupation. Total habitation area and, consequently, population size were significantly reduced. Reasons for this are unknown.

Descriptions of the skeletal biology, paleobotany and social dimensions relating to the Toqua site can be found in Parham (1982), Bogan (1980) and Scott (1983), respectively. In addition, a comprehensive review of all aspects of the site is contained in Polhemus (1984).

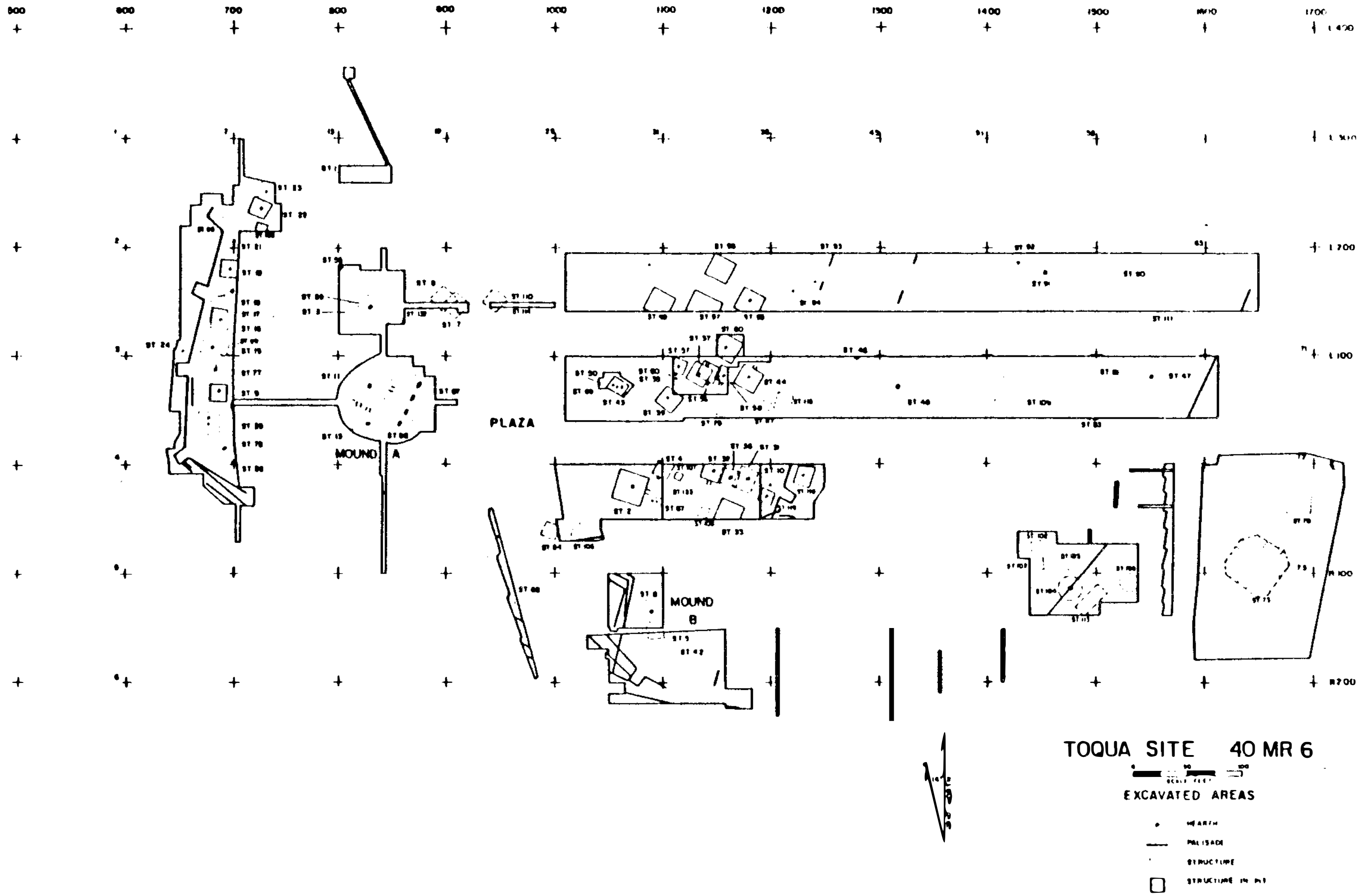


Figure 8. Generalized Excavation Plan of the Toqua Site (from Polhemus 1984:59a).

The Middle Cumberland Culture

A large number of stone lined graves has been located in the Nashville Basin section of Middle Tennessee. These are representative of the "Stone Box" or "Middle Cumberland" culture (Ferguson 1972). While considerations involving the skeletal remains have, in the past, been plentiful (Berryman 1975; Boyd et al. 1983; Dowd 1972; Thruston 1897; Ward 1972; Wright et al. 1973), archaeological data concerning the culture has been lacking. Some distinctive archaeological characteristics of the culture include the presence of hunch backed and blank faced effigy water bottles, filleted rim bowls and strap handled pottery (some with Southern Cult motifs) as burial associations (Boyd et al. 1983; Dowd 1972; Ferguson 1972). The culture is believed to have existed between the thirteenth and fifteenth centuries A.D., with a virtual vanishing of the Middle Cumberland people occurring prior to the eighteenth century (Berryman 1981:3). Ferguson (1972:45) suggests raiding from the northern Iroquois or epidemic disease introduced from the Spanish and French as two possible causes (not mutually exclusive) of the disappearance. In addition, Klippel (1984) points to the repeated utilization of anomalous, hinterland site locations (i.e., away from the major water source of the Cumberland Drainage area) as indicative of severe population pressure and stress in later Middle Cumberland manifestations. This could also have played a significant role in the demise of the Middle Cumberland culture.

The largest, systematically excavated Middle Cumberland skeletal series comes from the site of Averbuch (40DV60)--a Late Mississippian (circa 14th century, A.D.) village and cemetery complex located between the Nashville Basin and Highland Rim of Middle Tennessee (Berryman 1981:2). It is this site which is considered in the present study.

Averbuch (40DV60). The Averbuch site is located on the southern portion of a hill 300 meters east of Drake Branch in North Davidson County, Tennessee (Figure 9). Klippel (1984) notes that it is nearly 4 km from the rich Cumberland River Valley alluvial bottoms. Investigations of the site by the University of Tennessee and the Tennessee Division of Archaeology began with initial test excavations in 1975 and ended with final excavations in July 1978. These investigations were initiated to mitigate impact on the site as a result of the construction of the Royal Hills subdivision. The initial survey in 1975 revealed a village and cemetery area along with 49 stone-lined graves. Based on this, it was stated that the site dated between approximately A.D. 900 and A.D. 1200 and contained a total estimate of 150-200 burials (Klippel 1984:14.1). However, the first field season in 1977 demonstrated a much larger site than originally thought, as well as the existence of two additional cemeteries (Figure 10). A second season was needed to more fully examine the site. Subsequent radiocarbon dating and artifact analyses from Averbuch place the site in the 14th century A.D. (Klippel and Bass 1984).

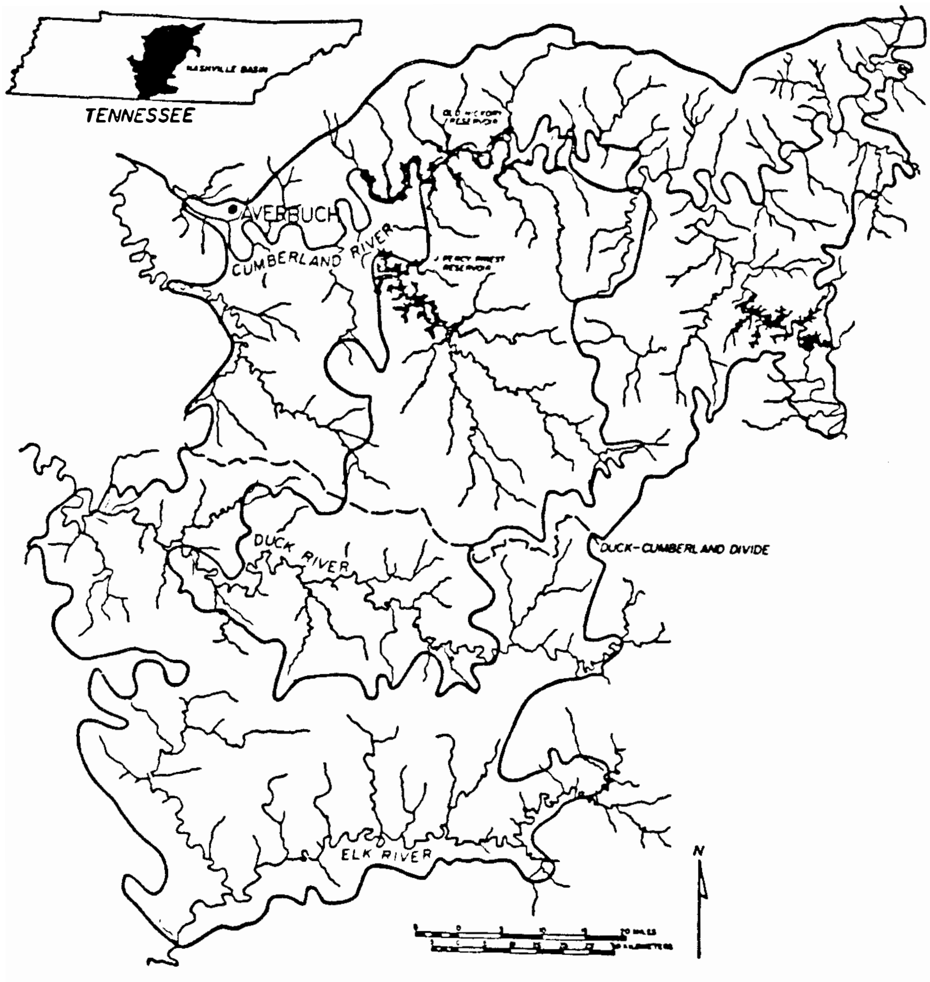


Figure 9. Location of the Averbuch Site in North Davidson County, Tennessee (after Berryman 1981:6).

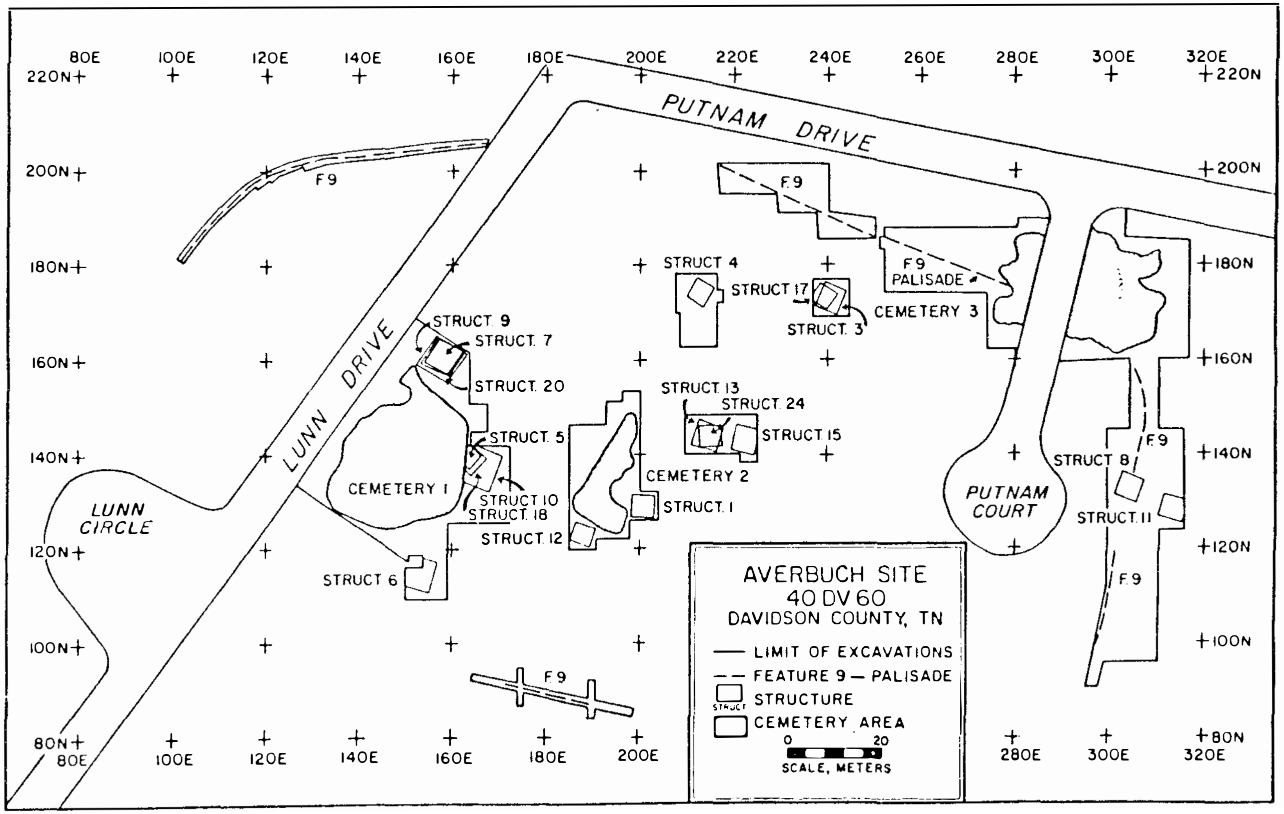


Figure 10. Generalized Excavation Plan of the Averbuch Site (from Berryman 1981:9).

Approximately 30% of the site had already been destroyed by construction (Berryman 1981:8). A total of 887 individuals were recovered, with another 409 estimated as missing or non-recoverable. The majority of the adult burials were associated with the three cemeteries, while most of the infant and fetal remains were buried in conjunction with structures.

Discussions relating to the skeletal biological data from the site can be found in Berryman (1981, 1984a), Guagliardo (1980, 1984), Jablonski (1981, 1984a, 1984b), and Guagliardo and Jablonski (1984), while a complete review of all aspects of the site is contained in Klippel and Bass (1984).

CHAPTER III

MATERIALS AND METHODS

I. THE DATA BASE

Approximately 799 individuals were recovered and were available for study from the three Mouse Creek Phase sites: Ledford Island (16BY13)--462 skeletons, Rymer (15BY11)--170 skeletons, and Mouse Creek (3MN3 and 4MN3)--167 skeletons. Although all of these individuals were examined by the author with respect to age, sex, pathologies and other variables, only 771 individuals were utilized in the following study--28 individuals from the Mouse Creek site were associated with a Late Woodland Hamilton mound, and thus were excluded from the analysis. Also, 27 Ledford Island, 6 Rymer, and 23 Mouse Creek specimens had been discarded by Lewis and Kneberg in the field at the time of excavation due primarily to poor bone preservation. Many of these individuals were small infants. Original laboratory records denoting the general sex and age of these individuals were integrated with the present study.

The preservation of the Mouse Creek Phase skeletons was quite variable, ranging from very good to very poor. However, the majority of the individuals lay on the average to poor end of the preservation continuum. Thus, complex and extensive (not to mention expensive) techniques normally reserved for better preserved skeletons (such as X-raying for Harris Lines and Enamel Hypoplasia, conducting

trace element analyses, etc.) were deemed inappropriate for the Mouse Creek Phase specimens.

For the most part, the original skeletons from Averbuch and Toqua were not analyzed by the author. Instead, the data utilized were taken from previous research by Berryman (1981, 1984a and 1984b) and Parham (1982), respectively. Approximately 887 individuals from Averbuch and 439 individuals from Toqua constituted this data set.

II. AGING AND SEXING TECHNIQUES

One prerequisite to an adequate demographic analysis is an accurate determination of age and sex of the skeletons involved. Original aging and sexing of each individual was conducted by Lewis and Kneberg as well as others in the early 1940s (Lewis and Kneberg n.d.a.) and exists on burial cards on file in McClung Museum at the University of Tennessee. However, due to their reliance, at times, on unsound aging criteria such as cranial suture closure, and with the proliferation of new and better aging and sexing techniques within the last 10-20 years, a reanalysis of the skeletons with respect to sex and age was necessary. As a test, a 5% sample was randomly chosen (via the R NON:IDA computer program) from each of the three Mouse Creek Phase sites. These individuals were examined with respect to age and sex and the results were compared with the data contained on the burial cards. As can be seen in Table 1, some significant differences were found with respect to both sex

Table 1. Test Comparison of Mouse Creek Phase Aging and Sexing Data from Original Burial Cards and the Author's Reanalysis Using a 5% Random Sample.+

Site/Ind.	Burial Card	Reanalysis
15BY 34	Infant (0-7)	1-4 (1.25-1.5)
35	Infant (0-7)	5-9 (8-9)*
41	Infant (0-7)	0-1 (.75)
56	Child (7-13) and Adult I (19-39)	SubAd + Adult I (Burned)
60	Infant (0-7)	0-1
109	Adult (32) M	40-50 M*
122	Child (7-13)	1-4*
136	Mature (40) M	40-50 M
4MN 28	Child (8)	5-9 (7-9.5)
49	Juvenile/Child (7-13) I	10-14 (10.5-12)
56	Child (7-13) I	5-9 (7-8)
80	Adult (35) F	30-40 M*
3MN 3	Adult (19-39) F	Adult I
25	Adult (19-39) F	Adult I
78	Adult (19-39) I	Adult I
16BY 1	Infant (0-7)	0-1
28	Juvenile (15) M	10-14 (10-11)*
40	Child (7-13)	5-9
72	Infant (18 Months)	1-4 (1-1.25)
105	Infant (0-7)	0-1
107	Adult (25) F	25-29 F
170	Mature (40) I	35-39 M
202	Adult (43) M	35-39 M*
237	Infant (2.5)	1-4 (1.5-2.5)
252	Mature/Adult (19-39) I	Adult M
255	Mature/Adult (19-39) I	Adult F
273	Adult M?/I	Adult I
303	Adult (19-39) I	20-24 F
317	Adult (19-39) I	1-4*
323	Adult (19-39) M	Adult I
338	Senile/Adult I	Adult I
347	Juvenile (6)	5-9 (5-6)
376	Infant (0-7)/Child (7-13) I	0-1
388	Adult (19-39) I	Adult I
399	Adult (35) F	25-29 F*
406	Child (7-13)	5-9
433	Mature (50) M	50+ F*

*Denotes Incongruous Results.

+I = Indeterminate Sex; F = Female; M = Male.

and age. After a general analysis of the skeletons was conducted, all of the Mouse Creek Phase individuals were examined a second time to verify the original results and to fine tune the aging for the demographic analysis.

Subadult age estimation was based on epiphyseal closure of long bones, dental eruption and calcification, and long bone lengths. Estimation of age according to epiphyseal closure followed McKern and Stewart (1957). Dental eruption was compared to Schour and Massler's (1941) chart of dentition. Dental calcification analysis followed Moorrees, Fanning and Hunt (1963a, 1963b). Since most of the teeth were either loose in the sockets or free altogether, X-rays were not utilized. Subadult long bone lengths were compared to Johnston's (1962) Indian Knoll long bone lengths as well as Merchant and Ubelaker's (1979) Arikara lengths.

Adult aging was based on visual comparison of pubic symphyses to the McKern and Stewart (1957) male casts and the Gilbert and McKern (1973) female casts. Degenerative changes, including degree of vertebral osteoarthritic lipping (Stewart 1958), lowering and broadening of the five lumbar vertebrae (Ericksen 1976, 1978a, 1978b), and dental attrition and loss, were also considered. Comparison of the coronal, sagittal and lambdoidal ectocranial sutures to McKern and Stewart (1957:28-30) and endocranial sutures to Todd and Lyon (1924:345, 351, 357) was only used as an aging supplement, since much variability exists in rates of suture closure (Singer 1953:56).

Sex estimation was based on visual observation of morphological features of the innominate and cranium. Classic cranial traits used included size of browridges (Bass 1971:72; Keen 1950:69-70), shape of upper eye orbit borders (dull versus sharp), degree of muscle markings (Keen 1950:69-70), shape of chin (square versus round) (Bass 1971:73), size of mastoid processes and overall appearance (robust versus gracile) (Bass 1971:74; Keen 1950:68-70; Krogman 1978:115). Innominate features considered included length of pubic portion and width of sub-pubic angle (Bass 1971:157), width of sciatic notch, degree of build-up of bone on the sacro-iliac articular surface (Bass 1971:159), presence of a ventral arc or sub-pubic concavity, width of the medial aspect of the ischio-pubic ramus (Phenice 1969:298-300) and the shape of the pre-auricular groove (Houghton 1974:381). The diameter of the femoral head as compared to Thieme and Schull (1957:249) was also used as a supplemental sex indicator as well as the curvature of the sacrum (Bass 1971:89). Anthropometric measurement of the cranium and the computation of a discriminant function for sex according to Giles and Elliot (1963) was employed only rarely, since the excessive incidences of cranial deformation, cranial warping, cranial fragmentation, and previous poor cranial reconstruction made this difficult. Sexing criteria were not applied to subadults (below 15 years). Appendix A contains the author's assessment of the ages and sexes of all of the Mouse Creek Phase skeletons.

III. DEMOGRAPHIC METHODOLOGY

The demographic methodology utilized in this analysis follows the life table approach as outlined by Acsádi and Nemeskéri (1970). In contrast to Bennett's (1973) United Nations Model Life Tables approach where r, the intrinsic rate of increase for a population, must be approximated, and Angel's (1971) comparison of mortality and fecundity where the number of births must be estimated from parturitional pits of female pubic bones, the life table approach only requires the age distribution at death for a population. Prior to the life table construction, all of the Mouse Creek Phase individuals were placed into five year age intervals with the exception of the first (0-1 year), second (1-4 years) and last categories (50+) (Tables 2, 3, and 4). Since the infant/early child period is considered a "high risk" time, it was felt that better control could be kept (with minimal loss of data) over this period by separating it into two sections. Also, the final age category reflects the inability to precisely determine the upper age limits of the populations. The 40-44 and 45-49 categories are simply the 40-50 (initial) category halved. Age category intervals follow standard statistical designations (Thomas 1976:44). For example, the 5-9 age category contains individuals ranging in age from 4.5 to 9.499 years. Since the subadults were not examined with reference to sex, the sex ratio is assumed to be 1:1 and, thus, sex specific data is obtained by halving the total number of individuals for each age category up to and including 14.

Table 2. Age and Sex Distribution of Skeletons from the Ledford Island Site.

Age Interval	Male	Female	Unknown	Total
Fetal	-	-	10	10
0-1	-	-	76	76
1-4	-	-	46	46
5-9	-	-	33	33
10-14	-	-	16	16
15-19	0	4	1	5
20-24	5	20	2	27
25-29	14	17	0	31
30-34	11	12	1	24
35-39	16	13	0	29
40-50	13	11	2	26
50+	5	7	0	12
Subadult	-	-	4	4
Adult	34	15	74	123
Total	98	99	80	462

Table 3. Age and Sex Distribution of Skeletons from the Rymer Site.

Age Interval	Male	Female	Unknown	Total
Fetal	-	-	1	1
0-1	-	-	23	23
1-4	-	-	17	17
5-9	-	-	13	13
10-14	-	-	7	7
15-19	2	4	0	6
20-24	0	5	0	5
25-29	7	8	0	15
30-34	3	2	0	5
35-39	5	2	0	7
40-50	7	8	0	15
50+	5	2	0	7
Subadult	-	-	3	3
Adult	14	6	26	46
Total	43	37	29	170

Table 4. Age and Sex Distribution of Skeletons from the Mouse Creek Site.

Age Interval	Male	Female	Unknown	Total
Fetal	-	-	3	3
0-1	-	-	7	7
1-4	-	-	8	8
5-9	-	-	18	18
10-14	-	-	9	9
15-19	2	1	1	4
20-24	2	3	0	5
25-29	2	3	0	5
30-34	1	1	0	2
35-39	2	2	0	4
40-50	3	3	0	6
50+	5	5	0	10
Subadult	-	-	6	6
Adult	0	0	52	52
Total	17	18	59	139

Due to the poor condition of many of the skeletons, only general age determinations could be made in some cases (for example, adult versus subadult, or 30-50). These particular specimens were proportioned across the appropriate age and sex categories based on the pre-existing age and sex frequency distributions of the respective population. Also, individuals with indeterminate sex were equally divided across the male and female categories. Since fetal individuals did not participate in postnatal life, these specimens (numbering 12 in all) were omitted from the life table calculations. And, because the life table approach requires the inclusion of all individuals in a population, burial card data concerning discarded specimens were integrated with the rest of the specimens in order to obtain complete skeletal samples. Tables 5, 6 and 7 represent the adjusted age and sex distributions for the three Mouse Creek Phase sites resulting from the above proportionings.

Abridged life tables were calculated based on combined as well as separate sex for each Mouse Creek Phase site. Eight columns make up each life table. The first, x, is simply the age intervals utilized, as outlined above. Dx, the second column, represents the number of individuals dying in each category, while dx, the third column, is merely the percent of deaths per category. Mortality curves based on these data were generated for each site. Survivorship, or lx, the fourth column, represents the percent surviving to the next category. The first interval value is always 100.00. Thereafter, the dx interval is subtracted from the lx to arrive at

Table 5. Adjusted Age and Sex Distribution of Skeletons from the Ledford Island Site.

Age Interval	Male	Female	Total
0-1	38.89	38.89	77.78
1-4	23.54	23.54	47.08
5-9	16.89	16.89	33.78
10-14	8.19	8.19	16.38
15-19	1.03	7.19	8.22
20-24	12.35	33.54	45.89
25-29	28.84	27.16	56.00
30-34	23.68	19.97	43.65
35-39	32.96	20.77	53.73
40-44	14.42	9.59	24.01
45-49	14.42	9.59	24.01
50+	10.30	11.18	21.48
Total	225.5	226.5	452.0

Table 6. Adjusted Age and Sex Distribution of Skeletons from the Rymer Site.

Age Interval	Male	Female	Total
0-1	12.08	12.08	24.16
1-4	8.93	8.93	17.86
5-9	6.82	6.82	13.64
10-14	3.67	3.67	7.34
15-19	3.92	6.32	10.24
20-24	0.00	7.91	7.91
25-29	13.75	12.65	26.40
30-34	5.90	3.17	9.07
35-39	9.82	3.17	12.99
40-44	6.88	6.32	13.20
45-49	6.88	6.32	13.20
50+	9.82	3.17	12.99
Total	88.47	80.53	169.0

Table 7. Adjusted Age and Sex Distribution of Skeletons from the Mouse Creek Site.

Age Interval	Male	Female	Total
0-1	4.00	4.00	8.00
1-4	4.57	4.57	9.14
5-9	10.29	10.29	20.58
10-14	5.14	5.14	10.28
15-19	6.11	3.67	9.78
20-24	4.89	7.33	12.22
25-29	4.89	7.33	12.22
30-34	2.44	2.44	4.88
35-39	4.89	4.89	9.78
40-44	3.67	3.67	7.34
45-49	3.67	3.67	7.34
50+	12.22	12.22	24.44
Total	66.78	69.22	136.0

the subsequent lx value. Curves depicting this statistic were also generated for each Mouse Creek Phase site. The fifth life table column is qx, or the probability of dying in interval x. This is calculated by dividing dx by lx for the corresponding x interval. Curves were also generated for this column. Lx is the sixth column of the life table, representing merely the total number of years lived in each interval. This is calculated by the formula Nx(lx + lx+1)/2 where Nx=5 (age interval length). However, corrections had to be made for the unequal age interval sizes of the first two age categories following Acsádi and Nemeskéri (1970:64): L_{0-1} = $0.2L_{0-1} + 0.8L_{1-4}$, and $L_{1-4} = 0.34L_{0-1} + 1.184L_{1-4} + 2.782L_{5-9}$. The seventh column, Tx, is the total number of years lived after time x. The first interval is merely the sum of all of the previous Lx values. Subsequent Tx intervals are calculated by subtracting the previous Tx value from the corresponding Lx interval. The final column, ex, represents life expectancy. It is computed by dividing the Tx value by the corresponding lx value for each age interval. Curves based on this statistic were generated for each Mouse Creek Phase site.

Finally, crude mortality rates were estimated for each population by dividing 1/ex. These values were compared, along with life expectancy at birth calculations, across selected Amerindian skeletal populations. Population size was determined according to Ubelaker (1974:66) by considering the time interval (T) of occupation, crude mortality rate estimated from above (m), and the sample size (n).

For comparisons of the Mouse Creek Phase demography to Averbuch and Toqua, several additional readjustments had to be made. Since the Ledford Island population exhibited both the largest and most reliable sample size (n=462), only this sample was utilized in the comparative analysis. First, the original aging categories of all three data sets were found to be significantly different. For example, in contrast to the aforementioned Mouse Creek age intervals, Berryman (1981) organizes the Averbuch subadult specimens into age categories of 0-1.5, 1.5-5.5, 5.5-10.5 and 10.5-15.5 years. Toqua subadults, on the other hand, are contained in 0-1, 1-5, 5-10 and 10-15 year intervals (Parham 1982) with, for example, individuals aged 5.0-9.99 years contained in the 5-10 year age interval. Also, the upper age limit interval of all three are distinctly dissimilar: Averbuch - 55-60, Toqua - 45+, and Mouse Creek - 50+ years. Consequently, the demographic data from the Ledford Island site had to be standardized. This was accomplished by referring back to the original aging and sexing records for that site. The individuals were regrouped in order to conform to the Toqua aging intervals (Table 8). Adjusted age and sex distributions for these specimens were then recalculated (Table 9) along with the subsequent abridged life tables. Because of special circumstances surrounding the Averbuch demographic construction (see Berryman 1981), these data were left intact. Adjusted age and sex distributions for this site are found in Table 10. The Toqua demography also remains essentially the same as presented in Parham (1982). Toqua age and sex distributions are presented in Table 11.

Table 8. Standardized Age and Sex Distribution of Skeletons from the Ledford Island Site.

Age Interval	Male	Female	Unknown	Total
Fetal	-	-	10	10
0-1	-	-	76	76
1-5	-	-	51	51
5-10	-	-	30	30
10-15	-	-	14	14
15-20	0	4	1	5
20-25	5	20	2	27
25-30	14	17	0	31
30-35	11	12	1	24
35-40	16	13	0	29
40-45	6.5	5	1	12.5
45+	11.5	13	1	25.5
Subadult	-	-	4	4
Adult	34	15	74	123
Total	98	99	80	462

Table 9. Standardized and Adjusted Age and Sex Distribution of Skeletons from the Ledford Island Site.

Age Interval	Male	Female	Total
0-1	38.89	38.89	77.78
1-5	26.10	26.10	52.20
5-10	15.35	15.35	30.70
10-15	7.16	7.16	14.32
15-20	1.03	7.19	8.22
20-25	12.35	33.54	45.89
25-30	28.84	27.16	56.00
30-35	23.68	19.97	43.65
35-40	32.96	20.77	53.73
40-45	14.42	8.79	23.21
45+	24.72	21.57	46.29
Total	225.5	226.5	452.0

Table 10. Adjusted Age and Sex Distribution of Skeletons from the Averbuch Site (from Berryman 1981:28).

Age Interval	Male	Female	Total
0-1.5	138.11	138.11	276.22
1.5-5.5	119.25	119.25	238.51
5.5-10.5	30.65	30.65	61.30
10.5-15.5	14.47	14.47	28.93
15.5-20	37.23	52.70	89.92
20-25	95.76	80.99	176.75
25-30	56.23	52.87	109.10
30-35	43.32	32.82	76.14
35-40	30.99	24.91	55.90
40-45	20.07	14.94	35.01
45-50	20.07	14.94	35.01
50-55	14.59	9.88	24.47
55-60	14.59	9.88	24.47
Total	635.33	596.41	1231.74

Table 11. Adjusted Age and Sex Distribution of Skeletons from the Toqua Site (from Parham 1982:35).

Age Interval	Male	Female	Total
0-1	50	49	99
1-5	29	28	57
5-10	14	23	37
10-15	20	4	24
15-20	14	27	41
20-25	31	30	61
25-30	16	19	35
30-35	23	13	36
35-40	17	9	26
40-45	9	6	15
45+	5	3	8
Total	228	211	439

IV. STATURE ESTIMATION

Stature measurements for the Mouse Creek individuals, including femur, tibia, radius and humerus lengths, are on file at McClung Museum. Since it was believed that these estimates were reliable and because considerable decomposition and decline in preservation of the long bones has occurred since the specimens were originally analyzed by Lewis and Kneberg, these original measurements were utilized in this study. However, only the femur and tibia raw measurements were used, due to the small number of measurable humerii and radii and the lessened reliability of such measurements in stature estimation (Trotter and Gleser 1958:120).

To correct for sex biasing, the Mouse Creek male and female stature estimates were examined independently. Also, only adults (older than 20) were examined in relation to stature for the three Mouse Creek Phase sites. It was felt that the slight decline in stature with increasing age was not great enough to significantly bias the resulting stature means.

Regression formulae from Trotter and Gleser (1952) were employed in the estimation of stature. The formulae for Mongoloid Males and White Females (due to the absence of a Mongoloid Female formula) were selected. Since relatively few Mouse Creek skeletons possessed both an intact femur and tibia, only the femur was employed in the regression formulae. Stature estimates for Averbuch and Toqua are taken from Berryman (1981) and Parham (1982), respectively.

V. PATHOLOGY IDENTIFICATION

The pathological examination of the Mouse Creek Phase skeletal remains involved identification of major pathological categories by means of a descriptive comparison of the skeletons primarily to the texts of Steinbock (1976) and Ortner and Putschar (1981). Because a differential diagnosis of a particular disease was not feasible (due in part to the similar nature of many different disease manifestations), disease classes containing many similar and related disease states were defined. Data such as location, state and severity of these major disease classes were recorded via a coding format. This format is presented in Appendix B. Pathology occurrence (in the form of incidences) across different sex and age groups as well as across the three Mouse Creek Phase sites as a whole was tabulated. For comparative purposes, frequencies of porotic hyperostosis/cribra orbitalia and periostitis were obtained from Berryman (1984b) and Parham (1982).

VI. CRANIOMETRIC ANALYSIS

Approximately 203 measurable Mouse Creek crania were analyzed with respect to 24 cranial measurements, utilizing sliding, spreading and coordinate calipers, as well as a Western Reserve Head Spanner. Subadults (below 15 years of age) were not considered in the metric analysis. Definitions of the measurements utilized are presented in Appendix C. Descriptive statistics, such as means and standard deviations, were generated for each measurement.

Because incidences of both intentional (including fronto-occipital, lambdoidal and occipital) and unintentional (post-mortem warping, for example) cranial deformation were widespread among the Mouse Creek specimens, the number of cranial measurements usable in the comparative study with Toqua and Averbuch was significantly limited. Table 12 summarizes the cranial deformation incidence and frequency for the Mouse Creek Phase sites. Since cranial deformation has been found to significantly alter overall vault measurements such as cranial length, breadth and height (Berryman and Owsley 1984), only facial measurements were considered. This problem, along with the extremely small sample sizes of many of the facial measurements, reduced the total number of utilizable comparative measurements to eight. Thus, unfortunately, the selection of usable measurements for the comparative analysis was predicated by sample size restrictions. Approximately 43 Mouse Creek Phase crania contained all or most (at least 6) of the eight selected measurements. Means (according to sex) obtained from the total (n=203) sample were substituted for the missing values. No values were estimated, and all questionable measurements were deleted from the data set.

Comparative data from Toqua and Averbuch were obtained from Parham (1982) and Berryman (1984b), respectively. Measurements from all of the sites had been taken using the same criteria with only one exception--Height of Ascending Ramus. Standardization was achieved by remeasuring this attribute for the Averbuch series following Bass (1971:72).

Table 12. Frequencies and Percentages of Incidences of Cranial Deformation for Male and Female Individuals from the Mouse Creek, Ledford Island and Rymer Sites.*

Def. Type	Male n	Male %	Female n	Female %	Indet. n	Indet. %	Total n	Total %
Mouse Creek								
None	1	7.7	1	7.7	0	0.0	2	6.1
F-O	3	23.1	6	46.1	0	0.0	9	27.3
L	0	0.0	0	0.0	0	0.0	0	0.0
O	0	0.0	0	0.0	0	0.0	0	0.0
PMW	1	7.7	0	0.0	0	0.0	1	3.0
I	4	30.8	3	23.1	6	85.7	13	39.4
F-O/L	1	7.7	1	7.7	0	0.0	2	6.1
F-O/PMW	3	23.1	2	15.4	1	14.3	6	18.2
L/PMW	0	0.0	0	0.0	0	0.0	0	0.0
L/O	0	0.0	0	0.0	0	0.0	0	0.0
Rymer								
None	1	4.5	0	0.0	0	0.0	1	2.2
F-O	0	0.0	1	4.5	0	0.0	1	2.2
L	8	36.4	6	27.3	1	50.0	15	32.6
O	1	4.5	1	4.5	0	0.0	2	4.3
PMW	0	0.0	0	0.0	0	0.0	0	0.0
I	2	9.1	3	13.6	1	50.0	6	13.0
F-O/L	1	4.5	1	4.5	0	0.0	2	4.3
F-O/PMW	0	0.0	0	0.0	0	0.0	0	0.0
L/PMW	1	4.5	1	4.5	0	0.0	2	4.3
L/O	8	36.4	9	40.9	0	0.0	17	37.0
Ledford Island								
None	1	1.8	1	1.4	0	0.0	2	1.6
F-O	15	27.8	31	44.3	0	0.0	46	36.8
L	0	0.0	4	5.7	0	0.0	4	3.2
O	1	1.8	0	0.0	0	0.0	1	0.8
PMW	6	11.1	5	7.1	1	100.0	12	9.6
I	23	42.6	19	27.1	0	0.0	42	33.6
F-O/L	3	5.6	1	1.4	0	0.0	4	3.2
F-O/PMW	5	9.3	9	12.9	0	0.0	14	11.2
L/PMW	0	0.0	0	0.0	0	0.0	0	0.0
L/O	0	0.0	0	0.0	0	0.0	0	0.0

Table 12 (Continued)

Def. Type	Male n	Male %	Female n	Female %	Indet. n	Indet. %	Total n	Total %
Combined Sites								
None	3	3.4	2	1.9	0	0.0	5	2.4
F-0	18	20.2	38	36.2	0	0.0	56	27.4
L	8	9.0	10	9.5	1	0.1	19	9.3
0	2	2.2	1	0.9	0	0.0	3	1.5
PMW	7	7.9	5	4.8	1	0.1	13	6.4
I	29	32.6	25	23.8	7	0.7	61	29.9
F-0/L	5	5.6	3	2.9	0	0.0	8	3.9
F-0/PMW	8	9.0	11	10.5	1	0.1	20	9.8
L/PMW	1	1.1	1	0.9	0	0.0	2	1.0
L/0	8	9.0	9	8.6	0	0.0	17	8.3

*F-0 = Fronto-Occipital; L = Lambdoidal; 0 = Occipital; PMW = Post-Mortem Warping; I = Indeterminate; F-0/L = Fronto-Occipital in combination with Lambdoidal; F-0/PMW = Fronto-Occipital in combination with Post-Mortem Warping; L/PMW = Lambdoidal in combination with Post-Mortem Warping; and L/0 = Lambdoidal in combination with Occipital Cranial Deformation.

VII. STATISTICAL TECHNIQUES

A summary of the statistical techniques utilized in the manipulation of the comparative cranial data as well as the stature analysis follows.

Analysis of Variance (ANOVA)

The analysis of variance approach to regression examines the relationship of one dependent (response) variable to one or more independent (indicator) variables by partitioning the sum of squares (SSTO) associated with the dependent variable into the sum of squares due to regression (SSR) and the sum of squares due to residual (SSE) (Neter and Wasserman 1974:77). An $\underline{F}$ test is used to test the significance of the relationship. ANOVA is used in this study to determine the relationship between stature (dependent Y variable) and sex and site (independent X variables). MANOVA (Multiple Analysis of Variance) fits several dependent variables to the independent variables (Ray 1982:175) and is used in the analysis of the relationship between site (Mouse Creek, Rymer and Ledford Island) and the comparative cranial means data. Both statistics were accomplished via the PROC GLM procedure (Ray 1982: 139-199).

Duncan's Multiple Range test analyzes the main effect means of a group of observations and separates these observations into distinct groups based on the classification variable(s) utilized (Ray 1982:151). This option can also be specified under the PROC GLM

analysis of SAS. In this study, the Duncan test examines the significance of long bone length with site when the sexes are pooled together.

Discriminant Analysis

Analyses grouped under the term "discriminant" examine the relationship between one classification variable (such as site or sex) and several continuous (metric) variables (Ray 1982:365). More specifically, as Hair et al. (1979:85) state, "Discriminant analysis involves deriving the linear combination of the two (or more) independent variables that will discriminate best between the a priori defined [classification] groups." This is best accomplished by the calculation of composite discriminant scores for each individual specimen. These are averaged for each group to form a group mean of discriminant scores, which are subsequently tested for statistical significance usually via Mahalanobis' generalized D^2 distance measurements. According to Hair et al. (1979:86), the smaller the overlap between the different group means, the better the discriminant function is able to separate the groups. Assumptions of a discriminant analysis are "multivariate normality of the distributions and unknown (but equal) dispersion and covariance structures for the groups" (Hair et al. 1979:86). In general, this analysis is very similar to the previously discussed MANOVA, except that with MANOVA, the relationship between metric dependent variables and independent classification variables is explored, while discriminant analyses relate a single dependent classification variable to metric independent variables (Hair et al. 1979:86).

Canonical discriminant analysis is, as the name implies, a type of discriminant analysis very much like a principal-components analysis. A canonical discriminant analysis is used in the craniometric study to find "linear combinations of the variables that best summarize the differences among the classes and computes scores for each observation on the linear combinations" (Ray 1982:365). This analysis serves primarily as a data reduction technique, reducing the total set of information into canonical variables--"linear combinations of the quantitative variables which summarize between-class variation" (Ray 1982:369). The correlations of these variables are then tested for significance using primarily an *F* approximation. Results of these relationships are plotted on graphs to aid in interpretation. The canonical discriminant analysis is accomplished via the SAS CAN.DISC program (Ray 1982:369-380).

CHAPTER IV

THE PALEODEMOGRAPHIC ANALYSIS

I. INTRODUCTION

Paleodemography or prehistoric demography includes the study of information relating to a past human population's mortality, longevity, fertility, and total population size. Several methodologies are currently available to anthropologists in reconstructing past population parameters. For example, many archaeological approaches exist which involve analyses of data relating to numbers and distributions of individual settlements, area of settlements, rooms per settlement area and persons per room (Ammerman et al. 1976:33-38; Howells 1960:160-164; Plog 1975) in order to arrive at population size estimates. Secondly, much ethnohistoric evidence is available for reconstructing population structure, varying greatly in detail and credibility. Perhaps the approach with the most potential for reflecting actual population status is the demographic method based on the biological analysis of a skeletal population. Instead of relying on archaeological inferences or even ethnohistoric data, analysis of the skeletons themselves has been viewed as being more reliable because it approaches more of a biological reality (Howells 1960; Ubelaker 1974:5).

Skeletal Demography Literature

Although the use of skeletal evidence for paleodemography is not new (see Acsádi and Nemeskéri [1970] and Ubelaker [1974:5-6] for a discussion of the history of its application in the Old World and New World, respectively), it is only recently that physical anthropologists have begun to recognize the potential value of these studies in the delineation of cultural processes (Blakely and Mathews 1975). While a full and detailed discussion of the pertinent literature here is both unwarranted and redundant (see Berryman 1981; Joerschke 1983; Owsley 1975; Parham 1982; and Ubelaker 1974), a brief synopsis of the types of skeletal demography studies will be presented. First, the simplest and by far most widespread demographic studies are what the author terms single synchronic analyses--that is, studies which involve the determination of population parameters for a single, isolated skeletal population at one particular point in time (a single generational cohort is assumed). Asch (1976), Bennett (1973), Berryman (1981), Blakely and Mathews (1975), Buikstra (1976), Joerschke (1983), Magennis (1977), Owsley (1975), Parham (1982) and Ubelaker (1974) are all excellent examples of the application of this approach. Usually, the end results of such studies (such as an estimation of life expectancy at birth or of total population size or crude mortality rate) are then compared to the corresponding values for similar populations.

Diachronic demographic studies are, by their nature, necessarily comparative, and are rather rare. These can involve contrasting

the population structure of several different populations from different periods of time. Blakely's (1971) contrast of Archaic, Middle Woodland and Middle Mississippian mortality profiles from four American Indian skeletal populations is an excellent example. Also, a single burial sample from a stratified, multicomponent site can be subdivided into a chronological sequence and a series of demographic profiles through time generated. Mobley's (1980) diachronic reconstruction of the demographic structure of the Pecos Indians of New Mexico from A.D. 1150 to 1700 is a pioneer work, in spite of recent criticisms to the contrary (Palkovich 1983).

The present demographic study is unique in that it is what the author terms a true comparative synchronic analysis. That is, the total demographic structure (including all aspects of mortality, fertility, longevity, etc.) of the three Mouse Creek Phase sites is compared and contrasted. The Mouse Creek Phase demographic structure (as represented by Ledford Island) is then compared to those of Toqua (Parham 1982) and Averbuch (Berryman 1981) to arrive at a comprehensive picture of demographic similarity and variability in the Late Mississippian populations. However, certain preconditions and assumptions must be met and made, respectively, before such a paleodemographic analysis can be conducted.

II. PRELIMINARY STEPS TO A PALEODEMOGRAPHIC ANALYSIS

Preconditions

Ubelaker's (1974) list of prerequisites for demographic analyses of skeletal populations is widely recognized:

(1) a knowledge of the completeness of the sample;

(2) information about the archaeological associations of the skeletons;

(3) a determination of the length of time the sample represents;

(4) an adequate assessment of sex and age at death;

(5) a proper selection of demographic methodology.

Life table critics such as Angel (1969) as well as others maintain that skeletal demographic analyses should not be done if all of these preconditions cannot be fully met. However, Moore et al. (1975:69) recommend the interpretation of life table results within a probabilistic framework--the analysis becomes more precise with each prerequisite that is met. When all of these requirements are attained, skeletal populations can provide the most accurate demographic picture of a culture (Ubelaker 1974:5).

Assumptions

A number of assumptions must also be made before a skeletal paleodemographic study can begin. These, like the preconditions stated above, are population-specific--that is, they should be considered in light of the particular population(s) being analyzed.

First, it must be assumed that the distribution gained from the skeletal analysis (age and sex) accurately reflects that of the living population as a whole. At least two factors are included in this supposition--(1) that the actual skeletons recovered are

representative of all of the skeletons from the entire site area, and (2) that the individuals interred in the specified area are reflective of the entire population (Cook 1972). This addresses the problem of differential burial treatment of infants or war dead, perhaps resulting in separate burial of these specimens away from the other interments. This is why a knowledge of the completeness of the skeletal sample as well as certain archaeological factors (such as differential burial treatment) is an important precondition to a demographic analysis.

One must also assume that even though the period of time represented in the skeletal sample may cover several generations, the life table reflects the status of a single cohort throughout one generation. Thus, knowledge of the time interval represented by a skeletal sample is very important in the generation of the life table and also in the overall estimation of population size.

The third demographic assumption is perhaps the most difficult to assess. The population under study must be stationary in terms of its major demographic structure--that is, having equal birth and death rates (no total growth).

The last assumption to be made is that of no in or out net migration within the population. However, reciprocal migration between populations is acceptable (such as the equal exchanging of mates). This also is very difficult to assess without the aid of ethnohistoric or archaeological information. Owsley and Bass (1979) present a good example of the application of these types of information in meeting the above assumptions.

Mouse Creek and the Paleodemographic Preliminaries

The skeletal sample from each of the three Mouse Creek Phase sites is by no means complete. None of the entire areas of any of the sites was fully excavated. Also, preservation in some areas of the sites was extremely poor. However, the sample size represented by the individuals from each of these sites is quite large--large enough, in fact, to smooth out any major differences between the sample and the true population (Moore et al. 1975). Also, in light of Mouse Creek Phase skeletal interment throughout the individual villages, no intentional differential burial of these specimens with respect to location can be discerned (with the possible exception of the probable cemetery area at Ledford Island containing only 15.8% of the total 462 individuals). Overall, it appears that Mouse Creek Phase interments are individual or family oriented, usually in association with a structure. No "ceremonial" burial centers were located. In regard to the burial of war dead or infants elsewhere, this factor cannot be readily assessed. It can be said, however, that there was a significant tendency to inter infants under the age of one under structure floors. This is evidently a rather common Late Mississippian practice. Moore et al. (1975:60) found minimal perturbations in computer simulated life tables intentionally biased to varying degrees by infant under-enumeration. Only the survivorship curve statistic was significantly altered. Thus, the supposition that the mean skeletal age at death of the Mouse Creek Phase skeletons reflects the actual mortality experience of the Mouse Creek Phase populations is not found untenable.

Since the time span involved in the Mouse Creek Phase occupation is relatively short, the assumption of little mortality or fertility change during this time is reasonable. In fact, even when nothing is known about this variable, Weiss (1973:10) states "In general, the assumptions of a stationary population are reasonable," and that even if the growth rates are anywhere close to zero, the error involved will not be great. Acsádi and Nemeskéri (1970:45) state that ". . .--for lack of other data--the stationary model population is a hypothesis that approximates the one-time historical reality fairly well." It is believed that the assumption of population stability for the Mouse Creek Phase samples is justified.

Along these lines, the evaluation of the existence of migration at Mouse Creek was the most difficult to assess. In fact, no evidence was found to support the case for either side. Thus, this will have to remain an "unknown" variable for the Mouse Creek Phase demographic analysis.

Given the above arguments concerning the appropriateness of the Mouse Creek data for the following demographic study, it is felt that a paleodemographic analysis utilizing the Mouse Creek Phase skeletal data is justified. For a discussion of similar evidence regarding Averbuch and Toqua, see Berryman (1981) and Parham (1982), respectively.

III. RESULTS OF THE PALEODEMOGRAPHIC COMPARISON OF THE MOUSE CREEK PHASE SITES

Mortality

Calculated abridged (i.e., using prescribed age categories in lieu of raw ages) life table values based on combined as well as separate sex for the three Mouse Creek Phase sites are presented in Tables 13-21. Mortality curves for combined as well as separate sex based on the third column, dx, were generated for each site. These are shown in Figures 11-13. From the Ledford Island mortality curve (Figure 11), it can be seen that the highest combined sex mortality rate occurs in the 0-1 age category. This rate decreases steadily up to and including the 15-19 age category, the lowest point, representing the healthiest period for the population. Mortality increases thereafter to reach a maximum adult peak at 25-29 and a third lower peak at 35-39. Mortality then decreases throughout the remaining age intervals. When the curve is visually analyzed in terms of sex, the female mortality rate is found to be greater than the male rate in the 15-19 and 20-24 age categories. Male mortality is higher than the female in the 35-39 age interval and remains slightly so in the rest of the age categories. However, a Kolmogorov-Smirnov test (Thomas 1976) comparing dx male and female values shows no significant differences between males and females of all ages.

A similar picture is seen in the Rymer mortality curve (Figure 12). A moderately high (though not the highest) combined

Table 13. Abridged Life Table Values Calculated Using the Age Distribution of the Ledford Island Individuals (Combined Sex).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	77.78	17.21	100.00	.172	86.23	2247.03	22.47
1-4	47.08	10.42	82.79	.126	333.36	2160.80	26.10
5-9	33.78	7.47	72.37	.103	343.17	1827.44	25.25
10-14	16.38	3.62	64.90	.056	315.45	1484.27	22.87
15-19	8.22	1.82	61.28	.030	301.85	1168.82	19.07
20-24	45.89	10.15	59.46	.171	271.92	866.97	14.58
25-29	56.00	12.39	49.31	.251	215.57	595.05	12.07
30-34	43.65	9.66	36.92	.262	160.45	379.48	10.28
35-39	53.73	11.89	27.26	.436	106.57	219.03	8.03
40-44	24.01	5.31	15.37	.345	63.57	112.46	7.32
45-49	24.01	5.31	10.06	.528	37.02	48.89	4.86
50+	21.48	4.75	4.75	1.000	11.87	11.87	2.50
Total	452.01	100.00	-	-	2247.03	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 14. Abridged Life Table Values Calculated Using the Age Distribution of the Ledford Island Males.*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	38.89	17.25	100.00	.172	86.35	2350.72	23.51
1-4	23.54	10.44	82.75	.126	333.84	2264.37	27.36
5-9	16.89	7.49	72.31	.104	343.62	1930.53	26.70
10-14	8.19	3.63	64.82	.056	315.75	1586.91	24.48
15-19	1.03	0.46	61.19	.007	305.50	1271.16	20.77
20-24	12.35	5.48	60.73	.090	290.62	965.66	15.90
25-29	28.84	12.79	55.25	.231	244.85	675.04	12.22
30-34	23.68	10.50	42.46	.247	186.05	430.19	10.13
35-39	32.96	14.62	31.96	.457	123.25	244.14	7.64
40-44	14.42	6.39	17.34	.368	70.72	120.89	6.97
45-49	14.42	6.39	10.95	.583	38.77	50.17	4.58
50+	10.30	4.57	4.56	1.000	11.40	11.40	2.50
Total	225.5	100.0	-	-	2350.72	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 15. Abridged Life Table Values Calculated Using the Age Distribution of the Ledford Island Females.*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	38.89	17.17	100.00	.172	86.26	2147.83	21.48
1-4	23.54	10.39	82.83	.125	333.60	2061.57	24.89
5-9	16.89	7.46	72.44	.103	343.55	1727.97	23.85
10-14	8.19	3.62	64.98	.056	315.85	1384.42	21.30
15-19	7.19	3.17	61.36	.052	298.87	1068.57	17.41
20-24	33.54	14.81	58.19	.254	253.92	769.70	13.23
25-29	27.16	11.99	43.38	.276	186.92	515.78	11.89
30-34	19.97	8.82	31.39	.281	134.90	328.86	10.48
35-39	20.77	9.17	22.57	.406	89.92	193.96	8.59
40-44	9.59	4.23	13.40	.316	56.42	104.04	7.76
45-49	9.59	4.23	9.17	.461	35.27	47.62	5.19
50+	11.18	4.94	4.94	1.000	12.35	12.35	2.50
Total	226.50	100.00	-	-	2147.83	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 16. Abridged Life Table Values Calculated Using the Age Distribution of the Rymer Individuals (Combined Sex).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	24.16	14.29	100.00	.143	88.57	2382.56	23.82
1-4	17.86	10.57	85.71	.123	344.52	2293.99	26.76
5-9	13.64	8.07	75.14	.107	355.52	1949.47	25.94
10-14	7.34	4.34	67.07	.065	324.50	1593.95	23.76
15-19	10.24	6.06	62.73	.097	298.50	1269.45	20.24
20-24	7.91	4.68	56.67	.082	271.65	970.95	17.13
25-29	26.40	15.62	51.99	.300	220.90	699.30	13.45
30-34	9.07	5.37	36.37	.148	168.42	478.40	13.15
35-39	12.99	7.69	31.00	.248	135.77	309.98	10.00
40-44	13.20	7.81	23.31	.335	97.02	174.21	7.47
45-49	13.20	7.81	15.50	.504	57.97	77.19	4.98
50+	12.99	7.69	7.69	1.000	19.22	19.22	2.50
Total	169.00	100.00	-	-	2382.56	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 17. Abridged Life Table Values Calculated Using the Age Distribution of the Rymer Males.*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	12.08	13.65	100.00	.136	89.08	2586.70	25.87
1-4	8.93	10.09	86.35	.117	348.39	2497.62	28.92
5-9	6.82	7.71	76.26	.101	362.02	2149.23	28.18
10-14	3.67	4.15	68.55	.060	332.37	1787.21	26.07
15-19	3.92	4.43	64.40	.069	310.92	1454.84	22.59
20-24	0.00	0.00	59.97	.000	299.85	1143.92	19.07
25-29	13.75	15.54	59.97	.259	261.00	844.07	14.07
30-34	5.90	6.67	44.43	.150	205.47	583.07	13.12
35-39	9.82	11.10	37.76	.294	161.05	377.60	10.00
40-44	6.88	7.78	26.66	.295	113.85	216.55	8.12
45-49	6.88	7.78	18.88	.412	74.95	102.70	5.44
50+	9.82	11.10	11.10	1.000	27.75	27.75	2.50
Total	88.47	100.00	-	-	2586.70	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 18. Abridged Life Table Values Calculated Using the Age Distribution of the Rymer Females.*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	12.08	15.00	100.00	.150	88.00	2158.31	21.58
1-4	8.93	11.09	85.00	.130	340.26	2070.31	24.36
5-9	6.82	8.47	73.91	.114	348.37	1730.05	23.41
10-14	3.67	4.55	65.44	.069	315.82	1381.68	21.11
15-19	6.32	7.85	60.89	.129	284.82	1065.86	17.50
20-24	7.91	9.82	53.04	.185	240.65	781.04	14.72
25-29	12.65	15.70	43.22	.363	176.85	540.39	12.50
30-34	3.17	3.94	27.52	.143	127.75	363.54	13.21
35-39	3.17	3.94	23.58	.167	108.05	235.79	10.00
40-44	6.32	7.85	19.64	.400	78.57	127.74	6.50
45-49	6.32	7.85	11.79	.666	39.32	49.17	4.17
50+	3.17	3.94	3.94	1.000	9.85	9.85	2.50
Total	80.53	100.00	-	-	2158.31	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 19. Abridged Life Table Values Calculated Using the Age Distribution of the Mouse Creek Individuals (Combined Sex).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	8.00	5.88	100.00	.059	77.30	2627.95	26.28
1-4	9.14	6.72	94.12	.071	388.58	2550.65	27.10
5-9	20.58	15.13	87.40	.173	399.18	2162.07	24.74
10-14	10.28	7.56	72.27	.105	342.45	1762.89	24.39
15-19	9.78	7.19	64.71	.111	305.58	1420.44	21.95
20-24	12.22	8.98	57.52	.156	265.15	1114.86	19.38
25-29	12.22	8.98	48.54	.185	220.25	849.71	17.50
30-34	4.88	3.59	39.56	.091	188.83	629.46	15.91
35-39	9.78	7.19	35.97	.200	161.88	440.63	12.25
40-44	7.34	5.40	28.78	.188	130.40	278.75	9.68
45-49	7.34	5.40	23.38	.231	103.40	148.35	6.34
50+	24.44	17.97	17.98	1.000	44.95	44.95	2.50
Total	136.0	100.00	-	-	2627.95	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 20. Abridged Life Table Values Calculated Using the Age Distribution of the Mouse Creek Males.

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	4.00	5.99	100.00	.060	95.21	2634.01	26.34
1-4	4.57	6.84	94.01	.073	387.81	2538.80	27.01
5-9	10.29	15.41	87.17	.177	397.33	2150.99	24.68
10-14	5.14	7.70	71.76	.107	339.55	1753.66	24.44
15-19	6.11	9.15	64.06	.143	297.43	1414.11	22.07
20-24	4.89	7.32	54.91	.133	256.25	1116.68	20.33
25-29	4.89	7.32	47.59	.154	219.65	860.43	18.08
30-34	2.44	3.65	40.27	.091	192.23	640.78	15.91
35-39	4.89	7.32	36.62	.200	164.80	448.55	12.25
40-44	3.67	5.50	29.30	.188	132.75	283.75	9.68
45-49	3.67	5.50	23.80	.231	105.25	151.00	6.34
50+	12.22	18.30	18.30	1.000	45.75	45.75	2.50
Total	66.78	100.00	-	-	2634.01	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 21. Abridged Life Table Values Calculated Using the Age Distribution of the Mouse Creek Females.*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	4.00	5.78	100.00	.058	95.38	2656.56	26.57
1-4	4.57	6.60	94.22	.070	389.31	2561.18	27.18
5-9	10.29	14.87	87.62	.170	400.93	2171.87	24.79
10-14	5.14	7.43	72.75	.102	345.18	1770.94	24.34
15-19	3.67	5.30	65.32	.081	313.35	1425.76	21.83
20-24	7.33	10.59	60.02	.176	273.63	1112.41	18.53
25-29	7.33	10.59	49.43	.214	220.68	838.78	16.97
30-34	2.44	3.52	38.84	.091	185.40	618.10	15.91
35-39	4.89	7.06	35.32	.200	158.95	432.70	12.25
40-44	3.67	5.30	28.26	.187	128.05	273.75	9.69
45-49	3.67	5.30	22.96	.231	101.55	145.70	6.35
50+	12.22	17.65	17.66	1.000	44.15	44.15	2.50
Total	69.22	100.00	-	-	2656.56	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

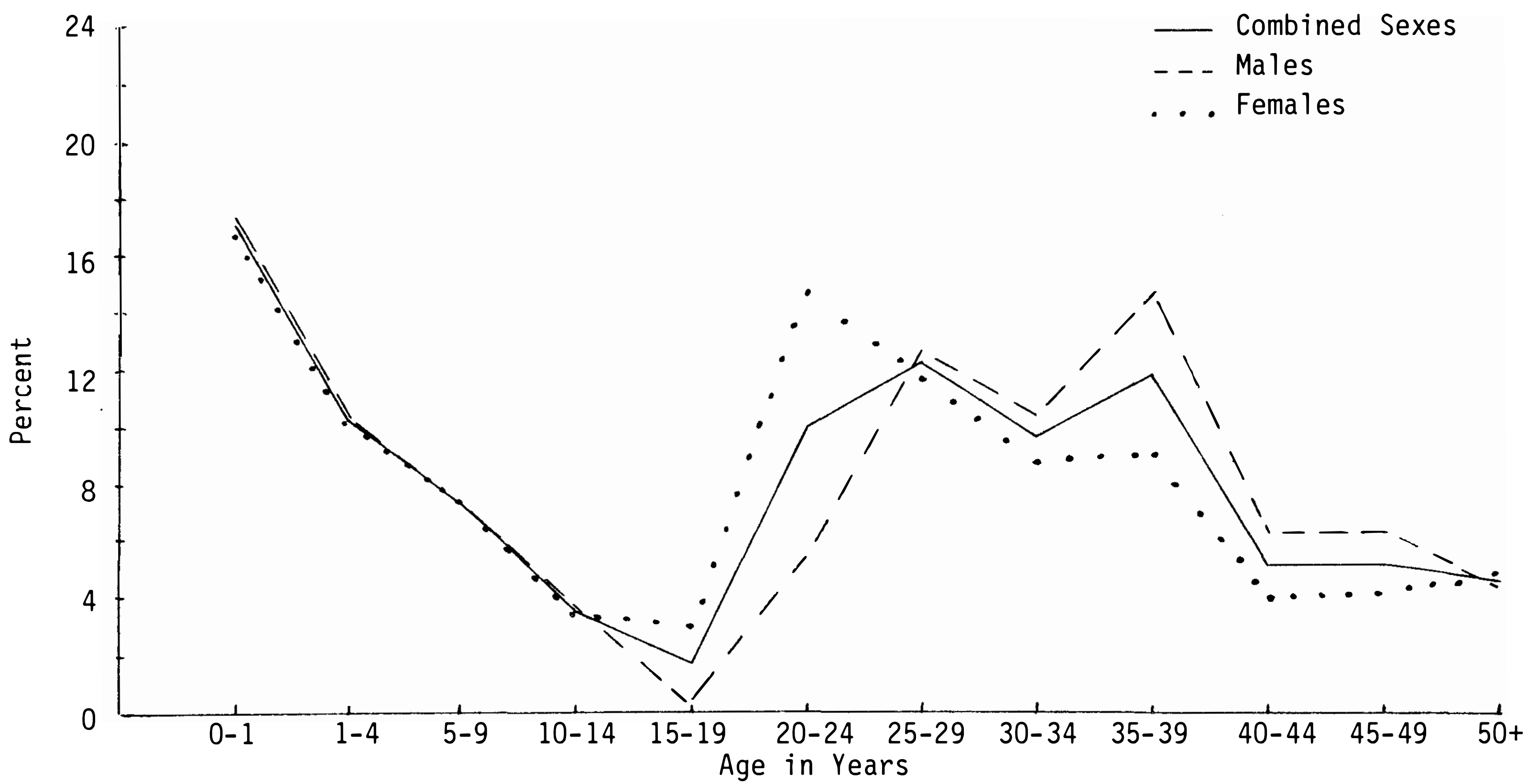


Figure 11. Mortality Curve for the Ledford Island Population.

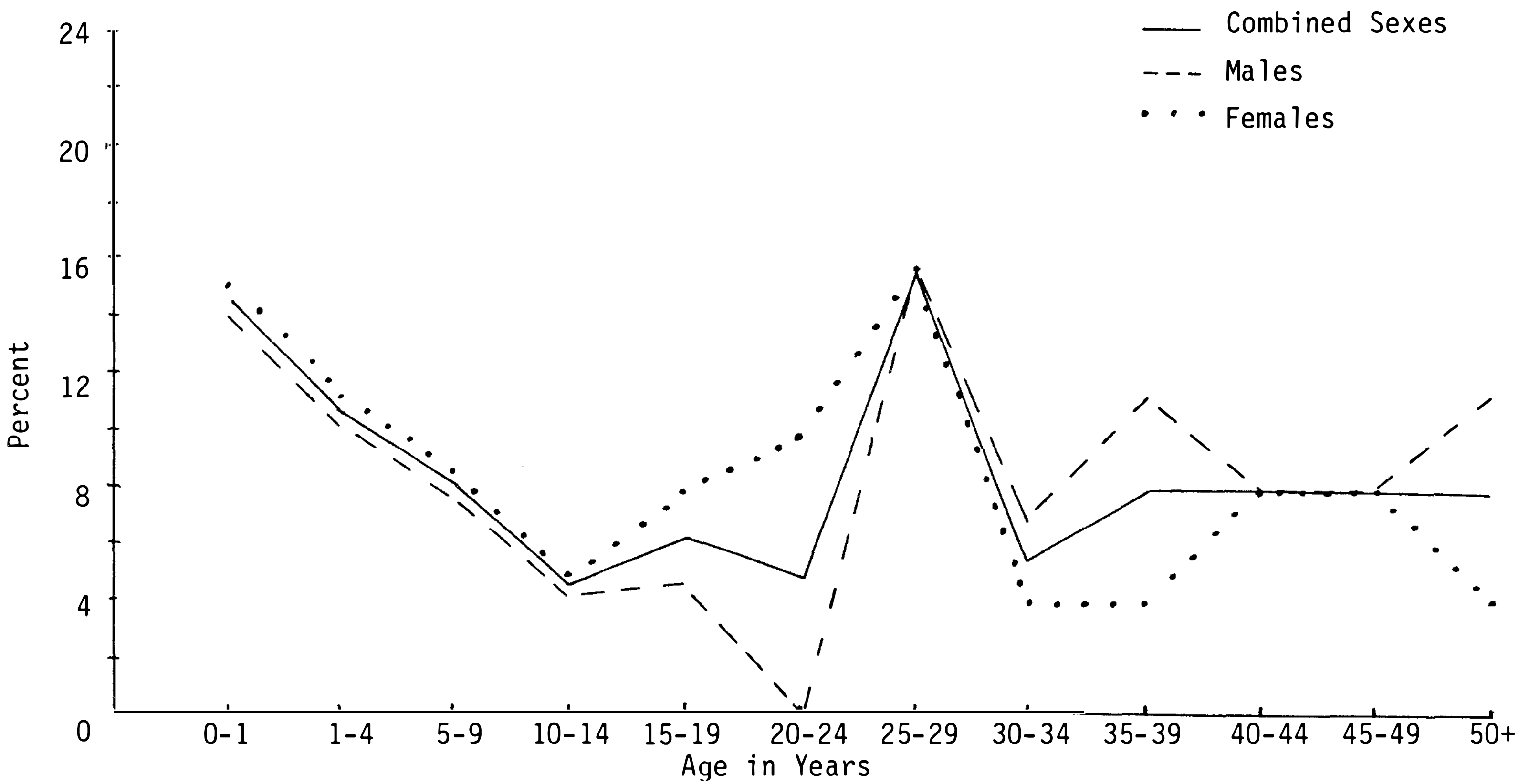


Figure 12. Mortality Curve for the Rymer Population.

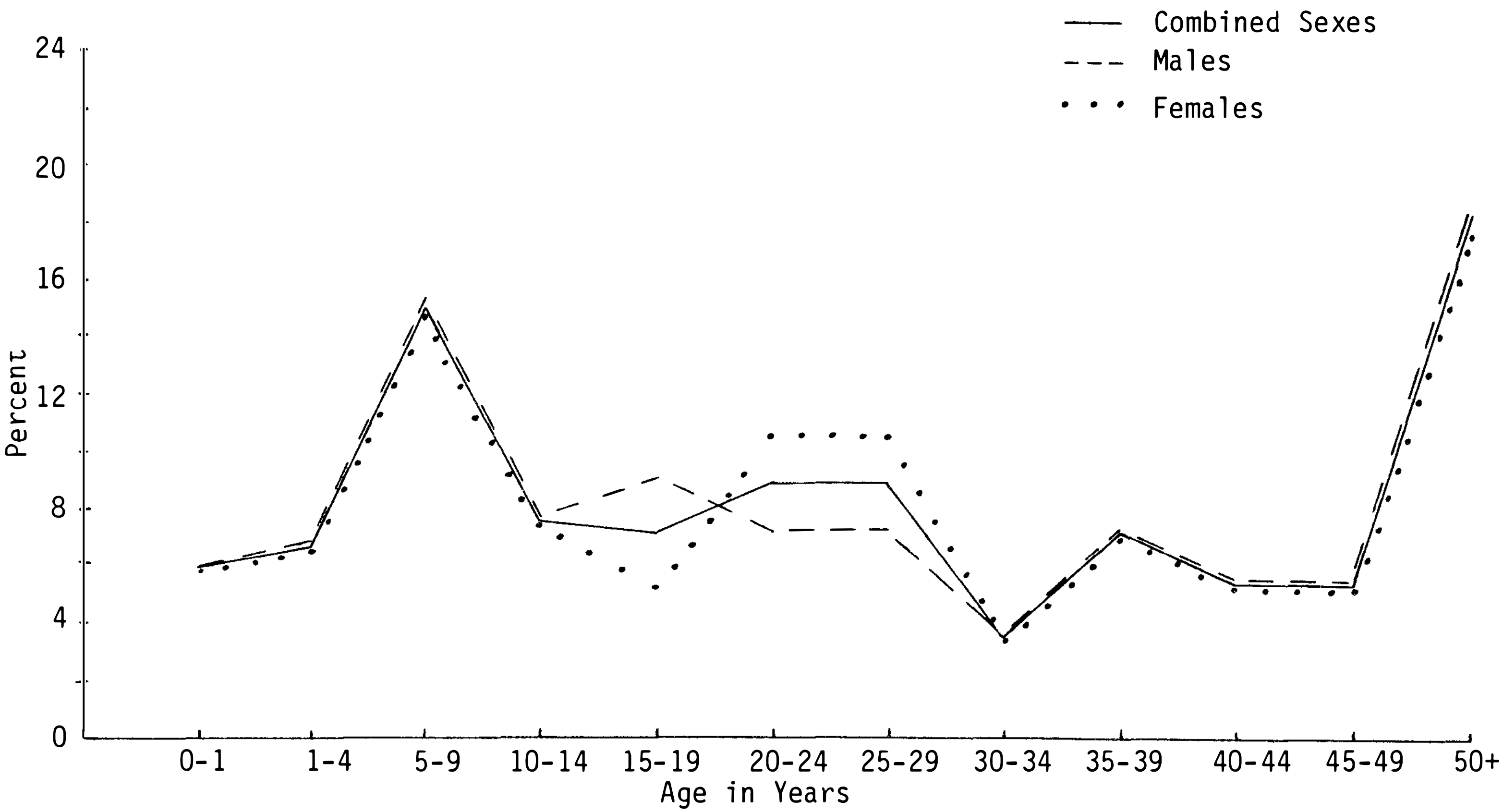


Figure 13. Mortality Curve for the Mouse Creek Population.

sex mortality rate is observed in the 0-1 interval, decreasing to the lowest (healthiest) point in the 10-14 age range. Overall mortality then increases to a maximum peak in the 25-29 age interval. A sharp decrease follows in the 30-34 range, with a slight increase and equalling occurring in the remaining intervals. Sex differences are observed throughout the curve, with female mortality higher in the 15-19 and especially the 20-24 age ranges (where 9.82% of the females are dying opposed to 0% males), and male mortality higher in the 35-39 and 50+ age intervals. However, the Kolmogorov-Smirnov test indicates no significant overall sex differences. When the Ledford Island and Rymer mortality dx (combined sex) values are also compared via a Kolmogorov-Smirnov test, no significant differences are present at the .05 level.

The mortality curve for the Mouse Creek site presents a vastly different picture (Figure 13). A Kolmogorov-Smirnov test comparing Ledford Island and Mouse Creek (combined sex) dx values indicates that almost all age categories are different at the .05 level. A very low combined sex mortality rate is seen in the 0-1 interval. In fact, this represents one of the healthiest periods for the population. Mortality then rises sharply to a peak at 5-9 followed by a decline. A second, smaller peak occurs in the 20-24 and 25-29 age categories, with subsequent decline. However, the highest mortality occurs in the 50+ category involving 17.97% of the population (combined sex). Male mortality is higher than the females' from 15-19, but lower from 20-29. However, the Kolmogorov-Smirnov test for sex relationships indicates no significant difference.

<u>Survivorship</u>

The fourth life table column, lx, the percent surviving to the next age category, is represented graphically via survivorship curves for each Mouse Creek Phase site (for both combined and separate sex) (Figures 14-16). Because of the high infant mortality, the Ledford Island survivorship curve descends rather abruptly from birth to the 10-14 age category, with only 64.90% (combined sex) of the individuals surviving to the 15-19 age category (Figure 14). The curve then decreases steadily throughout the remaining categories. At ages 25-29, 49.31% survive to the next category, while at 40-44, only 15.37% survive. Finally, only 4.75% are left surviving in the last category (50+). In terms of sex, survivability is slightly higher throughout most all of the adult male intervals.

For the Rymer site survivorship curve (Figure 15), a sharp descent is also noted throughout the subadult intervals with 67.07% (combined sex) of the individuals surviving after 10-14. At 25-29, 57.99% survive, but a sharp decrease from here to 30-34 leaves only 36.37% surviving. At 40-44, 23.31% survive, while at 50+, 7.69% still survive. Once again, male survivorship is slightly higher throughout.

The Mouse Creek survivorship curve does not show this sharp decline in the subadult intervals, rather a gradual decrease throughout (Figure 16). At 10-14, a fairly high 72.27% (combined sex) survive to the next category. At 25-29, 48.54% of the individuals live on; at 40-44, 28.78% and at 50+, 17.98% survive. Only the

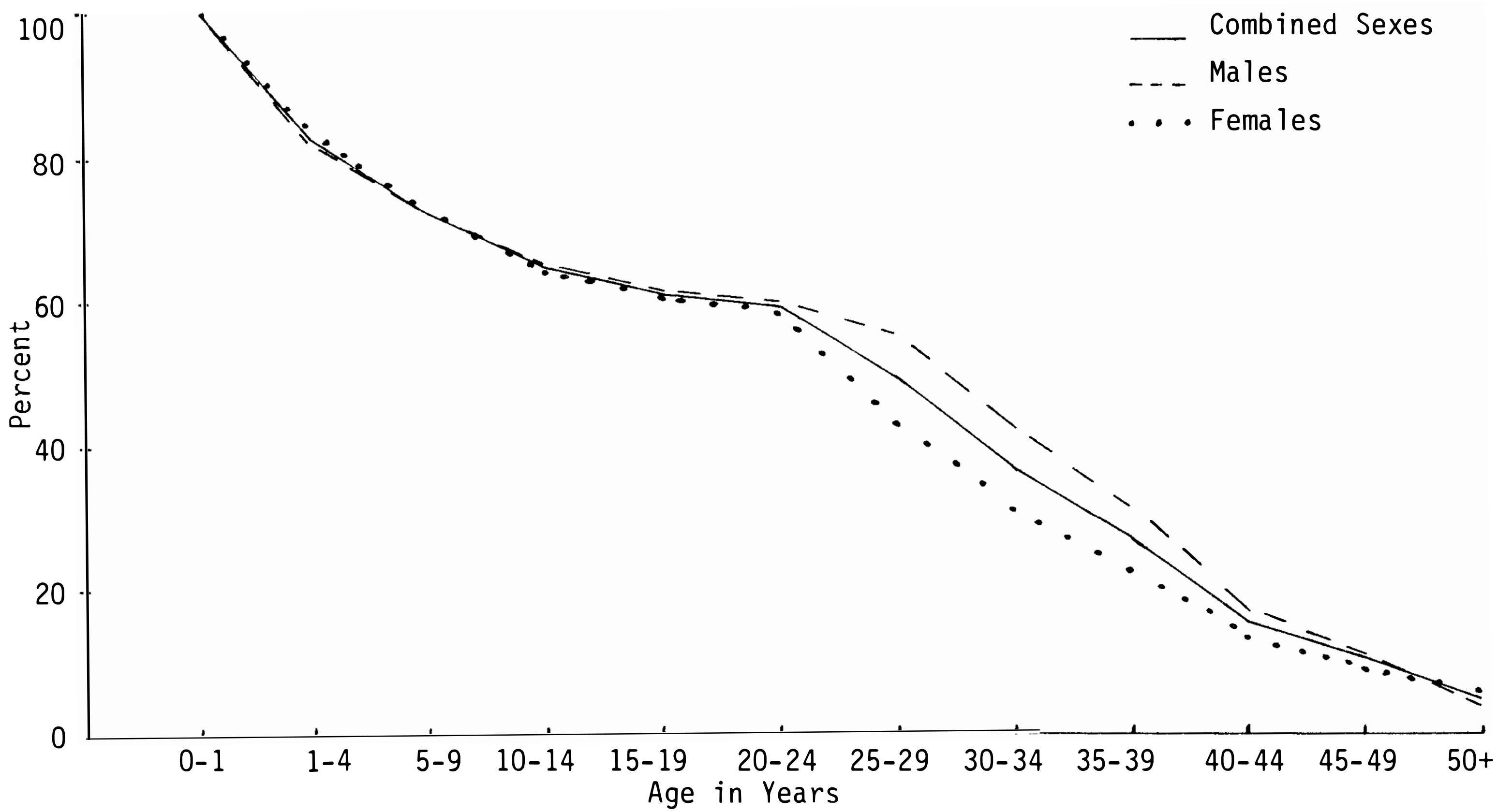


Figure 14. Survivorship Curve for the Ledford Island Population.

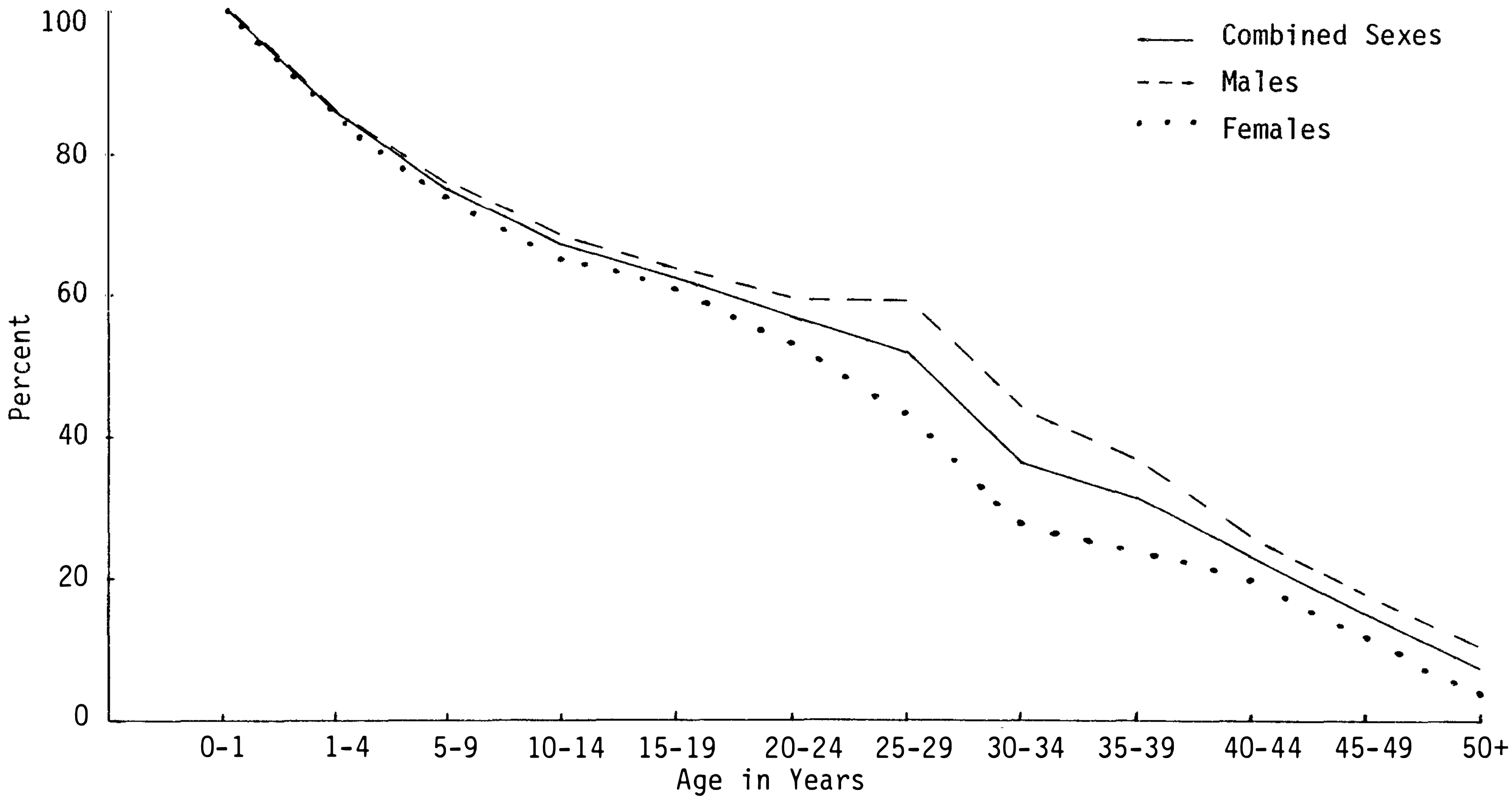


Figure 15. Survivorship Curve for the Rymer Population.

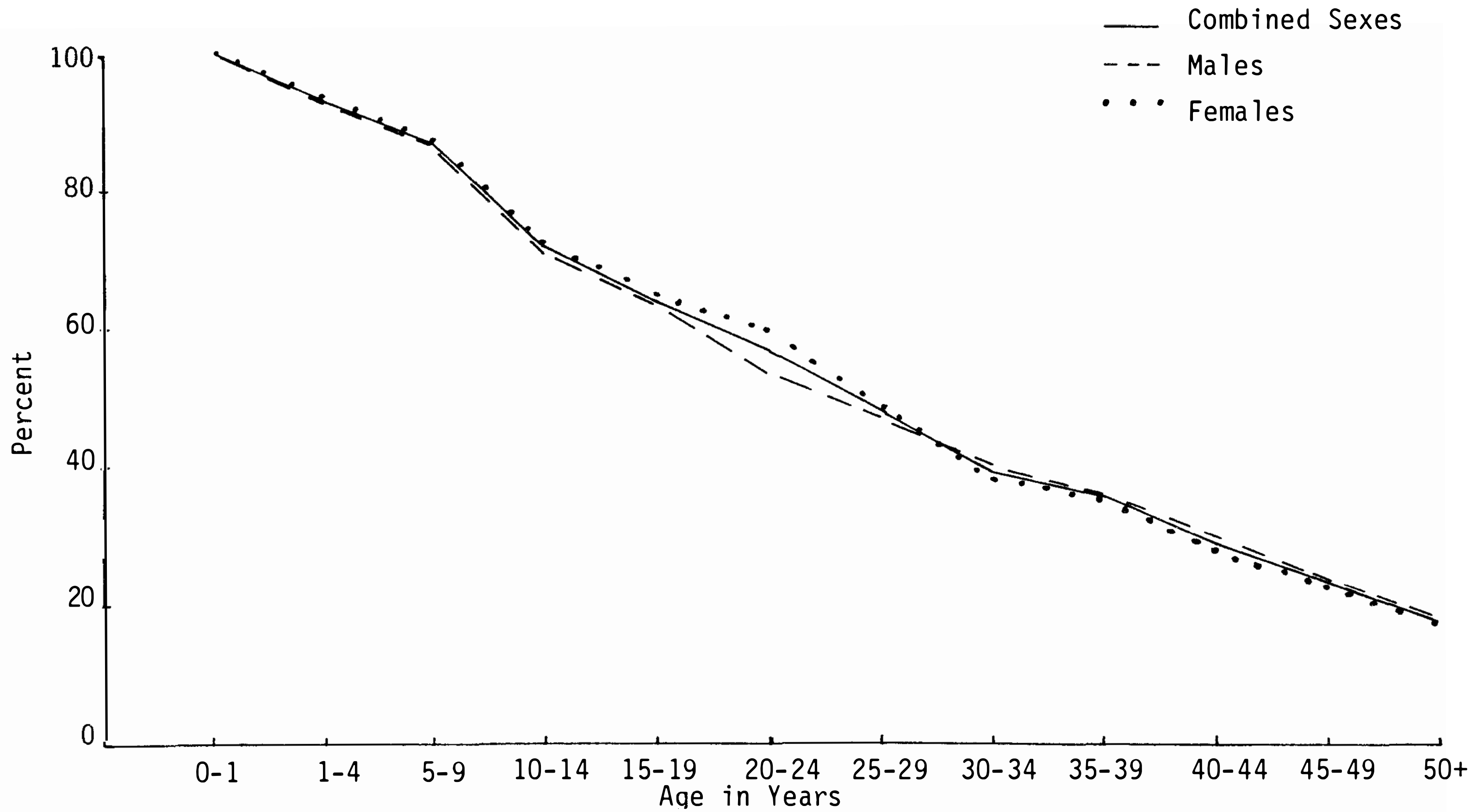


Figure 16. Survivorship Curve for the Mouse Creek Population.

20-24 age category showed any differences with regard to sex, with female mortality being substantially greater.

Probability of Dying

The fifth life table column, qx, represents the probability of dying for each interval. Curves were generated from these data for each site. The Ledford Island curve is fairly high for the qx_{0-1} interval and decreases steadily until 15-19, the least probable period of dying (Figure 17). This probability increases to a peak at 35-39 (qx = .436, combined sex) and, because the 50+ interval represents the last age category present, the probability of death for individuals still remaining becomes certain - 1.000. This statistic is substantially higher for females from ages 15-34, at which point male probability of death exceeds it throughout the remainder of the intervals.

The corresponding curve for the Rymer site shows a similar situation, with the slope decreasing slowly until 20-24, the healthiest (least likely to die) adult interval (Figure 18). The death probability increases sharply at 25-29 (qx = .300, combined sex), then decreases slightly and rises sharply at 45-49 (qx = .504, combined sex). Considerable sex differences are seen here once again, with the male probability of death consistently higher than the female with the exception of the 30-39 ages.

For the Mouse Creek probability of death curve (Figure 19), once again the 0-1 interval reflects a healthy period (qx of .050,

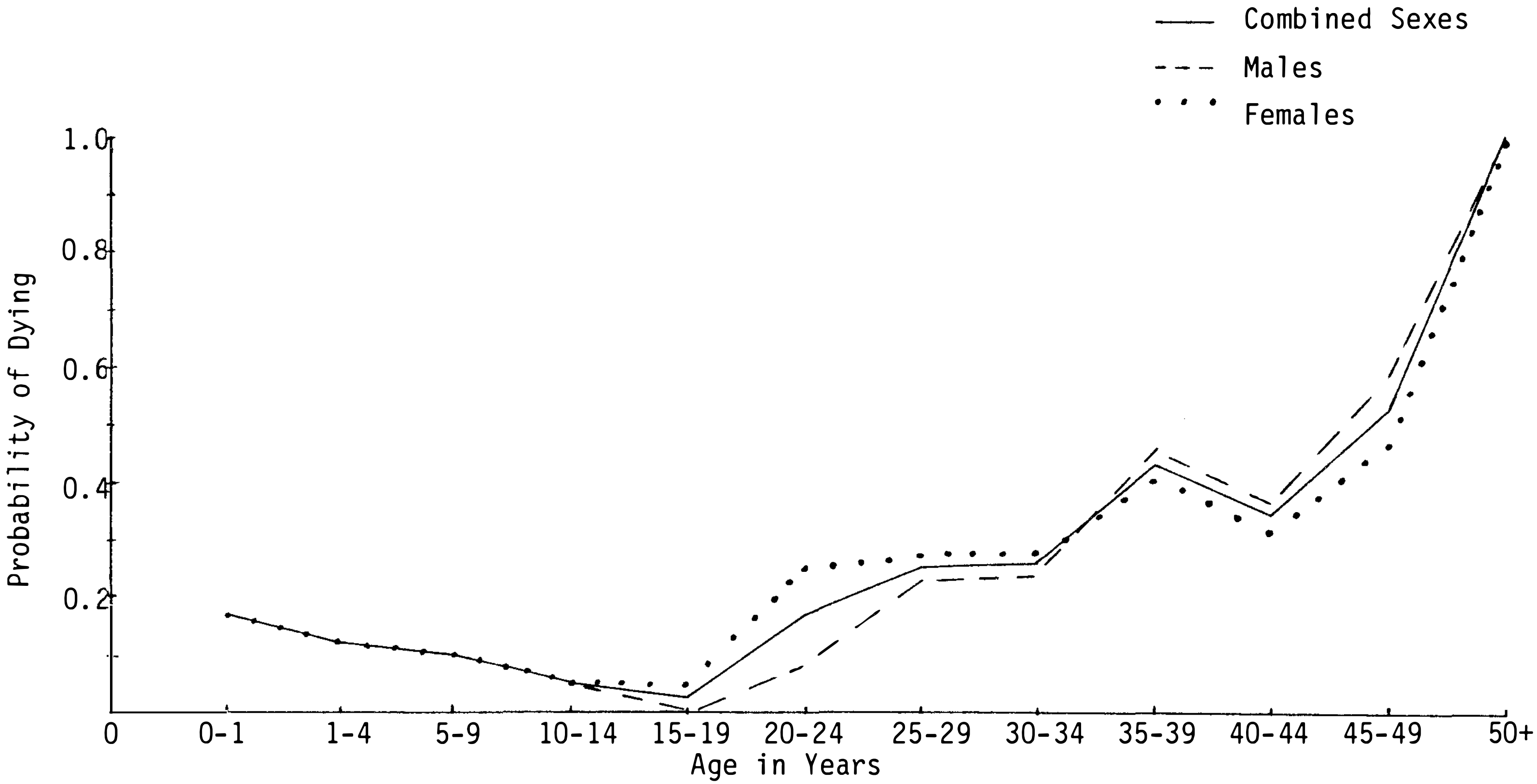


Figure 17. Probability of Dying Curve for the Ledford Island Population.

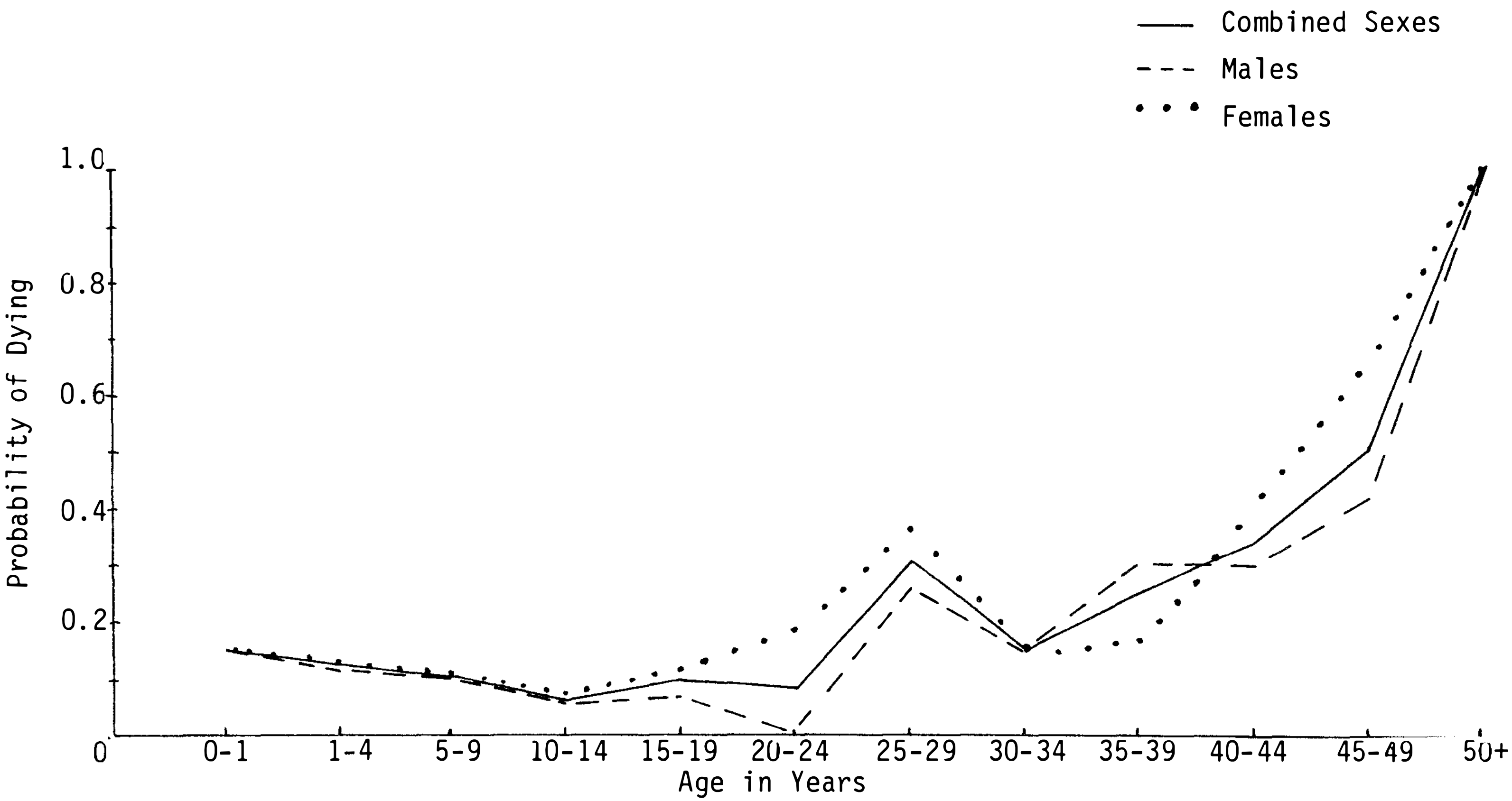


Figure 18. Probability of Dying Curve for the Rymer Population.

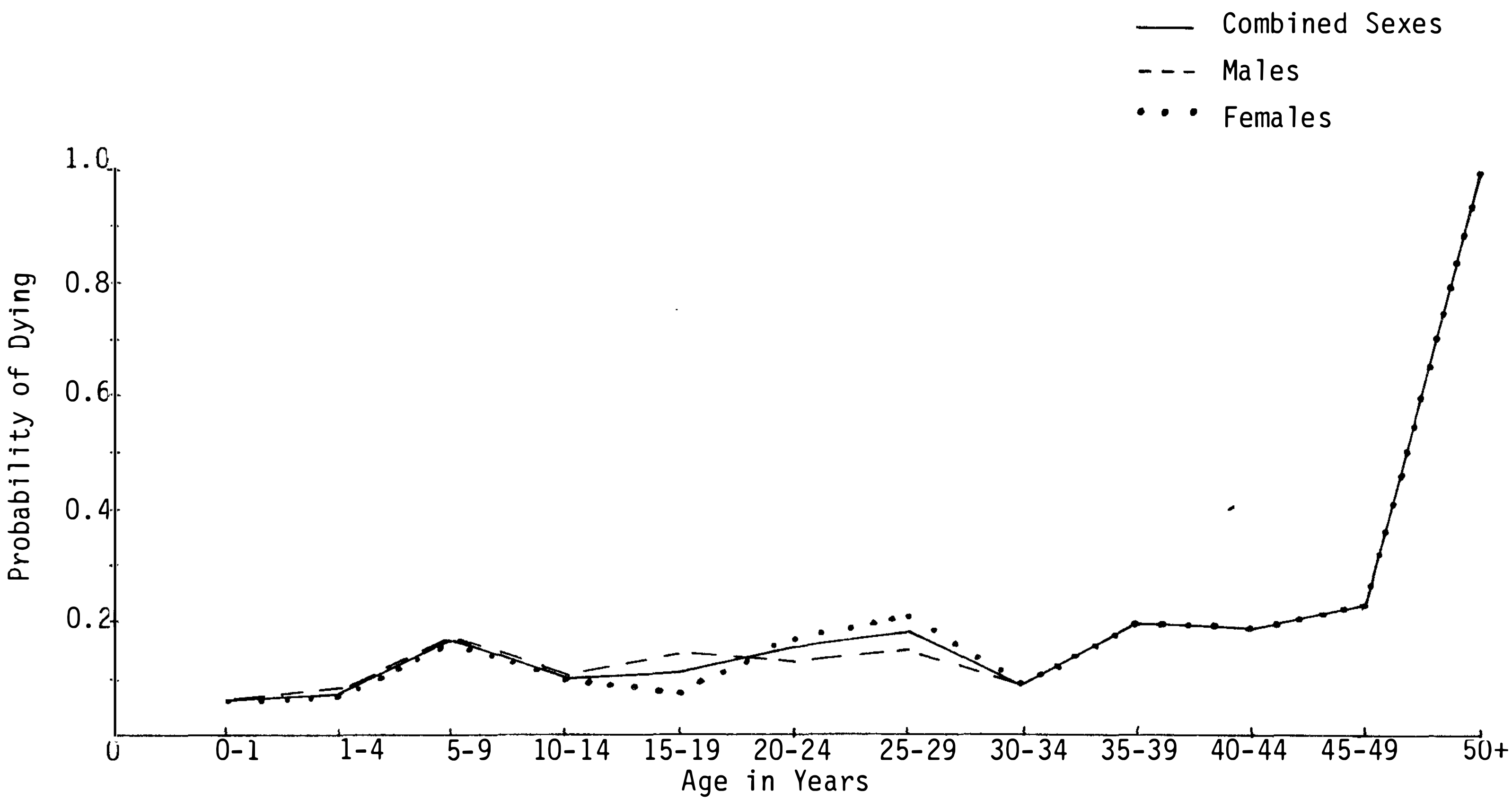


Figure 19. Probability of Dying Curve for the Mouse Creek Population.

combined sex, is the lowest of all age intervals). The death probability increases steadily throughout the remainder of the intervals (with the exception of slight decreases in the 10-14 and 30-34 age intervals), reaching a peak in the last two categories. Male probability of death is substantially higher than female in the 15-19 age category, while the reverse is true for the 20-24 and 25-29 values.

Column six, Lx, the total number of years lived in each interval, is not directly utilized in any curve generation or subsequent comparison. However, column seven (Tx - the total number of years lived after each interval) plays an integral role in the calculation of the final column, ex - life expectancy.

Life Expectancy

Curves based on life expectancy data in column seven are presented in Figures 20-22. At birth, the Ledford Island life expectancy curve shows a value of 22.47 years (combined sex), rising to a maximum peak of 26.10 years during the 1-4 age interval (Figure 20). Male life expectancy at birth is 2.03 years higher than that of females. It continues to exceed the female rate up until 25-29, when sex differences become minimal.

Life expectancy at birth for Rymer (Figure 21) is 23.82 years. This rises to a maximum peak of 26.76 years at 1-4 and declines steadily up to the 25-29 age interval. From here to 30-34, life expectancy decreases only .30 years. A steady decline follows.

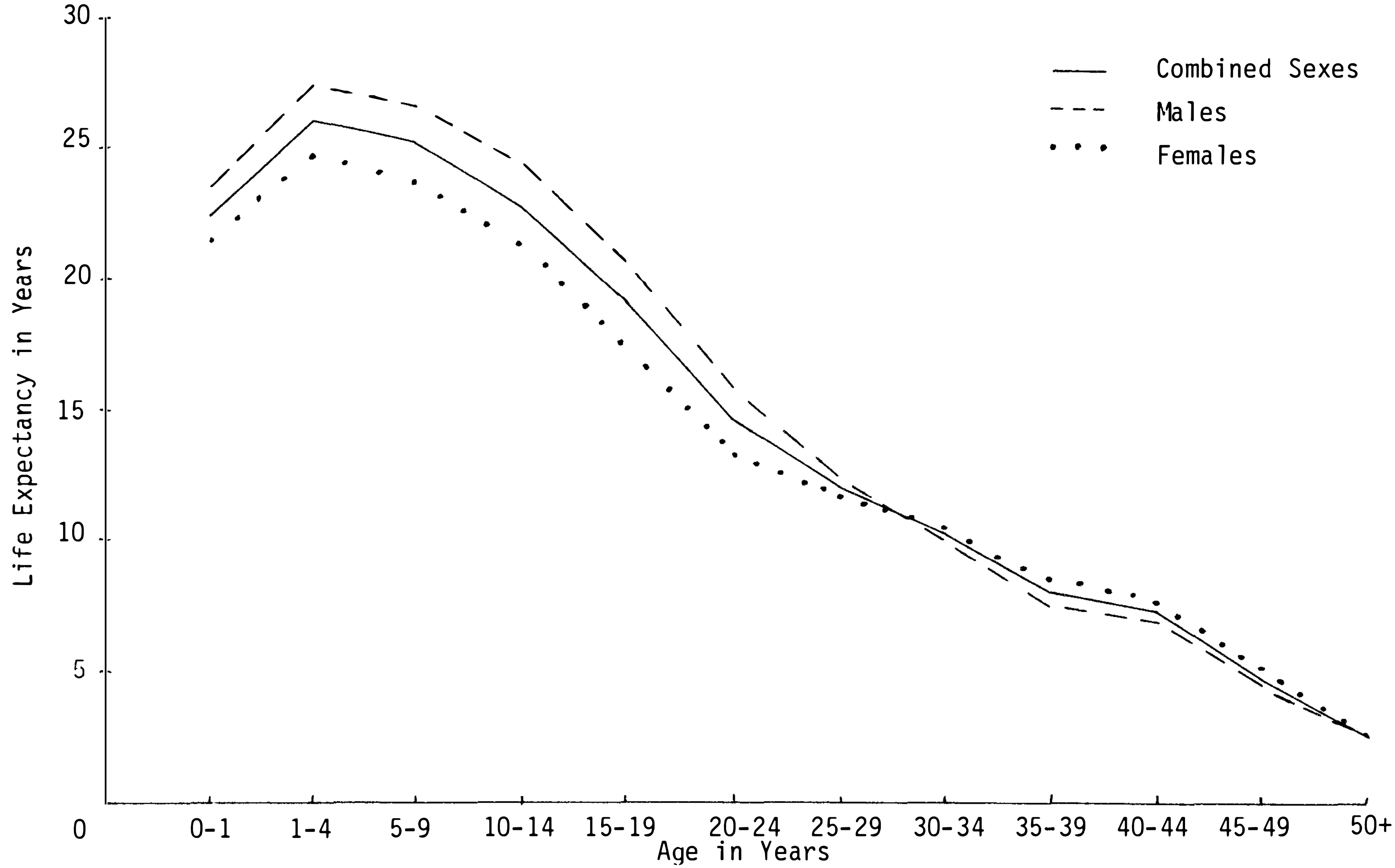


Figure 20. Life Expectancy Curve for the Ledford Island Population.

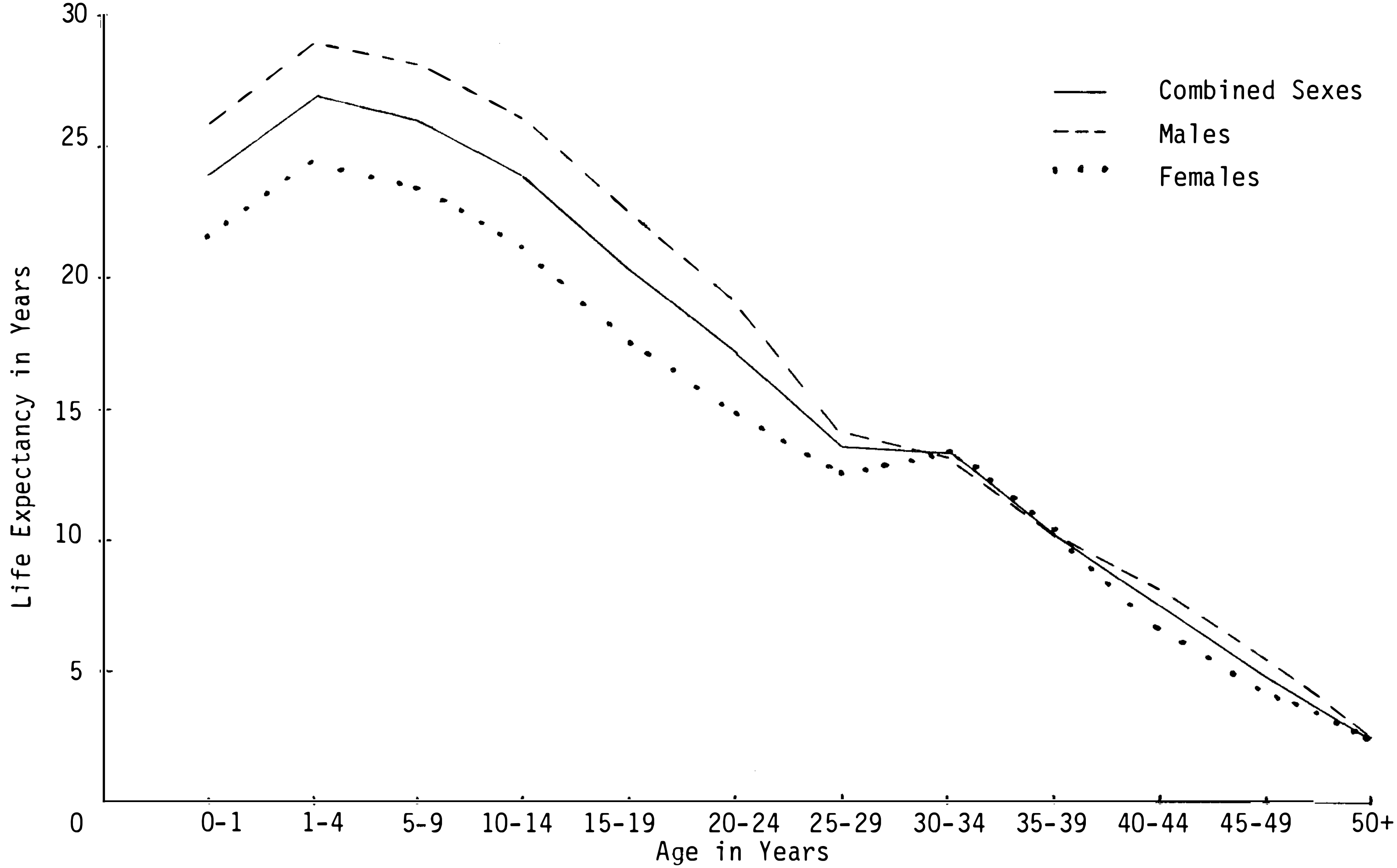


Figure 21. Life Expectancy Curve for the Rymer Population.

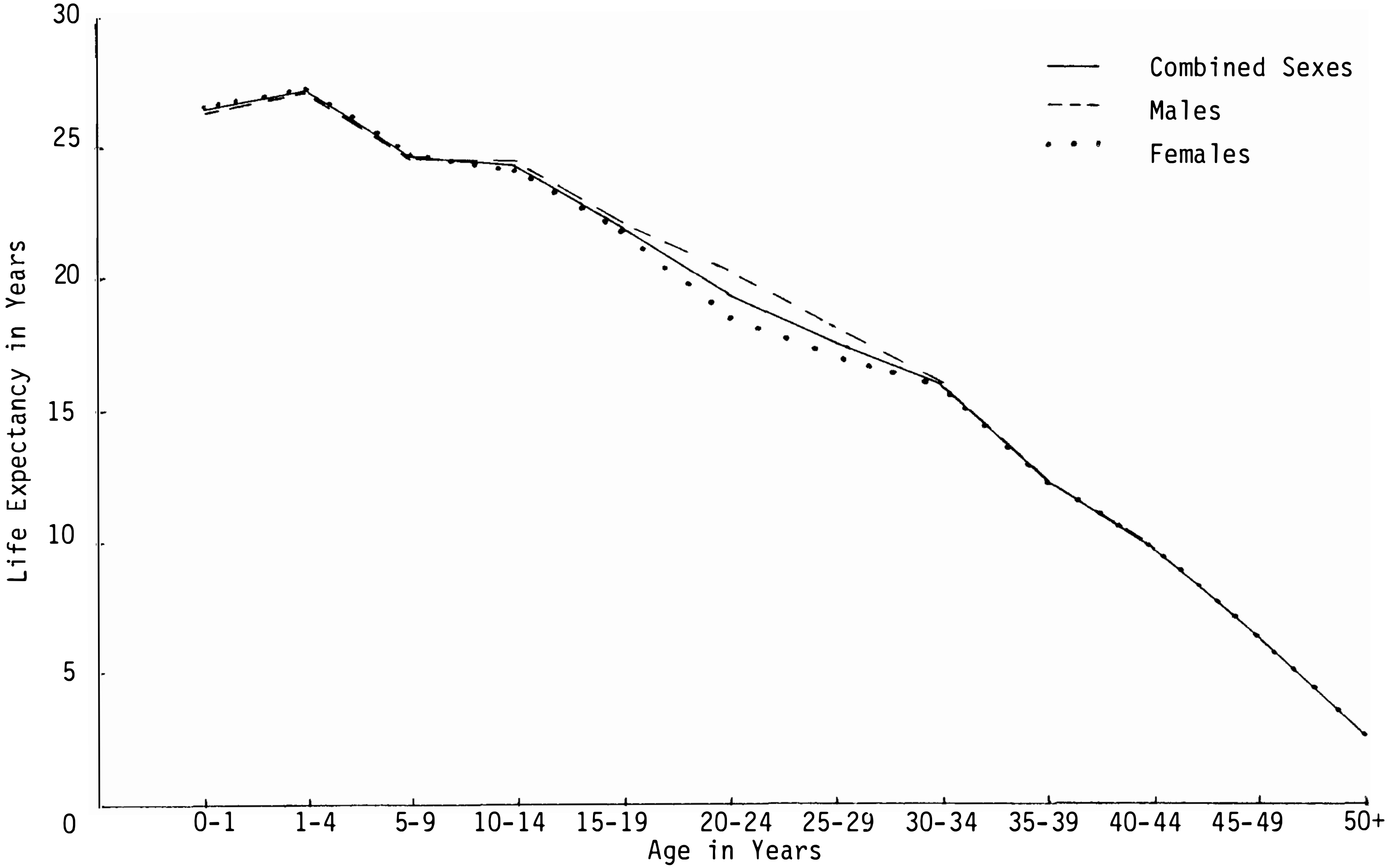


Figure 22. Life Expectancy Curve for the Mouse Creek Population.

Male life expectancy exceeds that of females at birth by 4.29 years and continues to exceed the female rate up to 30-34.

Mouse Creek life expectancy (Figure 22) at birth is 26.28 years (combined sex), with a maximum peak of 27.10 years reached during the 1-4 interval. The statistic decreases steadily throughout the remaining intervals. Sex differences are minimal throughout, with the only exception being slightly lower female values through the 15-19 ages.

Crude Mortality Rate and Population Size

Given the assumption of a stationary population, 1/ex estimates crude mortality rate (m). This represents the number of individuals dying per thousand per year (Ubelaker 1974:65). These values are calculated for each Mouse Creek Phase site:

Ledford Island. m=44.50/1000;

Rymer. m=41.98/1000;

Mouse Creek. m=38.05/1000;

A recent article by Sattenspiel and Harpending (1983) challenges the correlation between this statistic and information regarding population mortality. Instead they argue that the figure is more reflective of the crude birth rate, providing insights into fecundity data for a given population. For comparative purposes, however, a cross-cultural comparison of crude mortality rates as well as life expectancy at birth values for selected Amerindian skeletal populations is presented in Table 22.

Table 22. Comparison of Life Expectancy at Birth Values and Crude Mortality Rates for Selected Amerindian Skeletal Populations.*

Population	Date	Life Expectancy At Birth (Years)	Crude Mortality Rate (per 1000)
Averbuch, Tennessee	A.D. 1300-1400	16.6	60.0
Indian Knoll, Kentucky	3000 B.C.	18.6	59.0
Larson, South Dakota	A.D. 1750-1781	13.7	73.0
Leavenworth, South Dakota	A.D. 1800-1832	15.9	63.0
Ledford Island, Tennessee	A.D. 1420-1470	22.5	44.5
Mouse Creek, Tennessee	A.D. 1400-1500	26.3	38.1
Nanjemoy-Ossuary I, Maryland	A.D. 1500-1600	20.9	48.0
Nanjemoy-Ossuary II, Maryland	A.D. 1500-1600	22.9	44.0
Rymer, Tennessee	A.D. 1400-1500	23.8	42.0
Toqua, Tennessee	A.D. 1300-1600	16.1	62.0

*Modified from Owsley (1975:84), Berryman (1981:68) and Parham (1982:49).

Population size (P) can be estimated according to Ubelaker (1974:66) by considering the time interval (T) of population occupation, crude mortality rate (m), and total sample size (n) in the following formula: P=1000n/mT. For Ledford Island, a total skeletal population of approximately 3962 is estimated given that 11.66% of the site area was excavated. Considering the roughly 100 year span of occupation, a total population size (P) of 890.34 individuals at any specific point in time is obtained. Given the 20.83% of the Rymer site area excavated and the subsequent estimate of 811 total individuals, a total population size of 193.19 persons is estimated. Because no estimation could be made regarding the percent of site area excavated at the Mouse Creek site, or subsequently the total number of burials, no attempt will be made to calculate the Mouse Creek site population size.

IV. DISCUSSION OF THE MOUSE CREEK PHASE SITE RESULTS

Mortality, survivorship, probability of death and life expectancy curves for the combined sexes of Ledford Island, Rymer and Mouse Creek sites are directly compared in Figures 23-26. Generally, the similarity of the Ledford Island and Rymer individuals as manifested by all the curves can be seen, especially in reference to the subadult mortality experience. Both populations exhibit relatively high mortality and probability of death values (and thus low survivorship) in the first (0-1) age category, becoming lowest in the healthiest teen years. This similarity can also be seen

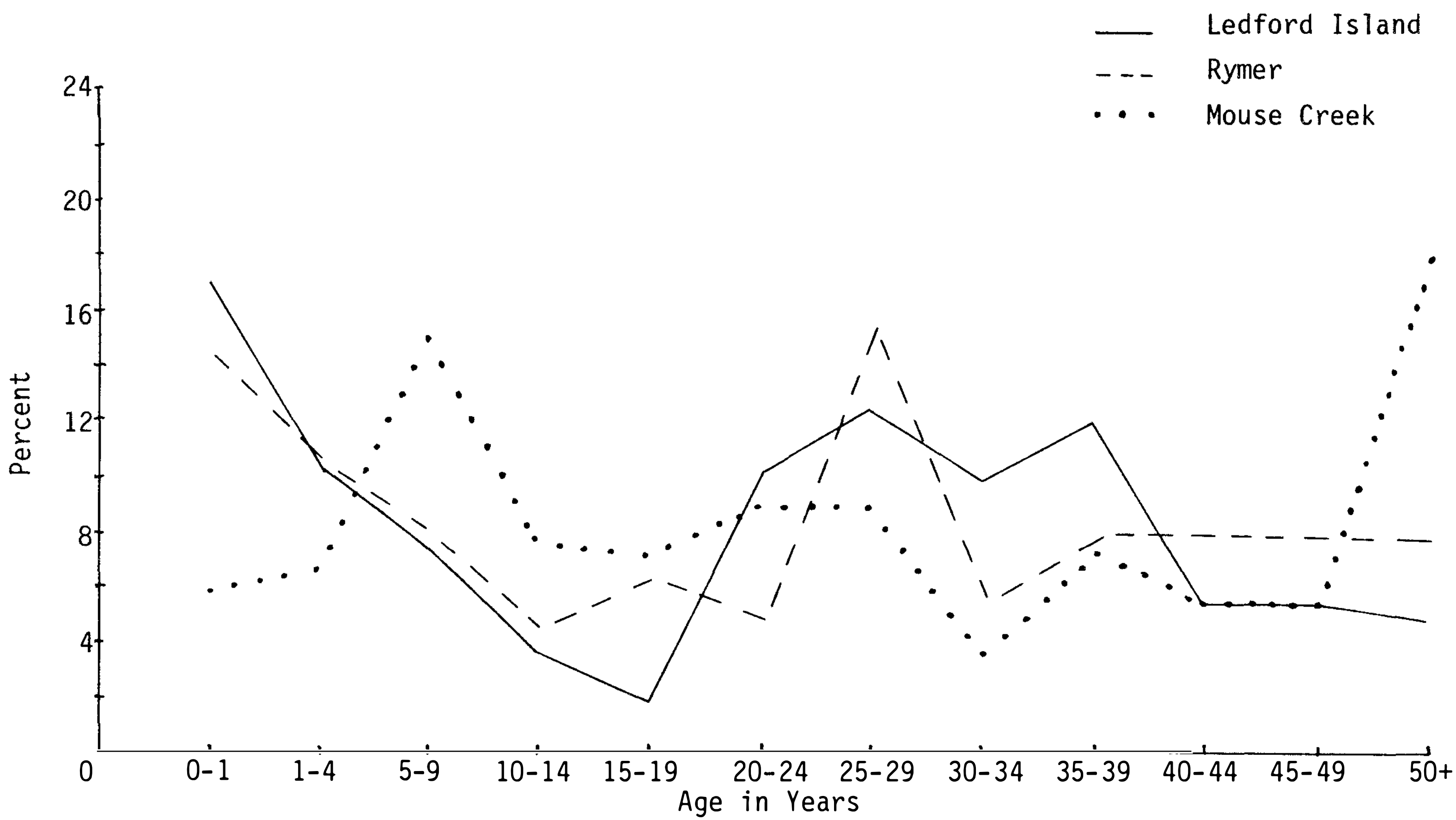


Figure 23. Mortality Curve Comparisons for the Ledford Island, Rymer and Mouse Creek Populations (Combined Sex).

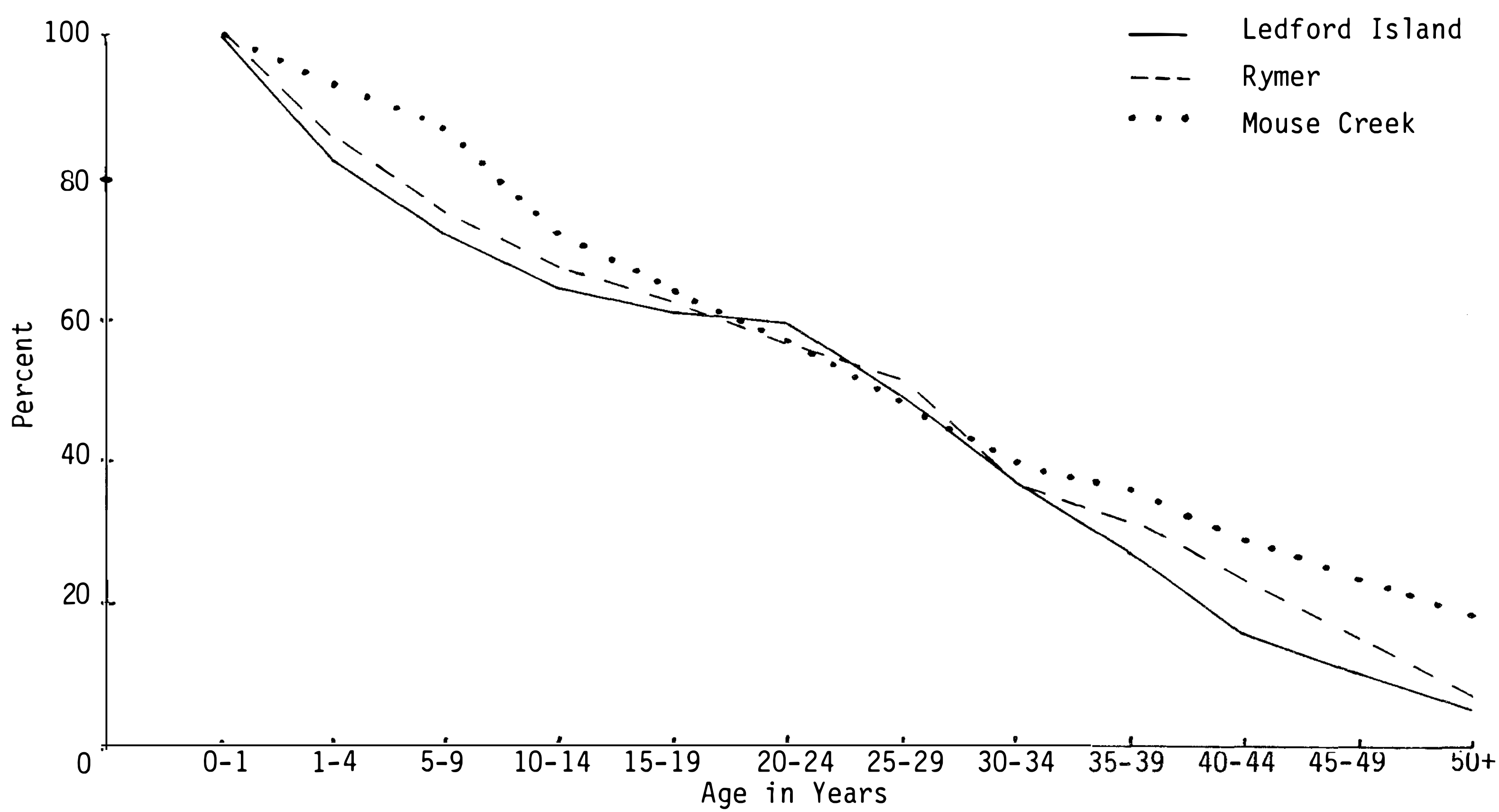


Figure 24. Survivorship Curve Comparisons for the Ledford Island, Rymer and Mouse Creek Populations (Combined Sex).

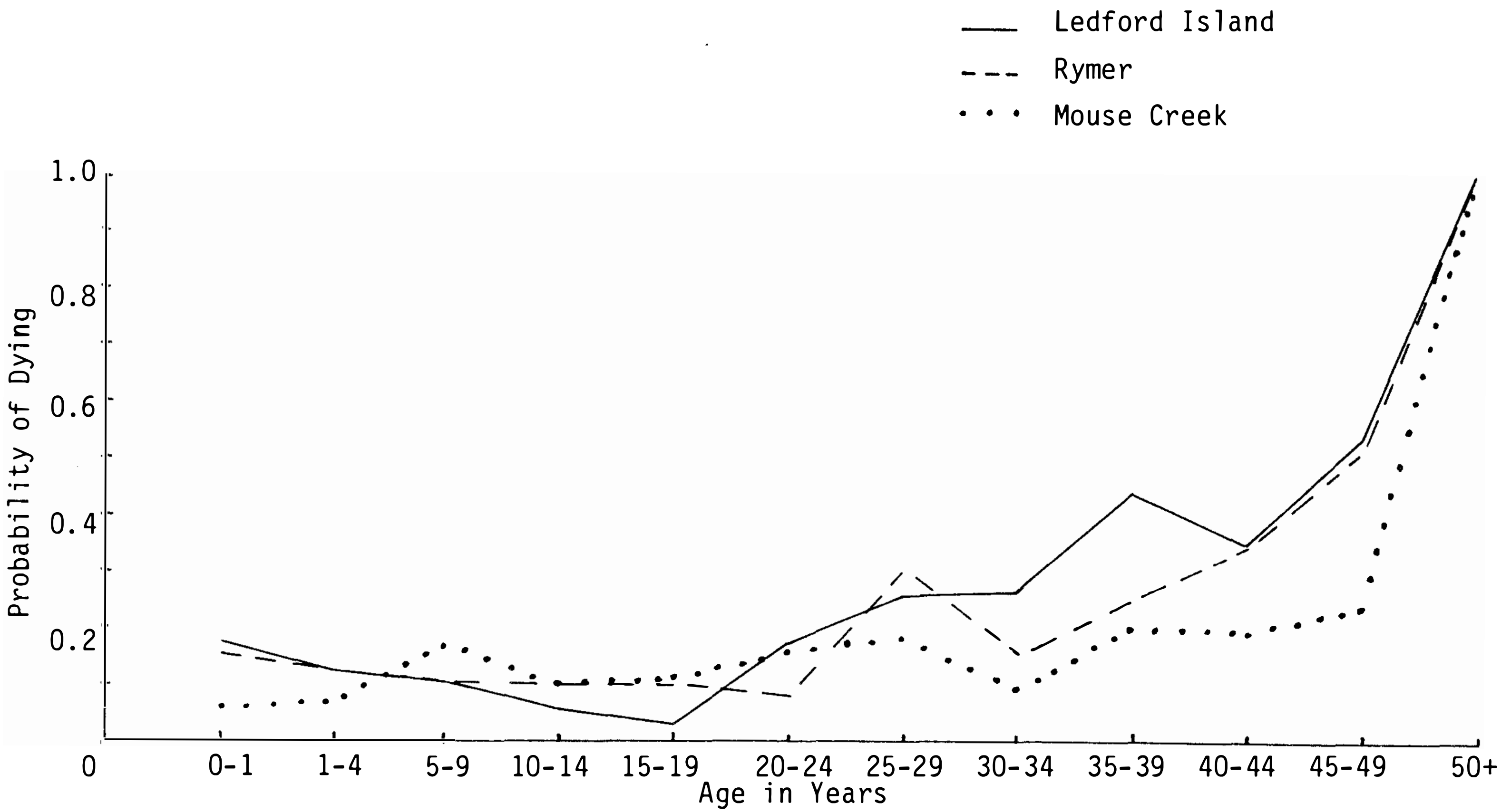


Figure 25. Probability of Dying Curve Comparisons for the Ledford Island, Rymer and Mouse Creek Populations (Combined Sex).

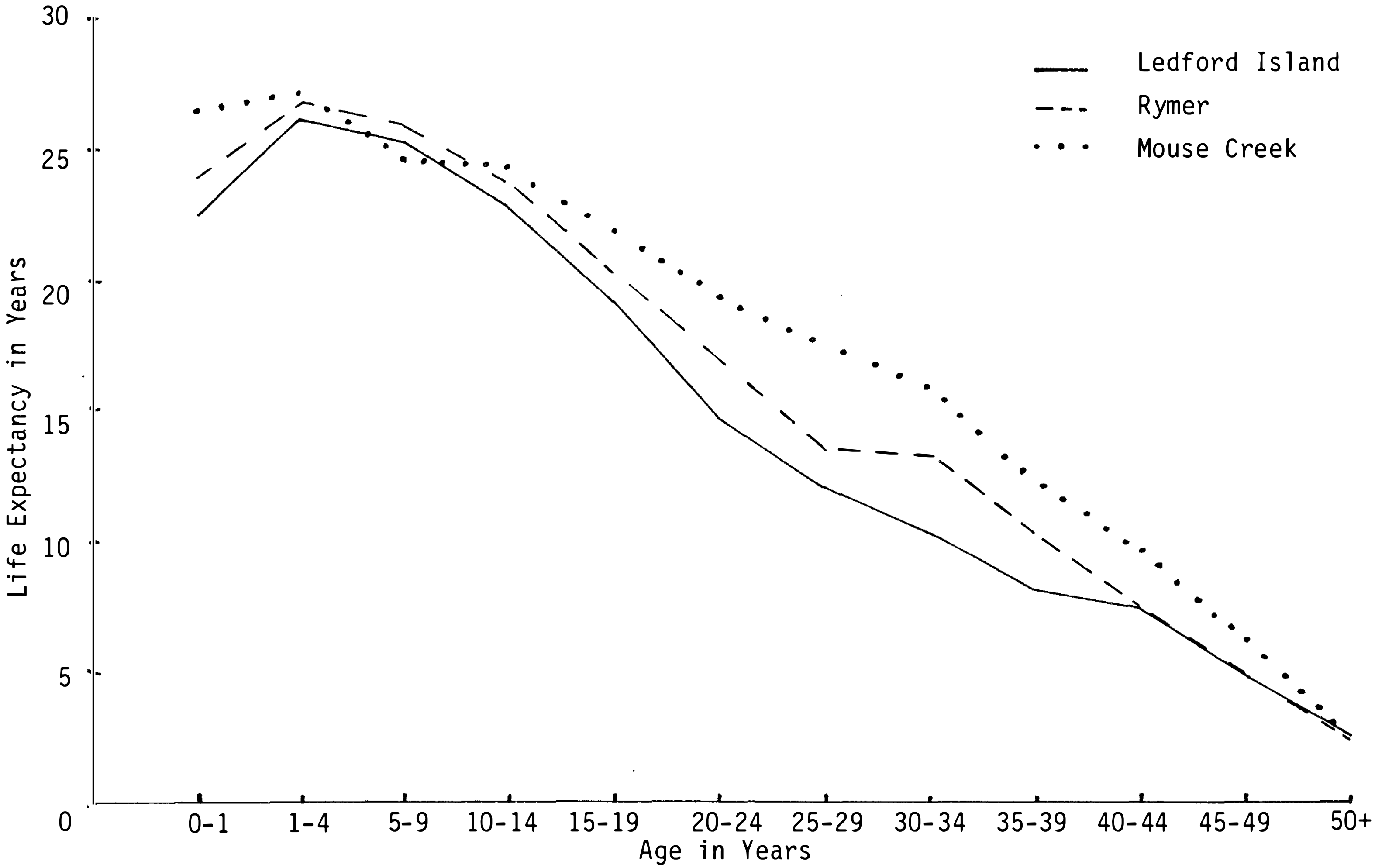


Figure 26. Life Expectancy Curve Comparisons for the Ledford Island, Rymer and Mouse Creek Populations (Combined Sex).

in the subadult life expectancy values. Some variability, however, is noted in the adult years, with Ledford Island manifesting relatively high mortality rates throughout the 20-40 age range. Rymer adult mortality, on the other hand, peaks at 25-29, remaining comparatively low otherwise. Life table curves for both the Ledford Island and Rymer populations approach the curve morphology noted for other similar Amerindian skeletal populations (Acsádi and Nemeskéri 1970). No indications of epidemic disease or warfare related demographic stress (Weiss 1975) are found.

In contrast, the Mouse Creek site demographic curves show a marked dissimilarity to those of Ledford Island and Rymer. As noted previously, subadult mortality and probability of death are lowest in the first (0-1) age category. This is dramatized by the extremely high (26.28 years) life expectancy at birth value--one of the highest noted for an Amerindian skeletal population. It is precisely this infant category, in conjunction with the 1-4 ages, in which one would expect high amounts of stress and thus mortality in a randomly sampled population. Mouse Creek children in the 5-9 age range, instead, exhibit this stress. Differences are also seen in the adult curves, with adult mortality being relatively low until the last 50+ age category. Archaeological sampling biases as well as differential disposal and preservation of subadults could be contributing to the skewed picture observed for the Mouse Creek site skeletal sample. None of the life table patterns from the Mouse Creek Phase sites could be readily correlated with Weiss' (1973) model life tables.

Demographic Sexual Dimorphism

Sex differences in the demographic curves of the Mouse Creek Phase sites are visually present, but Kolmogorov-Smirnov tests indicate male and female mortality at each site are not significantly different. At Ledford Island and Rymer, the slightly higher female mortality in the younger adult categories (15-24) compared to the males most likely reflects the greater stress associated with first- or second-time pregnancies and childbirth in young females. Higher male mortality in the later adult years (35+) could be a result of the relative greater susceptibility of the more active and outwardly mobile males to intentional or accidental traumatic death.

The Mouse Creek site sexual variation pattern shows a slightly different pattern. While young adult females (20-29) generally exhibit a higher mortality, 15-19 year males show a much greater amount of stress than females of the same age range. Later on in adulthood, male and female mortality rates become more similar. Explanatory frameworks for this situation are similar to those noted above.

V. RESULTS OF THE PALEODEMOGRAPHIC COMPARISON OF LEDFORD ISLAND, TOQUA AND AVERBUCH

The Ledford Island site, because of its large and reliable sample size and reasonable previous demographic results, was used in the comparison with Toqua and Averbuch. However, it first had to be standardized (in terms of age categories) with the other two sites. Tables 23-25 present revised life table calculations for

Table 23. Standardized Abridged Life Table Values Calculated Using the Age Distribution of the Ledford Island Individuals (Combined Sex).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	77.78	17.21	100.00	.172	86.23	2215.98	22.16
1-5	52.20	11.55	82.79	.139	330.21	2129.75	25.72
5-10	30.70	6.79	71.24	.095	339.23	1799.54	25.26
10-15	14.32	3.17	64.45	.049	314.33	1460.31	22.66
15-20	8.22	1.82	61.28	.030	301.85	1145.98	18.70
20-25	45.89	10.15	59.46	.171	271.92	844.13	14.20
25-30	56.00	12.39	49.31	.251	215.57	572.21	11.60
30-35	43.65	9.66	36.92	.262	160.45	356.64	9.66
35-40	53.73	11.89	27.26	.436	106.57	196.19	7.20
40-45	23.21	5.13	15.37	.334	64.02	89.62	5.83
45+	46.29	10.24	10.24	1.000	25.60	25.60	2.50
Total	452.0	100.00	-	-	2215.98	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 24. Standardized Abridged Life Table Values Calculated Using the Age Distribution of the Ledford Island Males.*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	38.89	17.25	100.00	.172	86.20	2315.73	23.16
1-5	26.10	11.57	82.75	.140	330.00	2229.53	26.94
5-10	15.35	6.81	71.18	.096	338.87	1899.53	26.69
10-15	7.16	3.17	64.37	.049	313.92	1560.66	24.24
15-20	1.03	0.46	61.20	.007	304.85	1246.74	20.37
20-25	12.35	5.48	60.74	.090	290.00	941.89	15.51
25-30	28.84	12.79	55.26	.231	244.32	651.89	11.80
30-35	23.68	10.50	42.47	.247	186.10	407.57	9.60
35-40	32.96	14.62	31.97	.457	123.30	221.47	6.93
40-45	14.42	6.39	17.35	.368	70.77	98.17	5.66
45+	24.72	10.96	10.96	1.000	27.40	27.40	2.50
Total	225.5	100.0	-	-	2315.73	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 25. Standardized Abridged Life Table Values Calculated Using the Age Distribution of the Ledford Island Females.*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	38.89	17.17	100.00	.172	86.26	2117.01	21.17
1-5	26.10	11.52	82.83	.139	330.45	2030.75	24.52
5-10	15.35	6.78	71.31	.095	339.60	1700.30	23.84
10-15	7.16	3.16	64.53	.049	314.75	1360.70	21.09
15-20	7.19	3.17	61.37	.052	298.92	1045.95	17.04
20-25	33.54	14.81	58.20	.254	253.97	747.03	12.83
25-30	27.16	11.99	43.39	.276	186.97	493.06	11.36
30-35	19.97	8.82	31.40	.281	134.95	306.09	9.75
35-40	20.77	9.17	22.58	.406	89.97	171.14	7.58
40-45	8.79	3.88	13.41	.289	57.35	81.17	6.05
45+	21.57	9.52	9.53	1.000	23.82	23.82	2.50
Total	226.5	100.0	-	-	2117.01	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Ledford Island males, females as well as combined sex based on the new age categories. Toqua life table values remain essentially intact as extracted from Parham (1982:39-41) and are reproduced in Tables 26-28. Because an accurate estimation of the total site and population size was made at Averbuch (Berryman 1981:25-29), more specific distributions of unrecoverable specimens according to location (Cemetery 1, 2, 3 and Structures) were conducted. These special circumstances along with Berryman's original life table calculations (Tables 29-31) are left intact and utilized in this comparison. Although the age categories differ slightly in the subadult age ranges (for example, 1.5-5.5 in contrast to 1-5), the essential morphology of the demographic curves remains comparable. It is this data, then, that is emphasized in the comparison.

Mortality

Mortality curve comparisons for the combined sexes of the three sites are found in Figure 27. Throughout the curve, Ledford Island generally manifests a lower (healthier) mortality rate in the subadult and early adult years (with the only exception being the lower Averbuch rate in the 10.5-15.5 age ranges) and a higher mortality in the older adult (30+) years. Toqua and Averbuch mortality curves both reflect much greater stress in the subadult range, particularly in the first highly stressed 0-1 (or 0-1.5) age category. However, in the next category (1.5-5.5 or 1-5), Averbuch mortality still remains quite high, while Toqua begins a rapid descent.

Table 26. Abridged Life Table Values Calculated Using the Age Distribution of the Toqua Individuals (Combined Sex) (from Parham 1982:39).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	99.00	22.55	100.00	.226	81.96	1611.96	16.12
1-5	57.00	12.98	77.45	.168	305.06	1530.00	19.75
5-10	37.00	8.43	64.47	.131	301.28	1224.94	19.00
10-15	24.00	5.47	56.04	.098	266.53	923.66	16.48
15-20	41.00	9.34	50.57	.185	229.50	657.13	12.99
20-25	61.00	13.90	41.23	.337	171.40	427.63	10.37
25-30	35.00	7.97	27.33	.292	116.73	256.23	9.38
30-35	36.00	8.20	19.36	.424	76.30	139.50	7.21
35-40	26.00	5.92	11.16	.530	41.00	63.20	5.66
40-45	15.00	3.42	5.24	.653	17.65	22.20	4.24
45+	8.00	1.82	1.82	1.000	4.55	4.55	2.50
Total	439.0	100.0	-	-	1611.96	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 27. Abridged Life Table Values Calculated Using the Age Distribution of the Toqua Males (from Parham 1982:40).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	50.00	21.93	100.00	.219	82.41	1705.12	17.05
1-5	29.00	12.72	78.01	.163	308.17	1662.71	20.80
5-10	14.00	6.14	65.35	.094	311.40	1314.54	20.16
10-15	20.00	8.77	59.21	.148	274.13	1003.14	16.94
15-20	14.00	6.14	50.44	.122	236.85	729.01	14.45
20-25	31.00	13.60	44.30	.307	187.50	492.16	11.11
25-30	16.00	7.02	30.70	.229	135.95	304.66	9.92
30-35	23.00	10.09	23.68	.426	93.18	168.71	7.12
35-40	17.00	7.46	13.59	.549	49.30	75.53	5.56
40-45	9.00	3.95	6.13	.644	20.78	26.23	4.28
45+	5.00	2.19	2.18	1.000	5.45	5.45	2.50
Total	228.00	100.0	-	-	1705.12	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 28. Abridged Life Table Values Calculated Using the Age Distribution of the Toqua Females (from Parham 1982:41).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1	49.00	23.22	100.00	.232	81.42	1510.89	15.11
1-5	28.00	13.27	76.78	.173	301.59	1429.47	18.62
5-10	23.00	10.90	63.51	.172	290.30	1127.88	17.76
10-15	4.00	1.90	52.61	.036	258.30	837.58	15.92
15-20	27.00	12.80	50.71	.252	221.55	579.28	11.42
20-25	30.00	14.22	37.91	.375	154.00	357.73	9.44
25-30	19.00	9.00	23.69	.380	95.95	203.73	9.00
30-35	13.00	6.16	14.69	.419	58.05	107.78	7.34
35-40	9.00	4.27	8.53	.501	31.98	49.73	5.83
40-45	6.00	2.84	4.26	.667	14.20	17.75	4.17
45+	3.00	1.42	1.42	1.000	3.55	3.55	2.50
Total	211.00	100.0	-	-	1510.89	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 29. Abridged Life Table Values Calculated Using the Age Distribution of the Averbuch Individuals (Combined Sex) (from Berryman 1981:57).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1.5	276.22	22.43	100.00	.224	82.06	1661.22	16.61
1.5-5.5	238.51	19.36	77.57	.250	287.78	1579.16	20.36
5.5-10.5	61.30	4.98	58.21	.086	278.60	1291.38	22.18
10.5-15.5	28.93	2.35	53.23	.044	260.28	1012.78	19.03
15.5-20	89.92	7.30	50.88	.143	212.54	752.50	14.79
20-25	176.75	14.35	43.58	.329	182.03	539.96	12.39
25-30	109.10	8.86	29.23	.303	124.00	357.93	12.25
30-35	76.14	6.18	20.37	.303	86.40	233.93	11.48
35-40	55.90	4.54	14.19	.320	59.60	147.53	10.40
40-45	35.01	2.84	9.65	.294	41.15	87.93	9.11
45-50	35.01	2.84	6.81	.417	26.95	46.78	6.87
50-55	24.47	1.99	3.97	.501	14.88	19.83	4.99
55-60	24.47	1.99	1.98	1.005	4.95	4.95	2.50
Total	1231.73	100.00	-	-	1661.22	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 30. Abridged Life Table Values Calculated Using the Age Distribution of the Averbuch Males (from Berryman 1981:58).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1.5	138.11	21.74	100.00	.217	82.61	1743.73	17.44
1.5-5.5	119.25	18.77	78.26	.240	292.16	1661.12	21.23
5.5-10.5	30.65	4.82	59.49	.081	285.40	1368.96	23.01
10.5-15.5	14.47	2.28	54.67	.042	267.65	1083.56	19.82
15.5-20	37.23	5.86	52.39	.112	222.57	815.91	15.57
20-25	95.76	15.07	46.53	.324	194.98	593.34	12.75
25-30	56.23	8.85	31.46	.281	135.18	398.36	12.66
30-35	43.32	6.82	22.61	.302	96.00	263.18	11.64
35-40	30.99	4.88	15.79	.309	66.75	167.18	10.59
40-45	20.07	3.16	10.91	.290	46.65	100.43	9.21
45-50	20.07	3.16	7.75	.408	30.85	53.78	6.94
50-55	14.59	2.30	4.59	.501	17.20	22.93	5.00
55-60	14.59	2.30	2.29	1.004	5.73	5.73	2.50
Total	635.33	100.0	-	-	1743.73	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

Table 31. Abridged Life Table Values Calculated Using the Age Distribution of the Averbuch Females (from Berryman 1981:59).*

x	Dx	dx	lx	qx	Lx	Tx	ex
0-1.5	138.11	23.16	100.00	.232	81.47	1462.98	14.63
1.5-5.5	119.25	19.99	76.84	.260	283.14	1381.51	17.98
5.5-10.5	30.65	5.14	56.85	.090	271.40	1098.37	19.32
10.5-15.5	14.47	2.43	51.71	.047	252.48	826.97	15.99
15.5-20	52.70	8.84	49.28	.179	90.99	574.49	11.66
20-25	80.99	13.58	40.44	.336	168.25	483.50	11.96
25-30	52.87	8.86	26.86	.330	112.15	315.25	11.74
30-35	32.82	5.50	18.00	.306	76.25	203.10	11.28
35-40	24.91	4.18	12.50	.334	52.05	126.85	10.15
40-45	14.94	2.50	8.32	.300	35.35	74.80	8.99
45-50	14.94	2.50	5.82	.430	22.85	39.45	6.78
50-55	9.88	1.66	3.32	.500	12.45	16.60	5.00
55-60	9.88	1.66	1.66	1.000	4.15	4.15	2.50
Total	596.41	100.0	-	-	1462.98	-	-

*See Chapter III, pages 39 and 43 for a discussion of the variables.

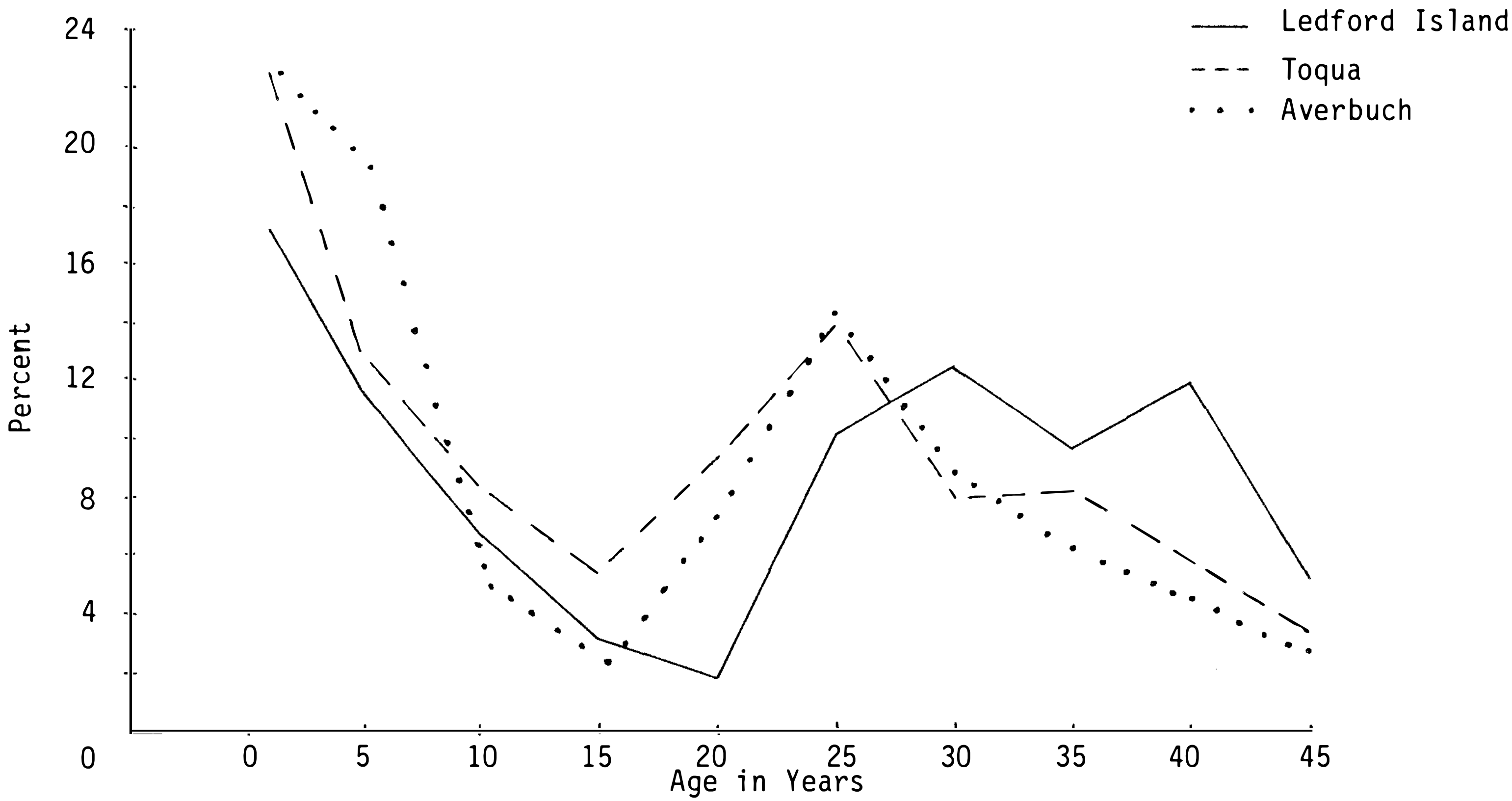


Figure 27. Mortality Curve Comparisons for the Ledford Island, Toqua and Averbuch Populations (Combined Sex).

The late teen years (15-20) represent the time period of the greatest difference between the two sites, with Toqua teenagers experiencing a much greater mortality in comparison with Averbuch. Otherwise, the mortality curves of the two sites are remarkably similar.

When this statistic is broken down into sexual components (Figures 28 and 29), young adult female Ledford Islanders experience more mortality than the males, while in the older years the reverse is true. Toqua and Averbuch sex differences are not pronounced, with the only significant exception being, once again, in the late teen category. Interestingly enough, it is the Toqua males which are responsible for the substantially higher mortality rate in this age category. Less significant differences are noted in the 35-40 age range, where again the Toqua males exceed Averbuch mortality figures. Toqua and Averbuch female mortality aged 25+ is remarkably similar.

Survivorship

A comparison of the survivorship curve for Ledford Island, Toqua and Averbuch (combined sex) is represented in Figure 30. Once again, the considerably better health status of the Ledford Island population is dramatically reflected throughout the curve. Although Averbuch survivorship is slightly higher than at Toqua, the close similarity between the demography of these two populations is clearly exemplified throughout the curve, with the only difference noted in the 10-15 age ranges (where Averbuch survivorship is slightly lower than at Toqua).

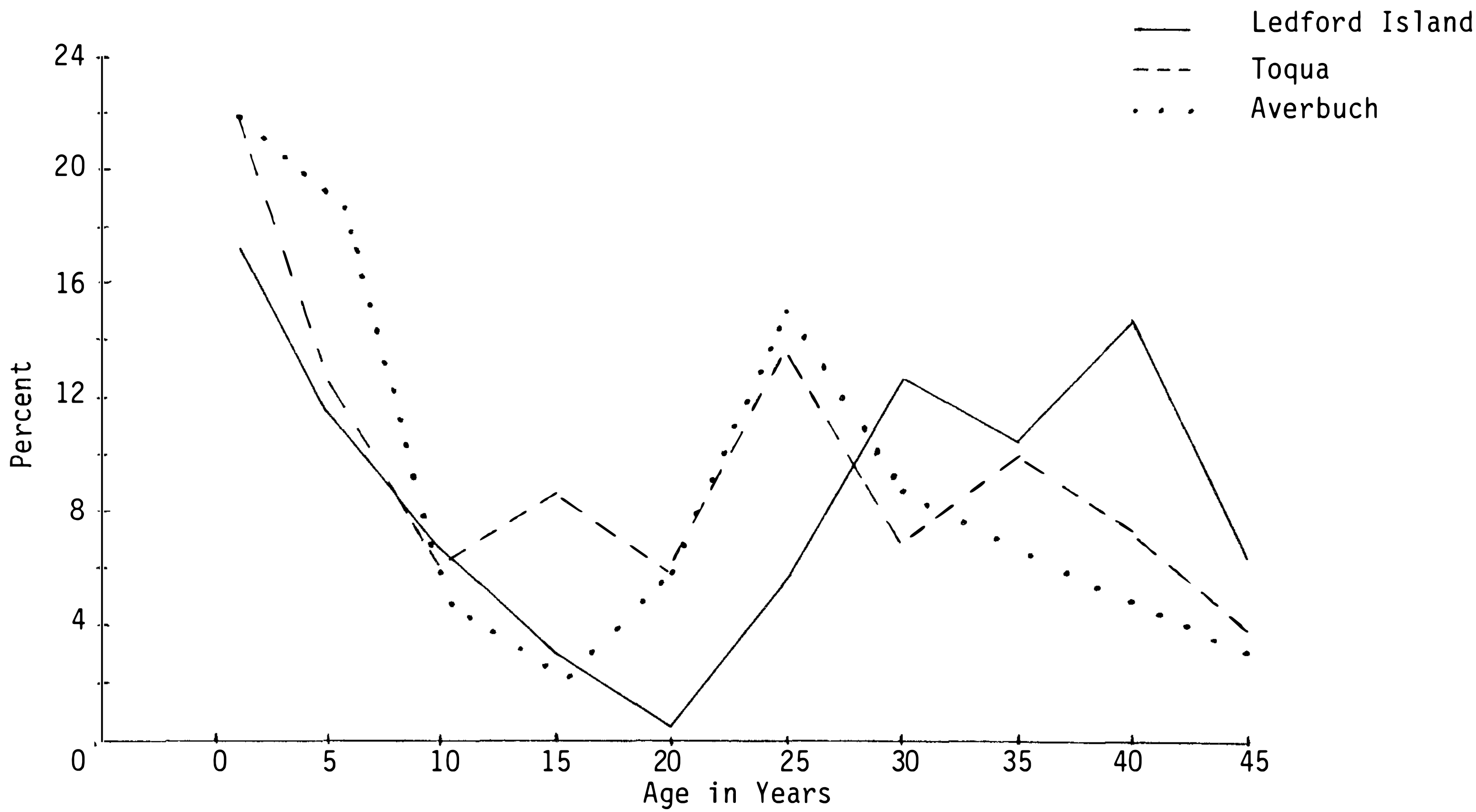


Figure 28. Mortality Curve Comparisons for the Ledford Island, Toqua and Averbuch Males.

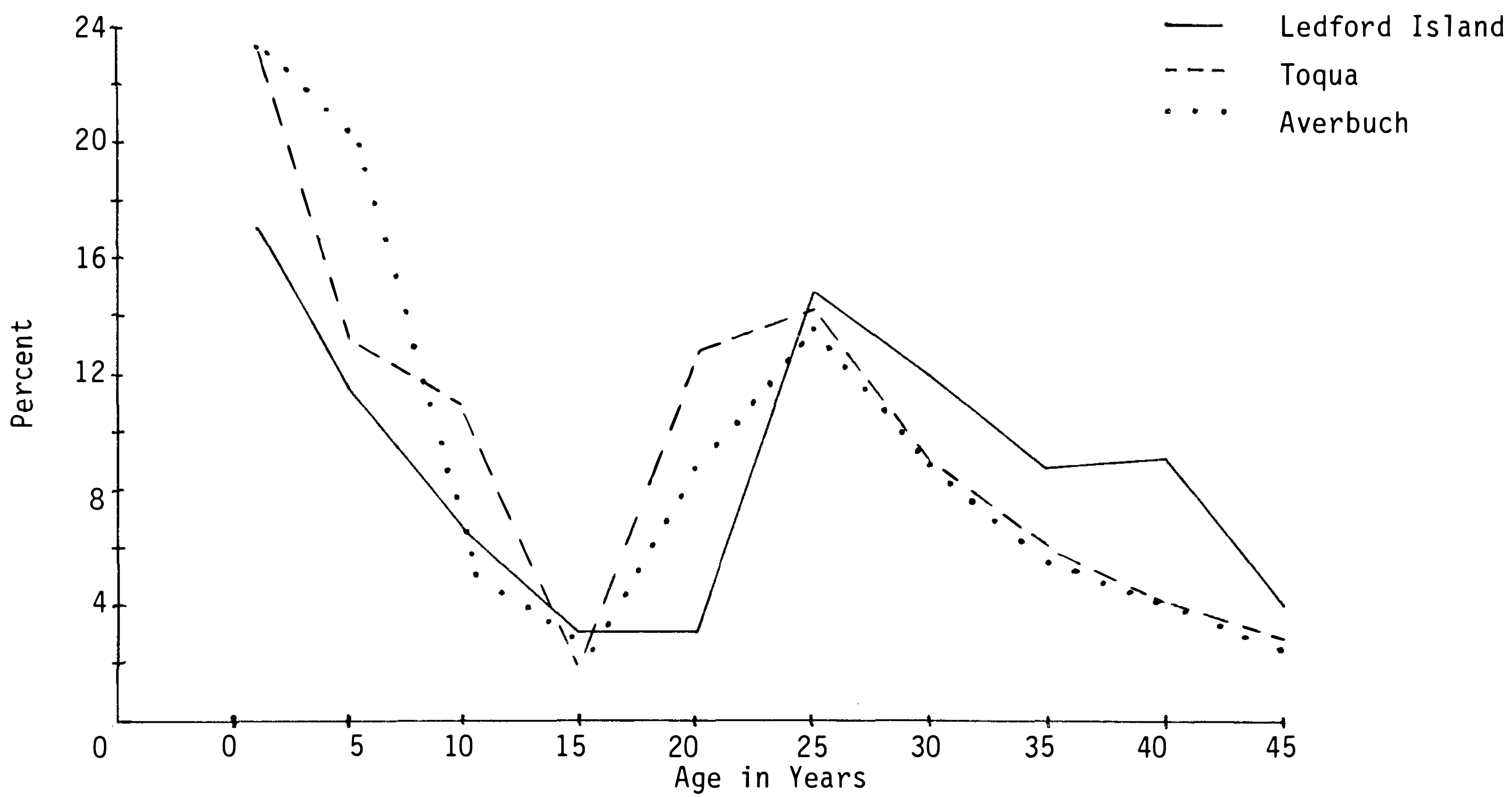


Figure 29. Mortality Curve Comparisons for the Ledford Island, Toqua and Averbuch Females.

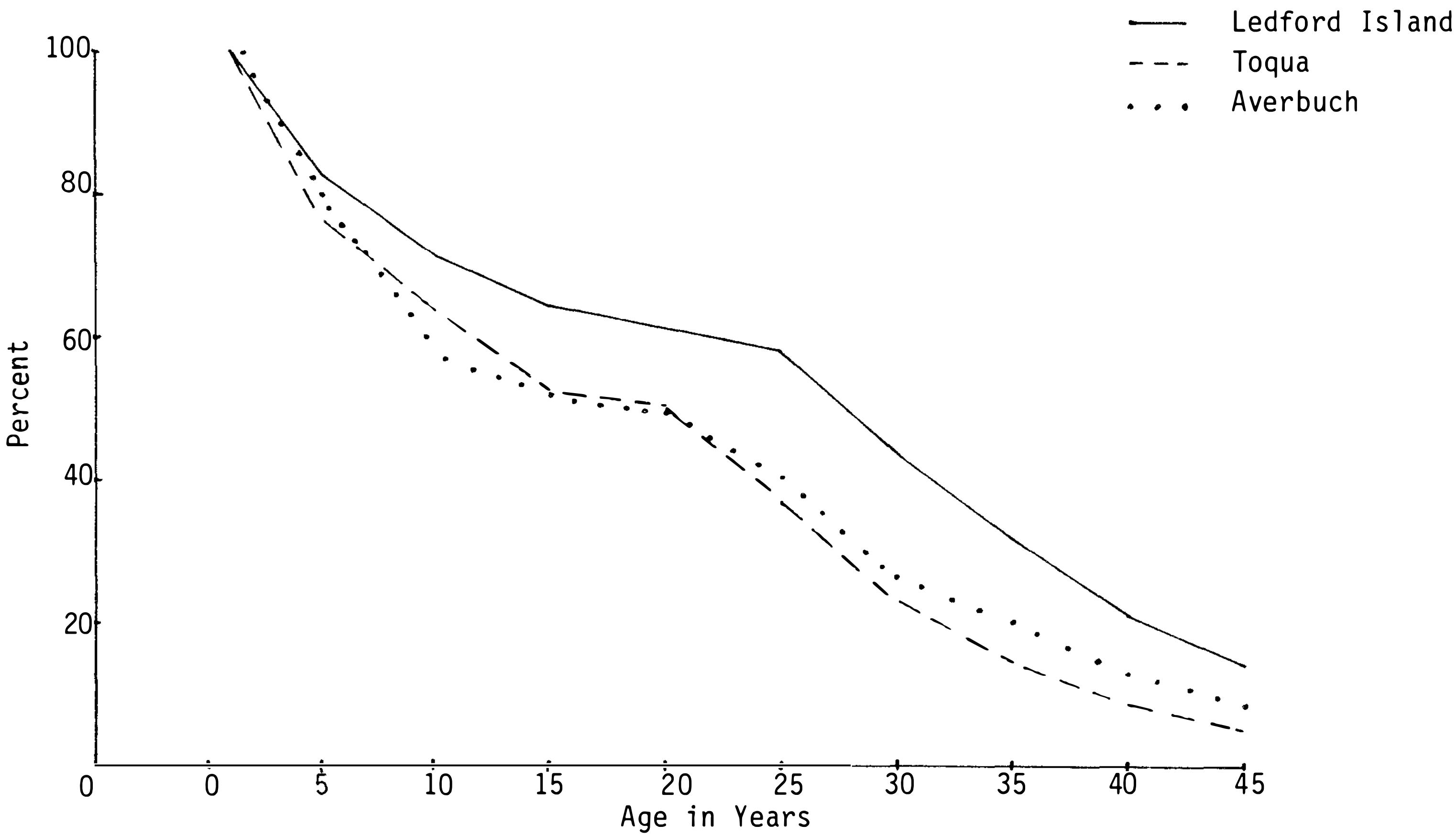


Figure 30. Survivorship Curve Comparisons for the Ledford Island, Toqua and Averbuch Populations (Combined Sex).

The same general patterns can also be seen in the individual male and female survivorship curves (Figures 31 and 32). Although very similar (especially the male curves), Averbuch survivorship runs slightly higher than at Toqua.

Probability of Dying

Figure 33 illustrates the probability of dying statistic for Ledford Island, Toqua and Averbuch (sexes combined). Once again, the relatively low probability of death rates for Ledford Island reflect that population's less stressed condition. Averbuch's elevated mortality pattern in the 1.5-5.5 age range is reflected in the relatively high probability of dying value for that category. Otherwise, the Averbuch curve compares favorably with that of Toqua, with the exception of the older adult (30+) categories, in which Toqua probability of death ascends rather abruptly. However, much of this is a function of the necessary truncation of the Averbuch curve at 45 years to insure comparability of samples.

Some sex differences are noted for this statistic (Figures 34 and 35). In the adult ages, Toqua females experience a slightly higher probability of death than Averbuch females throughout, whereas the males from the two sites differ substantially in the late teen and late adult categories.

Life Expectancy

The life expectancy at birth value of 22.16 years for the Ledford Island (combined sex) individuals in contrast to the similar

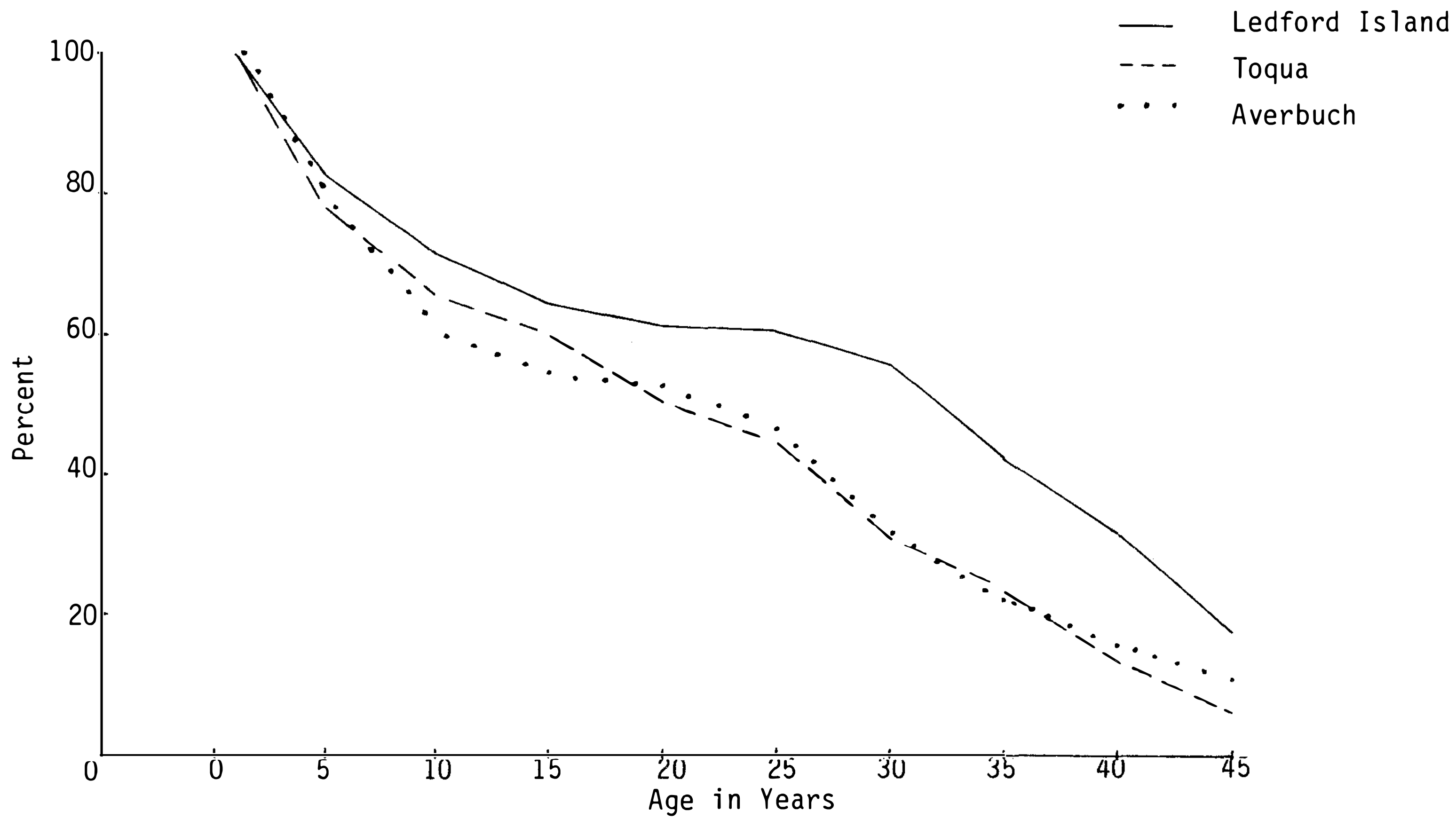


Figure 31. Survivorship Curve Comparisons for the Ledford Island, Toqua and Averbuch Males.

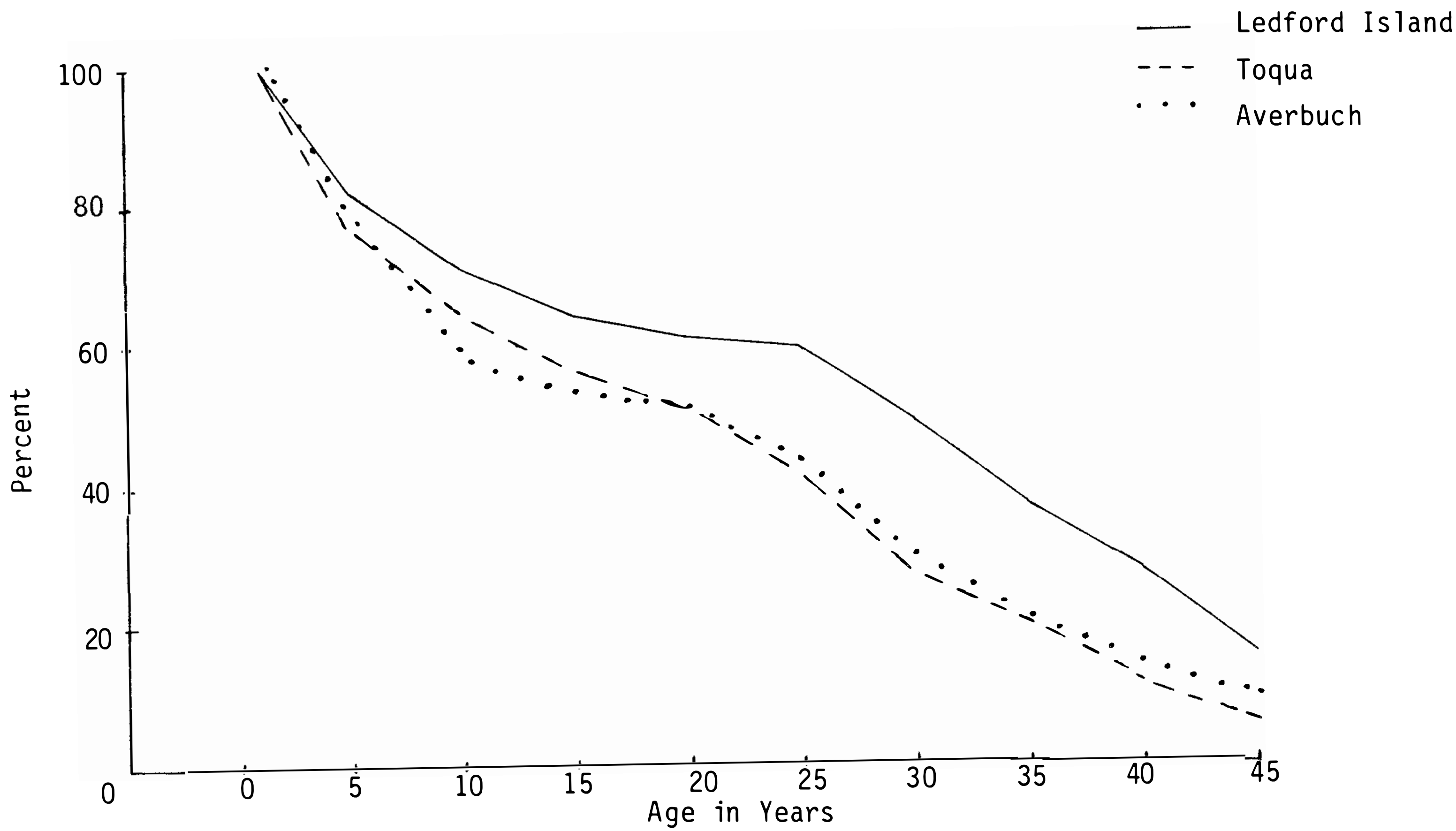


Figure 32. Survivorship Curve Comparisons for the Ledford Island, Toqua and Averbuch Females.

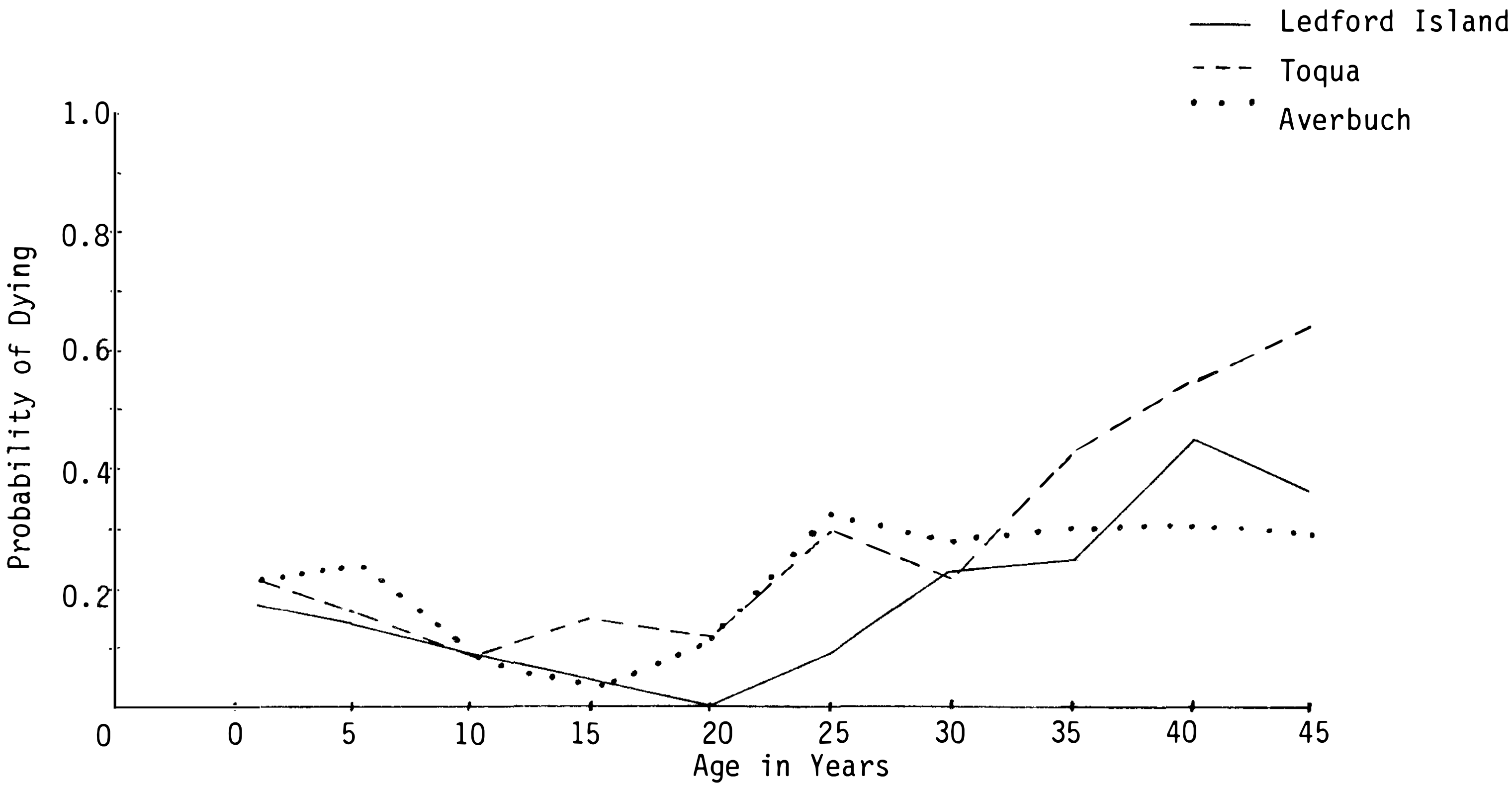


Figure 33. Probability of Dying Curve Comparisons for the Ledford Island, Toqua and Averbuch Populations (Combined Sex).

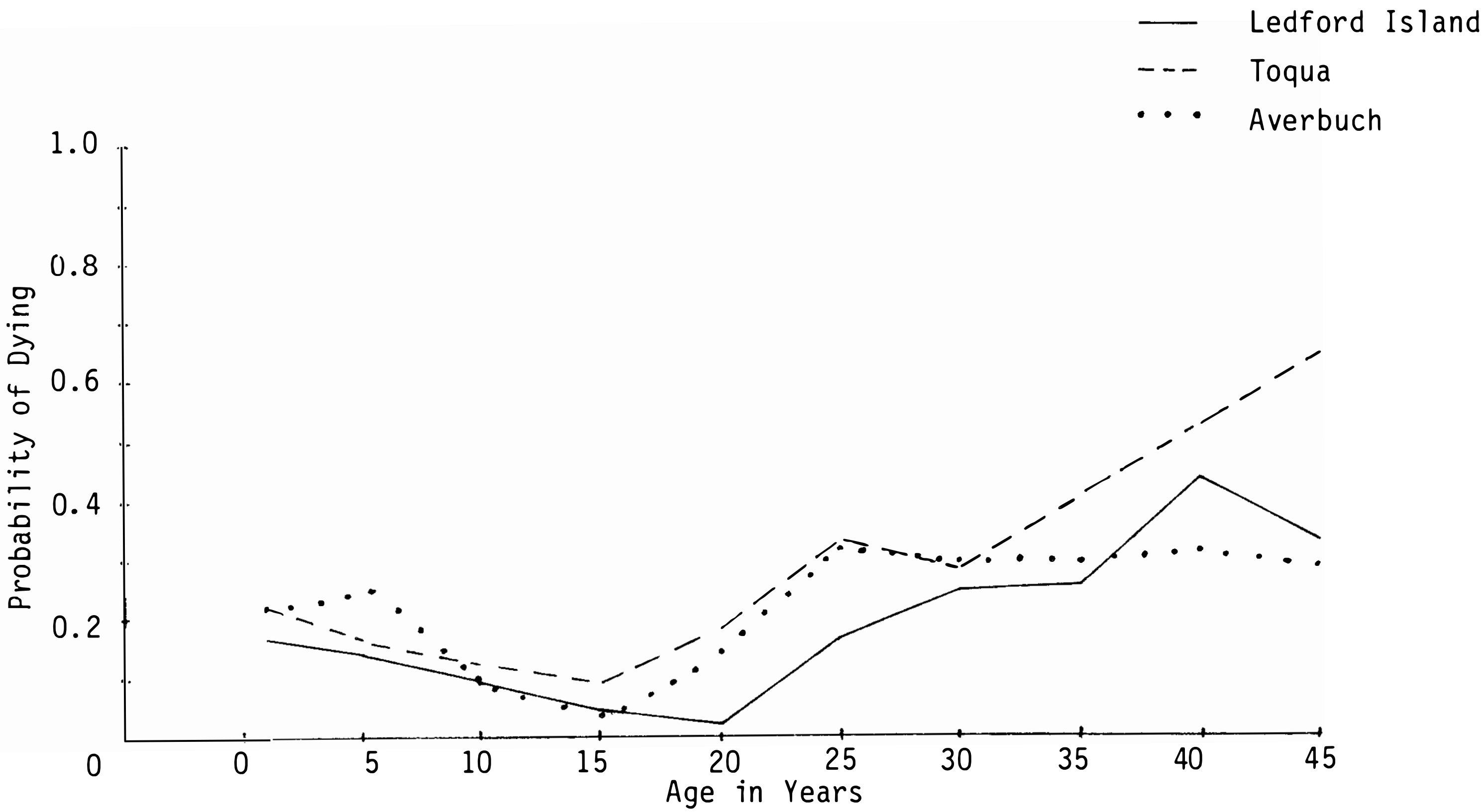


Figure 34. Probability of Dying Curve Comparisons for the Ledford Island, Toqua and Averbuch Males.

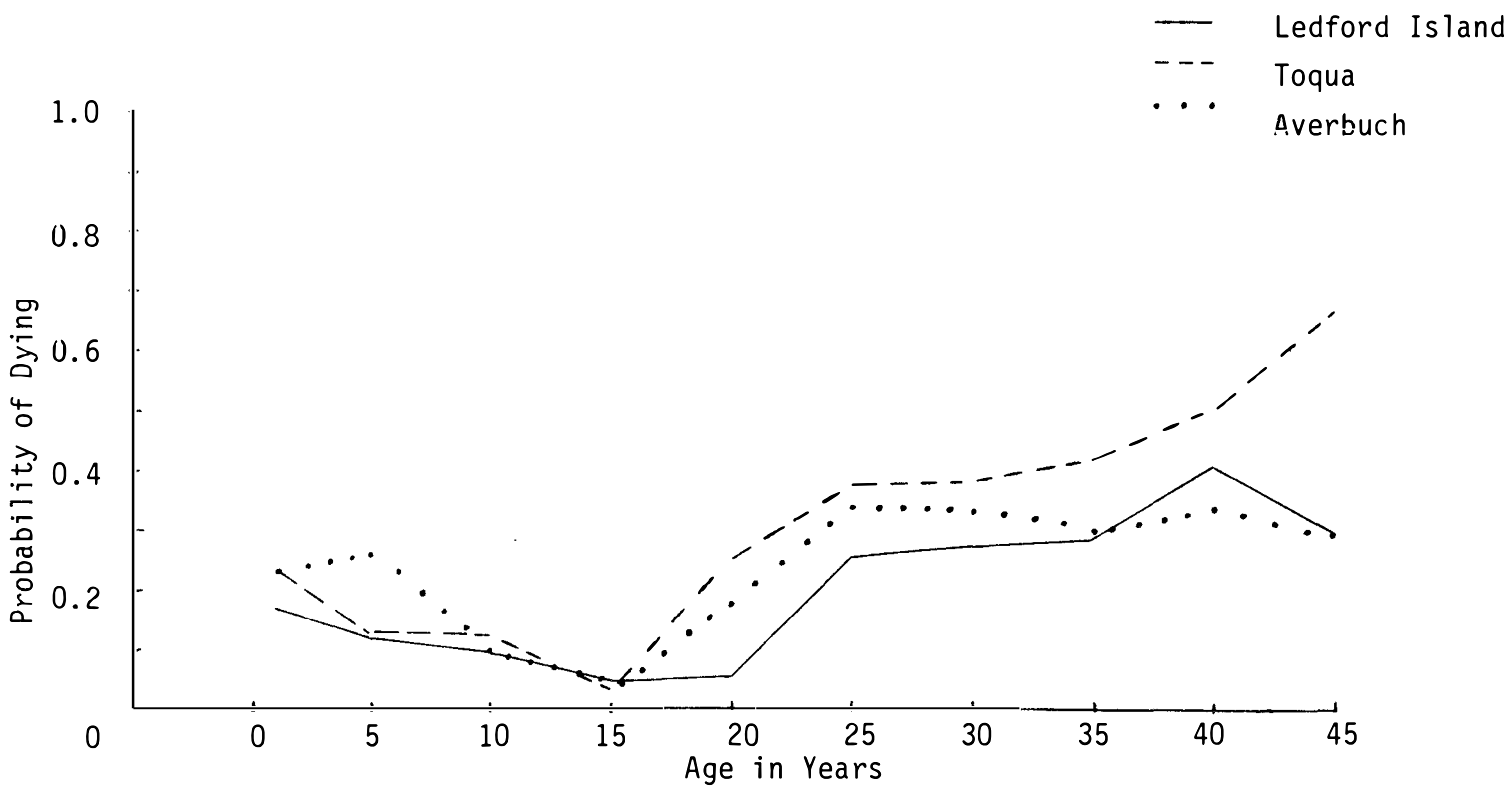


Figure 35. Probability of Dying Curve Comparisons for the Ledford Island, Toqua and Averbuch Females.

statistics of 16.12 and 16.61 years for Toqua and Averbuch, respectively, dramatically emphasizes the higher stress conditions within the Averbuch and Toqua populations. This is illustrated in Figure 36. Ledford Island exceeds the other two sites in life expectancy values throughout most of the curve until Averbuch supercedes it in the late adult years (probably also a result of the truncation and subsequent compression of data here). Toqua life expectancy exhibits the lowest slope throughout the curve comparison.

The same general pattern is noted in the male (Figure 37) and female (Figure 38) life expectancy curves. However, once again, the males from Toqua and Averbuch differ more in the late teens, and both sexes from the two sites differ in the late adult life expectancy curve portions.

VI. DISCUSSION OF THE LEDFORD ISLAND, TOQUA AND AVERBUCH RESULTS

The mortality, survivorship, probability of death, and life expectancy demographic curves for Ledford Island, Toqua and Averbuch show significant differences: (1) The Averbuch and Toqua populations appear to experience substantially greater demographic stress compared to the Ledford Island population. It is apparent from these conclusions that the relatively healthier Rymer and Mouse Creek sites would have dramatized this difference even further had they been included in the comparison; (2) One factor involved in this discrepancy is the relatively greater percentages of deaths in the highly

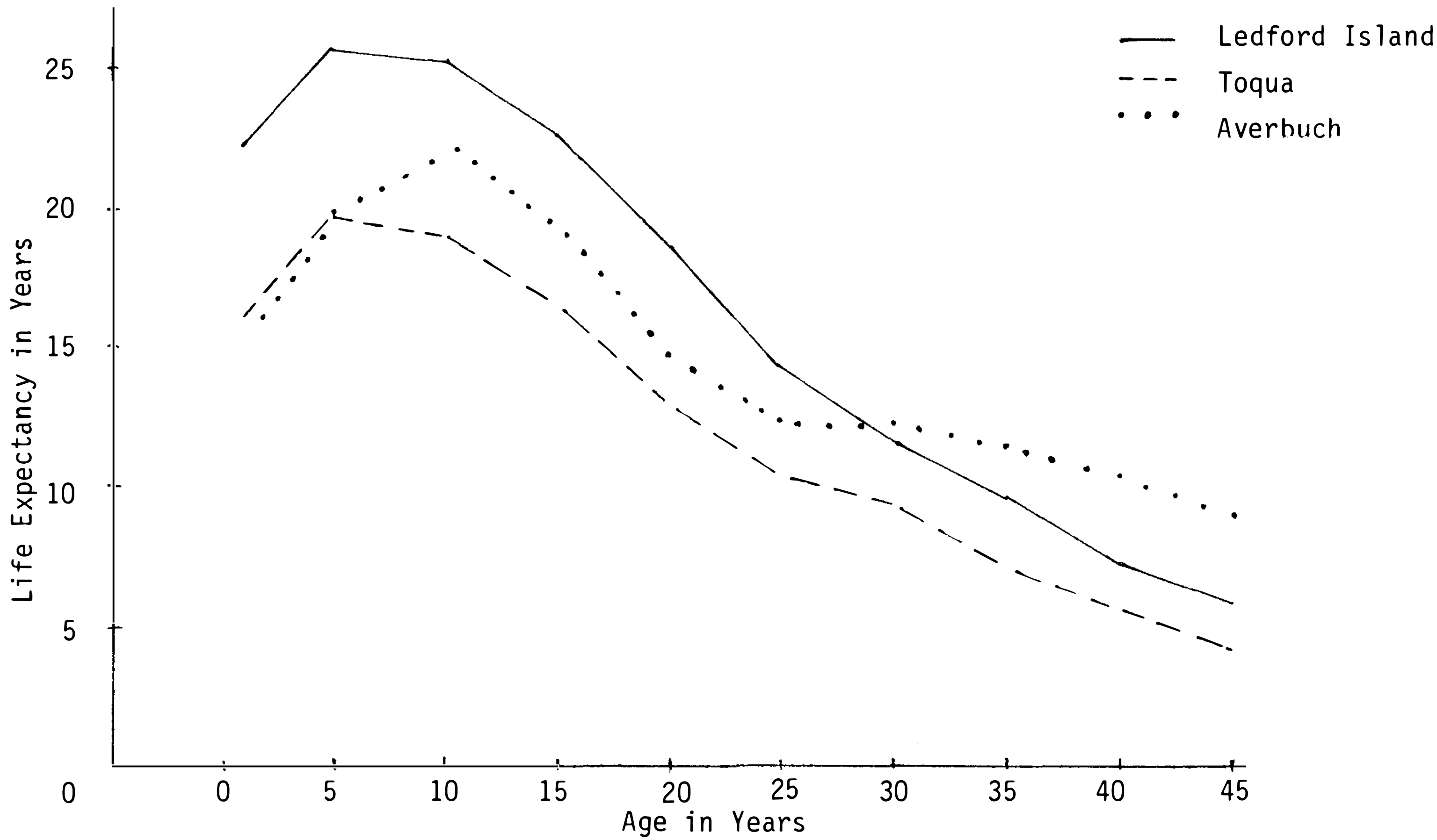


Figure 36. Life Expectancy Curve Comparisons for the Ledford Island, Toqua and Averbuch Populations (Combined Sex).

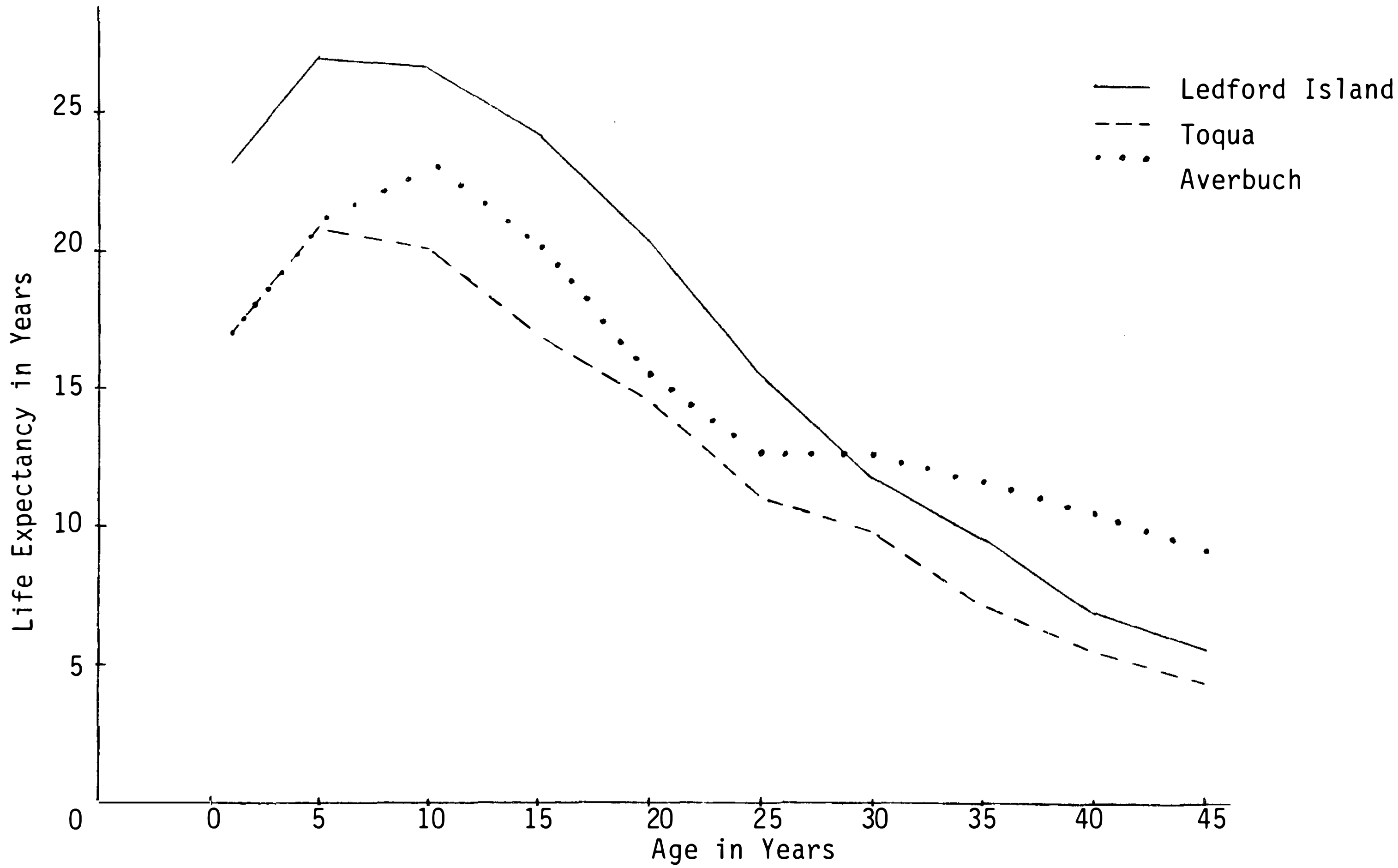


Figure 37. Life Expectancy Curve Comparisons for the Ledford Island, Toqua and Averbuch Males.

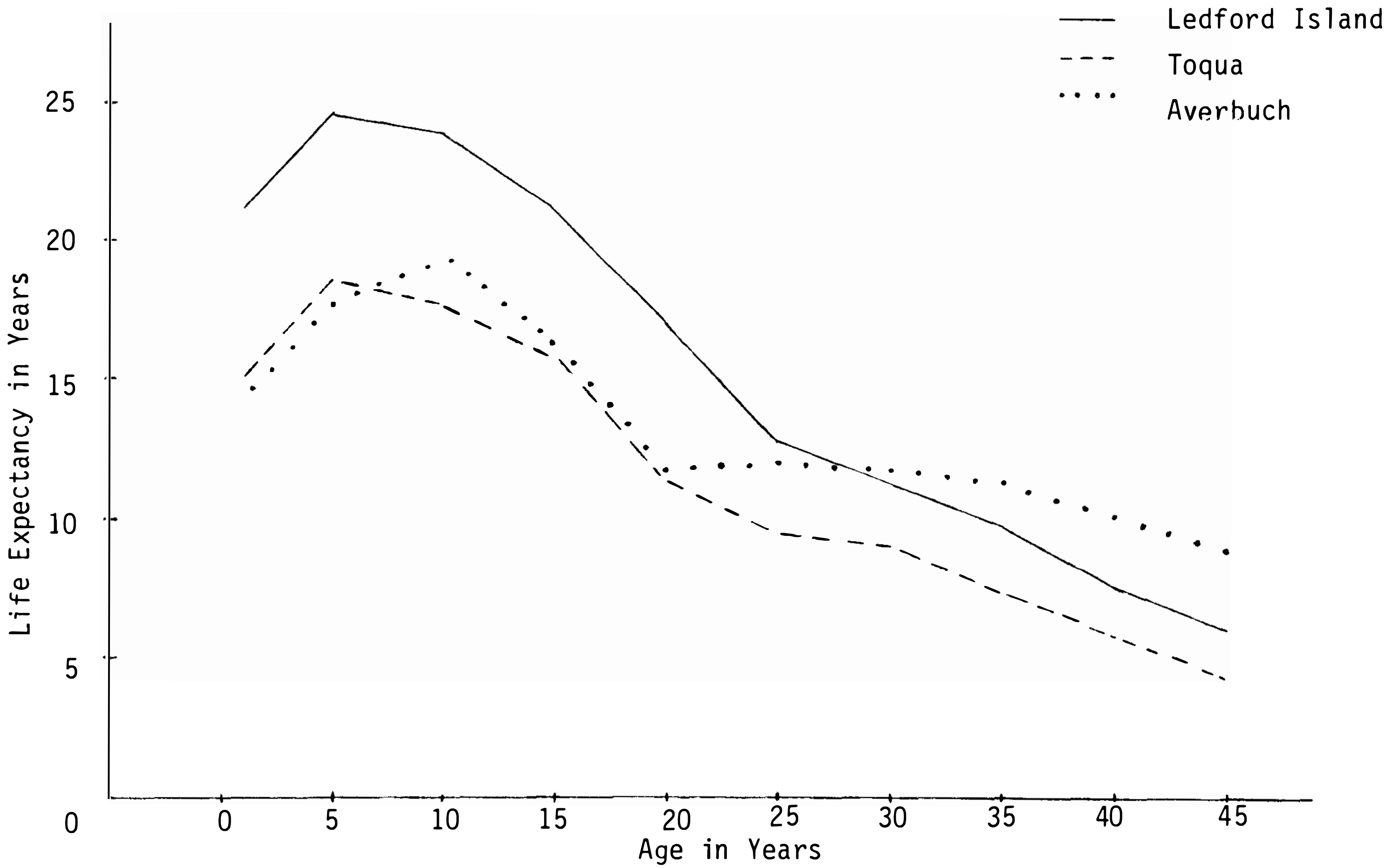


Figure 38. Life Expectancy Curve Comparisons for the Ledford Island, Toqua and Averbuch Females.

stressed 0-1 (or 0-1.5) age range at Averbuch and Toqua as opposed to the lower percentages for Ledford Island (and the rest of the Mouse Creek Phase sites); in contrast, mortality is higher for Ledford Islanders in the late adult years. (3) Averbuch children of 1.5-5.5 continue to experience high death rates, while mortality of Toqua children of the same approximate age begins to decrease; (4) Toqua males in the late teen years (15-20) experience a rather high mortality rate in comparison with the other sites; (5) Overall, a notable similarity is seen in the demographic curves of the Averbuch and Toqua populations.

From the above, a relatively low stressed/healthy Mouse Creek Phase population status is suggested. Two alternative explanations can be proposed in interpretation of this data. First, it is conceivable that significant biasing inherent in the Mouse Creek Phase site samples and analyses could produce the above picture. For example, variations in the nature of the samples utilized as evidenced by the cemetery versus structure archaeological distinction of burial at Averbuch in contrast to the mound versus village differentiation at Toqua and the more general structure-associated burial at the Mouse Creek Phase sites might have clouded the comparability of the samples utilized. Milner (1984), in his recent examination of American Bottom Mississippian cemetery variability, found important differences between more peripherally located cemeteries and those associated with regional (including mound and village) centers. He also noted changes in cemetery organization through time.

Differential methods of excavation of the sites (including, for example, archaeological biasing in the recovery of infants) as well as variability in methods of analysis (for example, aging and sexing techniques) could also produce errors. And, factors relating to taphonomic variability (leading to poorer preservation of infants) are also important. Finally, skewing resulting from inappropriate use of the demographic method (i.e., not meeting the aforementioned preconditions or making erroneous and/or unjustified demographic assumptions) in addition to slight differential life table construction across the three sites (age category difference, for example) could also exist. However, as much control as possible was maintained over all of these variables throughout the analysis. It is believed by the author that biasing resulting from any of the previously mentioned factors is minimal: "Even if we suspect that our estimated vital rates are all as much as 10% in error, we can determine a reasonable life table and get a fair idea of the ecological circumstances under which primitives live" (Weiss 1975:56).

The second alternative is simply that the demographic scenario of the low stressed Mouse Creek Phase populations in contrast to the more highly stressed Averbuch and Toqua populations represents an accurate estimate of the health status of these populations. In order to verify these results, further consideration of other skeletal health indicators such as stature and paleopathology are conducted.

CHAPTER V

STATURE COMPARISONS

I. INTRODUCTION

Concomitant with most biological analyses of skeletal populations is a consideration of long bone length as it relates to stature. While these examinations are as a rule widespread and common, they are also usually quite limited in scope. Calculation of adult stature values obtained from various regression formulae usually make up the analyses. The resulting means are then compared to the mean stature estimates recorded for other genetically similar populations to arrive at an overall view of stature variability. Any interpretation, however, of the meaning of this variability is severely limited. One major reason for this is the ongoing controversy concerning the factors affecting stature.

Environmental as well as genetic variables have been shown to be significant potential contributors to the attainment of adult stature. Genetic factors such as inbreeding (Mange 1964) (leading to decreased stature within the group), immigration (Buikstra 1976:38) and social control of mating (Hatch and Willey 1974:121) have been recognized as affecting adult stature.

While genetic variables tend to have more effect on stature in the adolescent years, environmental factors may influence stature more in the pre-adolescent years (Johnston et al. 1976). Dietary

deficiencies can substantially limit the maximum genetic stature potentially obtainable during this critical period. These deficiencies are often culturally regulated or predetermined, particularly in ranked societies, wherein access to food is controlled by higher status individuals. This can lead to distinct stature differences between members of the same group, usually falling along class structure lines (Hatch and Willey 1974). More commonly, however, these limitations are more or less random fluctuations varying concurrently with the availability of food resources. This should result in a general and equal decrease in stature across the population. Childhood illnesses can also play a vital role in restricting the attainment of adult stature (Roche 1974), although compensation can be made later on during childhood in the form of accelerated growth spurts (Prader et al. 1963).

In addition to the above stated variables, significant stature differences are also encountered in relation to variation in sex and age. Male long bone lengths have been found to be, on the average, longer than those of females (Krogman 1978). And, maximum adult stature is not reached until the age of 25 (Trotter and Gleser 1952) and declines slightly thereafter with ensuing age. This age and sex variability is also assumed to be the case for the prehistoric Amerindian groups used in this study.

The purpose of this chapter is to compare the stature estimates of the three Mouse Creek Phase sites in terms of mean height attained, maximum and minimum height ranges, analysis of variance of the long

bone lengths in relation to site, and comparison of the long bone measurement means by way of a Duncan Multiple Range test. Because of the unavailability of dependable tibia data and also because of the lessened reliability of tibial measurements in reflecting actual living stature (Bass et al. 1971:166), only femoral measurements are used in these comparative calculations. The Mouse Creek Phase site data are then pooled and similarly compared with Toqua and Averbuch. The results are discussed in light of the aforementioned variables.

II. RESULTS

Table 32 presents the maximum femur and tibia length measurement means and standard deviations for the three Mouse Creek sites separated by sex. The Rymer male height ranged from 162.66 cm (5'4") to 172.54 cm (5'8"). Rymer females ranged from 151.91 cm (4'11 3/4") to 164.26 (5'4 1/2"). The tallest Mouse Creek male was 173.41 cm (5'8 1/2"), while the shortest was 164.59 cm (5'4 3/4"). The females ranged from 148.70 cm (4'10 1/2") to 161.54 cm (5'3 1/2"). Ledford Island males ranged from 159.65 cm (5'2 3/4") to 175.32 cm (5'9"). The shortest Ledford Island female stood 140.06 cm (4'7"), while the tallest stood 164.02 cm (5'4 1/2").

Similar maximum femur and tibia mean lengths for Averbuch and Toqua are presented in Table 33. Since no significant stature differences were found with respect to the individual Averbuch cemeteries (Berryman 1981:141), these data are combined. Toqua

Table 32. Maximum Femur and Tibia Mean Lengths (in mm) and Standard Deviations for Both Sexes and the Three Mouse Creek Phase Sites.

Site	Sex	n	Femur Mean	S.D.	n	Tibia Mean	S.D.
Rymer	M	21	446.33	13.7	16	374.44	16.9
Rymer	F	15	415.60	13.9	10	352.90	14.8
Mouse Creek	M	8	447.25	16.6	5	362.50	16.9
Mouse Creek	F	9	412.44	21.5	4	349.00	29.3
Ledford Island	M	39	443.85	23.7	36	374.17	19.2
Ledford Island	F	41	408.22	17.8	39	340.54	13.8

Table 33. Maximum Femur Mean Lengths (in mm) and Standard Deviations for Both Sexes and the Averbuch and Toqua Sites.

Site	Sex	n	Femur Mean	S.D.
Averbuch	M	105	448.12	18.1
Averbuch	F	73	423.07	17.9
Toqua	M	43	443.14	17.5
Toqua	F	37	414.17	17.8

mound and village stature values are also pooled due to the non-significant differences in these data (Parham 1982:82). However, only the femur measurements were available for comparison here.

The maximum adult Averbuch male stood 179.43 cm (5'10") tall, while the shortest was 158.14 cm (5'2"). The "normal" females ranged from 173.15 cm (5'8") to 146.48 cm (4'9"); however, a midget from Burial 256A stood only 111.90 cm (3'8") high (Berryman 1981:141). Toqua male stature ranged from 158.9 cm (5'2") to 176.0 cm (5'9"), while the females varied from a maximum of 166.7 cm (5'5") to a minimum of 148.5 cm (4'10") (Parham 1982:76).

Table 34 presents a comparison of the maximum femur mean lengths from the above sites with those of other similar archaeological populations. The Mouse Creek Phase male individuals from all three sites are on the upper (higher) end of the stature scale. The Ledford Island females, however, reflect one of the lowest of the recorded mean stature estimates. Averbuch and Toqua males also exhibit high statures, with Averbuch males showing one of the highest stature means of any American Indian skeletal series (Berryman 1981:143).

The analysis of variance procedure for the long bone lengths from the Mouse Creek Phase sites examines the relationship between stature (as represented by the femur lengths) and site. Since sexual variation in relation to the measurements is expected, the femur versus sex analysis is not conducted. Sexual variation is standardized by setting the mean for the femur variable equal to zero via

Table 34. A Comparison of Stature Estimates Across Several Archaeological Populations.*

	Male				Female			
	Femur Mean		Stature		Femur Mean		Stature	
Population	cm	n	cm	in	cm	n	cm	in
Arnold	42.80	14	164.59	64.80	42.90	2	160.06	63.02
Arikara	44.68	164	168.63	66.39	41.50	159	156.61	61.65
Averbuch	44.81	105	168.91	66.50	42.30	73	156.20	61.50
Brown	43.52	6	166.14	65.41	41.57	3	154.54	60.84
Dallas	-	117	168.38	66.29	-	94	157.89	62.16
Ganier	44.06	6	167.30	65.87	41.80	4	157.35	61.95
Indian Knoll	43.71	263	166.68	65.62	41.27	192	156.04	61.43
Ledford Island	44.38	39	168.00	66.14	40.82	41	152.83	60.17
Mouse Creek	44.72	8	168.73	66.43	41.24	9	153.79	60.55
Rymer	44.63	21	168.52	66.35	41.56	15	154.52	60.83
Toqua	44.30	43	167.60	65.98	41.50	37	156.50	61.61

*Modified from Berryman (1981); Arnold and Ganier = Ward (1972), Arikara = Bass et al. (1971), Averbuch = Berryman (1981), Brown = Boyd et al. (1983), Dallas = Hatch and Willey (1974), Indian Knoll = Snow (1948), Toqua = Parham (1982).

the PROC STANDARD procedure (Ray 1982:493). No significant differences are indicated by the ANOVA results between the stature estimates and site (Table 35). Similarly, the femur versus site analysis of the Duncan's Multiple Range test (Table 36) also results in the association of the three sites into one comprehensive group, indicating no major differences in the femur means across the three sites.

Since no significant overall differences are found between the Mouse Creek Phase site stature estimates, these values are pooled in the comparison with Toqua and Averbuch. The analysis of variance between these three populations indicates a significant difference in the relationship of femur long bone lengths and site (Table 37). This site-specific stature differential is also reflected in the Duncan's Multiple Range test (Table 38) wherein the source of this variability is revealed. Once again, sexual variation is held constant in the site versus stature analysis. The test combines the stature means for the three groups into three significantly different groups--one consisting of only the Averbuch female estimates, another comprising only the Mouse Creek Phase female femur means, and a third containing the remainder of the values (Averbuch males, Mouse Creek Phase males and Toqua males and females). This most probably reflects the substantially higher Averbuch female and lower Ledford Island female stature estimates noted previously in Table 34.

Table 35. Analysis of Variance for Femur Lengths for Both Sexes and the Three Mouse Creek Phase Sites (n = 133).*

Source	DF	Sum of Squares	F Value	P>F
Model	5	767.14	0.42	.8349
Error	127	46306.09		
Corrected Total	132	47073.23		
<u>Type I SS</u>				
Site	5	767.14	0.42	.8349
<u>Type II SS</u>				
Site	5	767.14	0.42	.8349

*R-Square = 0.016297

Table 36. Duncan's Multiple Range Test of Femur Length Between the Three Mouse Creek Phase Sites (Sexes Combined).

Bone	Site/Sex	Standardized Mean	n	Grouping*
Femur	Rymer M	1.3186	21	A
Femur	Rymer F	5.0923	15	A
Femur	Mouse Creek M	2.2353	8	A
Femur	Mouse Creek F	1.9368	9	A
Femur	Ledford Island M	1.1686	39	A
Femur	Ledford Island F	2.2882	41	A

*Means with the same letter are not significantly different.

Table 37. Analysis of Variance for Femur Lengths for Both Sexes and Toqua, Averbuch and the Combined Mouse Creek Phase Sites (n = 391).*

Source	DF	Sum of Squares	F Value	P>F
Model	5	6449.88	4.05	.0015
Error	385	122539.41		
Corrected Total	390	128989.29		
Type I SS				
Site	5	6449.88	4.05	.0015
Type III SS				
Site	5	6449.88	4.05	.0015

*R-Square = .050003

Table 38. Duncan's Multiple Range Test of Femur Lengths Between Toqua, Averbuch and the Combined Mouse Creek Phase Sites (Sexes Combined).

Bone	Site/Sex	Standardized Mean	n	Grouping*
Femur	Averbuch F	6.3771	73	A
Femur	Averbuch M	1.9710	105	A/B
Femur	Toqua M	3.0132	43	B/C
Femur	Toqua F	1.7185	37	B/C
Femur	Mouse Creek M	1.1381	68	B/C
Femur	Mouse Creek F	6.1837	65	C

*Means with the same letter are not significantly different.

III. DISCUSSION

No major differences are found in the analysis of stature between the three Mouse Creek Phase sites. Statistically, femur measurements do not separate out with reference to site. Also, compared to other archaeological populations, the majority of the Mouse Creek Phase individuals, particularly the males, manifest above average stature. This supports the previous demographic suggestion of a low stressed (healthy) environment for the Mouse Creek Phase specimens. However, both environmental and genetic factors play a vital role in the attainment of adult stature and the appropriate weighting of each set of factors in the interpretation of long bone length variability remains unclear. As Milner (1982:206) states, ". . . the variation one would like to attribute to different environments could be attributable to genetic differences among populations that are widely separated in time and space [and vice versa]." Thus, the import of the above results is uncertain. But it can be said that no significant evidence of reduced stature and therefore stress was observed in the Mouse Creek Phase populations. However, at Averbuch, Berryman (1981) found no signs of reduced stature, but yet was dealing with a significantly stressed population as evidenced by established stress indicators such as Harris lines and enamel hypoplasia. As a result, he questioned the usefulness of the analysis of stature as an indicator of biological stress at Averbuch (Berryman 1981:143).

The inter-cultural comparison results in the separation of Averbuch and Mouse Creek Phase females from Toqua, Averbuch and Mouse Creek Phase male individuals in relation to stature. The Averbuch females are significantly taller, while the Mouse Creek Phase females are significantly shorter than the Mouse Creek Phase and Averbuch male and Toqua male and female individuals. The source of this variability is difficult to identify. Other variables relating more directly to stress in the populations, such as pathologies, need to be considered.

CHAPTER VI

PALEOPATHOLOGY

I. INTRODUCTION

Recently, anthropological inquiries concerned with reconstructing health levels of prehistoric populations have been met with much optimism and encouragement. Not only have new techniques and methodologies been developed toward this goal in such related fields as biology, chemistry and medicine, but also more traditional approaches to the study of early health states have undergone renewed interest (Buikstra and Cook 1980). One such line of evidence is the field of paleopathology, the study of diseases in ancient human populations as revealed by their skeletal remains (Steinbock 1976:ix).

The Literature

Literature dealing with the topic of paleopathology essentially is of two types. Most prevalent is the "atlas"-type handbooks compiled by professional pathologists or physical anthropologists specializing in paleopathology for the purpose of aiding anthropologists in the identification of disease states and processes on human dry bone. Of the numerous such texts available, those of Brothwell and Sandison (1967), Jarcho (1966), Ortner and Putschar (1981), Steinbock (1976) and Zimmerman and Kelley (1982) offer the most complete and usable guidelines to pathogen identification and

interpretation. Although these texts are somewhat particularistic in that their approach to disease identification involves a bone-by-bone analysis of skeletal material, this individualistic framework is a necessary first step in any paleopathological study. These sources are relied upon considerably in the present study.

Works of the second kind adopt more of a site- or region-specific perspective. For example, in the New World, Morse (1969) examines disease patterns of midwestern archaeological populations, Rathburn et al. (1980) of South Carolinian Formative individuals and Joerschke (1983) and Parham (1982) of Middle and East Tennessee populations, respectively. While these studies are somewhat narrower in their focus, at the same time, they have a much broader goal of relating disease pattern information to implications of the population's adaptive success in its natural environment. It is precisely this factor which has been responsible for the welcomed proliferation of population-oriented health studies recently seen in North America.

The present study of Mouse Creek Phase paleopathology and subsequent comparison with analogous information from Toqua and Averbuch is, obviously, of the second kind. However, before presentation of those results can proceed, a consideration of the paleopathological model utilized in this analysis must be outlined.

The Paleopathological Approach

The disease model utilized in this thesis follows that of Milner's (1982) examination of Mississippian period American Bottom

material, although on a much more limited scale. One of Milner's primary research objectives is to "develop a model that places the study of discrete, static, and incomplete archaeological data sets within a series of contextual relationships that permit inferences to be drawn about the dynamic qualities of health and disease" (Milner 1982:3). Precluding any such model development is first an understanding of the concepts of "health" and "disease." Health is considered "the ability of the body to maintain a state within certain physiologically tolerated limits" (Milner 1982:15), thereby continuously fluctuating throughout an organism's lifetime, while disease is seen as "a state of lowered ability to respond effectively to environmental stimuli" (Milner 1982:15-16). Thus, as Milner (1982:16) states:

> Health and disease are not dichotomous, polar opposites; instead, they describe a single property of the host, which is the differential ability to counter or compensate for environmental challenge.

Systemic interactions between the independent dimensions of the hosts, the natural environment and culture determine the health level of prehistoric populations at any given point in time (Figure 39). Changes in these variables necessarily affect a population's overall fitness or "adaptive success" as it relates to the demographic parameters of fecundity, longevity and mortality. Thus, analyses of disease and health states cannot be conducted in a vacuum. And, given the above set of intricate interrelationships, *a priori* predictions concerning expected disease patterns in the

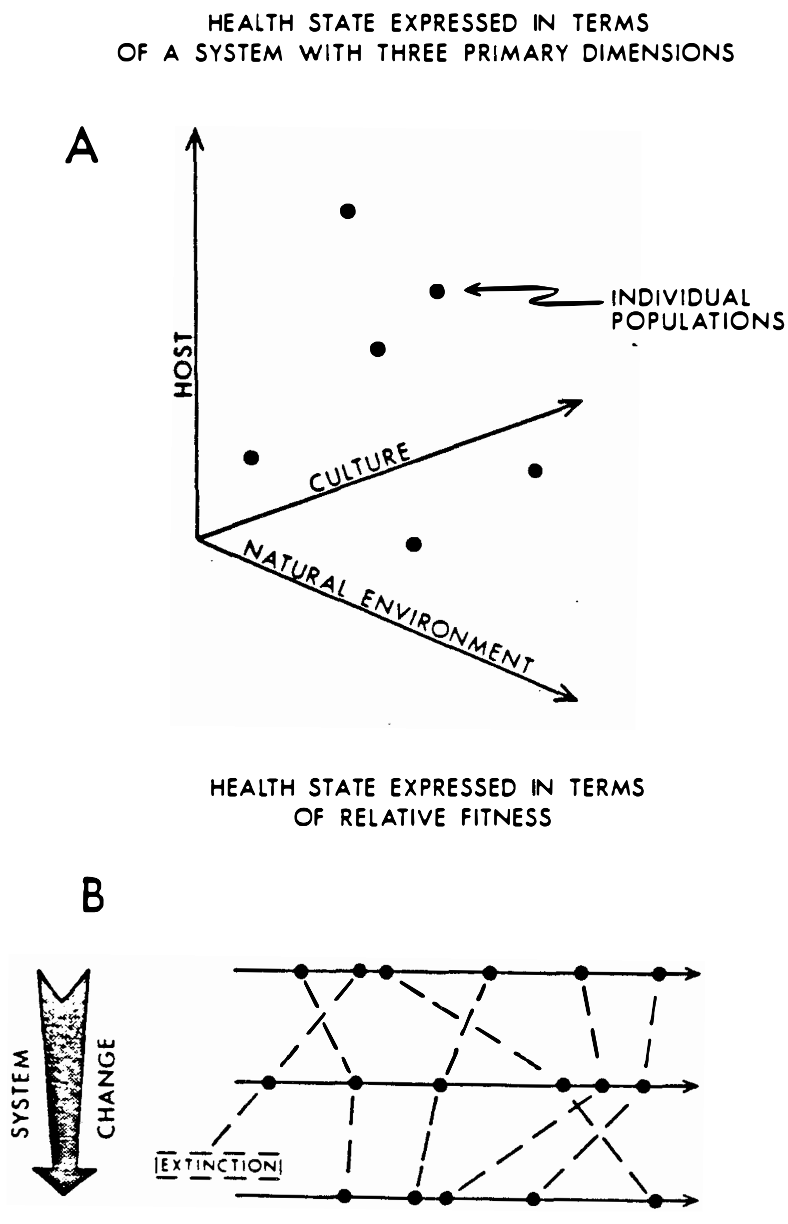


Figure 39. Systemic View of Health Model (from Milner 1982:47).

archaeological record should be approached with caution. Factors such as host resistance, pathogen virulence, population size, aggregation and length of occupation, refuse disposal and sanitation, nutrition and health care practices should be considered. For example, the synergistic effect of poor nutrition and infectious disease susceptibility has long been recognized as playing a vital role in prehistoric health states, particularly among subadults in the weaning period (Milner 1982:38). Mensforth et al. (1978:12) note that this effect is greatest in children between the ages of 6 and 24 months. Indigenous iron supplies begin to be depleted at this time and reliance is forced upon external sources of nutrients.

Finally, given the homologous nature of many different disease manifestations, differential diagnoses of particular pathologies is not feasible. Instead, more general disease classes containing many similar and related disease states are more appropriate for most anthropologically-oriented paleopathological analyses and are utilized in this study. Inferences as to causality are kept to a minimum. Also, in keeping with the strictly population approach employed in this thesis, the temptation to present the following data in an individualistic manner is, for the most part, resisted. Instead, the demographic attributes of age and sex are utilized in the comparison of relative incidence of pathological classes across the Mouse Creek Phase sites. Comparisons of a more general nature are then conducted utilizing the Toqua and Averbuch populations.

II. RESULTS

Mouse Creek Phase Pathologies

General disease classes. Summary data for incidences of disease state classes for Ledford Island are presented in Tables 39-41. The coding format for these pathology groups is found in Appendix B. Because of differential preservation, frequencies of pathologies are not calculated using these data. Instead, ratios are computed showing the incidence of a pathology class (at times showing multiple expression on a single individual) per the total amount of diagnostic individuals (defined intuitively by the author as generally those individuals with at least 50% of the skeleton in good condition). Thus, only a general and relative measure of the pathological occurrence across age and sex parameters is needed and subsequently generated. In Table 39, it can be seen that roughly 246 pathologies were recorded for an analyzable 223 individuals, resulting in a figure of approximately 1.10 pathologies per individual. Of the 223 total individuals, 52.47% exhibit some type of pathology. Males generally exhibit more incidences of pathology than the females. An analysis of the age distribution reveals that 41.33% of the sub-adults and 58.90% of the adults manifested pathologies, with the relative incidences increasing steadily (with the exception of the lowered 20-29 range) to a peak at 50+ with 3.58 pathologies per individual (Tables 40 and 41).

Table 39. Observed Incidences of Pathology Classes for the Ledford Island Site by Sex (n = 223).

Pathology Class	Male n	Female n	I/SubAd n	Total n
General/Unknown Infection	4	1	0	5
Abscess/Lesion	16	8	2	26
Tumor/Exostosis	12	8	0	20
Osteoporosis	9	11	0	20
Osteoarthritis	19	15	0	34
Bone Resorption	12	13	1	26
Porotic Hyperostosis/ Cribra Orbitalia	2	2	31	35
Bone Fusion	10	4	1	15
Fracture	7	2	1	10
Dental Anomaly	0	1	4	5
Periostitis	10	10	0	20
Bone Rarefaction	3	3	0	6
Bone Deformity	12	4	0	16
Trauma	1	5	2	8
Tuberosity	0	0	0	0
Bone Decalcification	0	0	0	0
Total Incidences	117	87	42	246
Total Individuals	62	82	77	233
Disease Ratio*	1.89	1.06	0.54	1.10

*Disease Ratio = Total Incidences/Total Individuals.

117 Individuals Affected / 223 Total Individuals = 52.47% Individuals Affected.

Table 40. Observed Incidences of Pathology Classes for the Ledford Island Subadults (n = 75).

Pathology Class	0-1 n	1-4 n	5-9 n	10-14 n	Total n
General/Unknown					
Infection	0	0	0	0	0
Abscess/Lesion	0	0	2	0	2
Tumor/Exostosis	0	0	0	0	0
Osteoporosis	0	0	0	0	0
Osteoarthritis	0	0	0	0	0
Bone Resorption	0	0	0	0	0
Porotic Hyperostosis/ Cribra Orbitalia	5	9	8	9	31
Bone Fusion	0	0	1	0	1
Fracture	1	0	0	0	1
Dental Anomaly	0	0	2	2	4
Periostitis	0	0	0	0	0
Bone Rarefaction	0	0	0	0	0
Bone Deformity	0	0	0	0	0
Trauma	0	0	0	0	0
Tuberosity	0	0	0	0	0
Bone Decalcification	0	0	0	0	0
Total Incidences	6	9	13	11	39
Total Individuals	20	27	16	12	75
Disease Ratio*	0.30	0.33	0.81	0.92	0.52

*Disease Ratio = Total Incidences/Total Individuals.

31 Individuals Affected / 75 Total Individuals = 41.33% Individuals Affected.

Table 41. Observed Incidences of Pathology Classes for the Ledford Island Adults (n = 146).

Pathology Class	15-19 n	20-24 n	25-29 n	30-34 n	35-39 n	40-50 n	50+ n	Adult n	Total n
General/Unknown Infection	0	0	0	2	3	0	0	0	5
Abscess/Lesion	0	3	6	1	9	2	2	1	24
Tumor/Exostosis	0	0	1	5	6	2	6	0	20
Osteoporosis	3	1	7	0	2	4	1	2	20
Osteoarthritis	0	3	0	3	9	9	10	0	34
Bone Resorption	0	0	0	1	6	6	13	0	26
Porotic Hyperostosis/ Cribra Orbitalia	1	0	0	0	1	1	0	1	4
Bone Fusion	0	0	0	3	5	4	2	0	14
Fracture	0	0	0	2	2	3	1	1	9
Dental Anomaly	0	0	1	0	0	0	0	0	1
Periostitis	0	0	3	2	4	4	3	3	19
Bone Rarefaction	0	0	0	2	0	4	0	0	6
Bone Deformity	0	0	3	3	1	4	4	1	16
Trauma	0	1	1	0	1	2	1	2	8
Tuberosity	0	0	0	0	0	0	0	0	0
Bone Decalcification	0	0	0	0	0	0	0	0	0
Total Incidences	4	8	22	24	49	45	43	11	206
Total Individuals	4	23	28	22	27	24	12	6	146
Disease Ratio*	1.0	0.35	0.78	1.09	1.81	1.88	3.58	1.83	1.41

*Disease Ratio = Total Incidences/Total Individuals.

86 Total Affected Individuals / 146 Total Individuals = 58.9% Total Individuals Affected.

In comparison, Rymer site individuals exhibit a relatively higher incidence of pathology (1.52/individual), with approximately 72.04% of all of the population manifesting a disease state (Table 42). However, it is the females which show a dominance of this statistic. A similar general increase in pathology with increasing age can be seen (although of a less clearly defined pattern) with a peak of 3.08 pathologies/individual in the 40-50 age range (Tables 43 and 44).

Approximately 60.71% of the Mouse Creek site individuals showed some type of pathology, amounting to 1.16 pathologies/ individual (Table 45). Sex differences are minimal, with males leading in pathology incidence only slightly. The age breakdown of Tables 46 and 47 presents a more heterogeneous pattern than noted above for Ledford Island and Rymer. For subadults, ages 1-9 show the highest occurrence of pathologies, while the older age categories (35+) of the adults show similar high values. However, the small sample sizes involved in this data set warrant a cautious approach to these Mouse Creek results.

Infection. Relative occurrence of infections at Ledford Island, Rymer and Mouse Creek was not widespread. Incidences of osteoporosis, periostitis, porotic hyperostosis/cribra orbitalia and general or unknown infection were, for the most part, of a very slight and limited nature (Figure 40 is an example). However, a few severe cases of infection did exist (see Figures 41 and 42).

Table 42. Observed Incidences of Pathology Classes for the Rymer Site by Sex (n = 93).

Pathology Class	Male n	Female n	I/SubAd n	Total n
General/Unknown Infection	0	2	0	2
Abscess/Lesion	3	1	0	4
Tumor/Exostosis	7	3	0	10
Osteoporosis	6	7	2	15
Osteoarthritis	8	10	0	18
Bone Resorption	3	3	0	6
Porotic Hyperostosis/ Cribra Orbitalia	0	2	11	13
Bone Fusion	1	1	0	2
Fracture	2	5	2	9
Dental Anomaly	1	1	0	2
Periostitis	5	15	2	22
Bone Rarefaction	2	6	1	9
Bone Deformity	11	10	1	22
Trauma	2	1	0	3
Tuberosity	1	0	0	1
Bone Decalcification	1	2	0	3
Total Incidences	53	69	19	141
Total Individuals	31	30	32	93
Disease Ratio*	1.71	2.30	0.59	1.52

*Disease Ratio = Total Incidences/Total Individuals.

67 Individuals Affected / 93 Total Individuals = 72.04% Individuals Affected.

Table 43. Observed Incidences of Pathology Classes for the Rymer Subadults (n = 30).

Pathology Class	0-1 n	1-4 n	5-9 n	10-14 n	Total n
General/Unknown Infection	0	0	0	0	0
Abscess/Lesion	0	0	0	0	0
Tumor/Exostosis	0	0	0	0	0
Osteoporosis	0	0	0	0	0
Osteoarthritis	0	0	0	0	0
Bone Resorption	0	0	0	0	0
Porotic Hyperostosis/ Cribra Orbitalia	0	2	6	3	11
Bone Fusion	0	0	0	0	0
Fracture	0	0	0	0	0
Dental Anomaly	0	0	0	0	0
Periostitis	0	0	0	0	0
Bone Rarefaction	0	0	0	1	1
Bone Deformity	0	0	0	0	0
Trauma	0	0	0	0	0
Tuberosity	0	0	0	0	0
Bone Decalcification	0	0	0	0	0
Total Incidences	0	2	6	4	12
Total Individuals	4	13	9	4	30
Disease Ratio*	0.00	0.15	0.67	1.00	0.40

*Disease Ratio = Total Incidences/Total Individuals.

10 Individuals Affected / 30 Total Individuals = 33.33% Individuals Affected.

Table 44. Observed Incidences of Pathology Classes for the Rymer Adults (n = 63).

Pathology Class	15-19 n	20-24 n	25-29 n	30-34 n	35-39 n	40-50 n	50+ n	Adult n	Total n
General/Unknown Infection	0	0	1	0	0	0	1	0	2
Abscess/Lesion	1	0	2	0	0	1	0	0	4
Tumor/Exostosis	0	0	1	0	0	9	0	0	10
Osteoporosis	2	2	1	0	2	3	1	4	15
Osteoarthritis	0	0	2	2	3	6	5	0	18
Bone Resorption	0	0	0	1	0	2	3	0	6
Porotic Hyperostosis/ Cribra Orbitalia	1	1	0	0	0	0	0	0	2
Bone Fusion	0	0	0	0	0	2	0	0	2
Fracture	2	0	0	1	1	3	0	2	9
Dental Anomaly	0	1	1	0	0	0	0	0	2
Periostitis	3	3	2	0	2	6	1	5	22
Bone Rarefaction	0	0	2	1	2	1	1	1	8
Bone Deformity	1	1	4	1	1	6	1	7	22
Trauma	1	0	2	0	0	0	0	0	3
Tuberosity	0	0	0	0	0	0	1	0	1
Bone Decalcification	0	0	1	0	0	1	0	1	3
Total Incidences	11	8	19	6	11	40	14	20	129
Total Individuals	5	5	12	5	6	13	7	10	63
Disease Ratio*	2.20	1.60	1.58	1.20	1.83	3.08	2.00	2.00	2.05

*Disease Ratio = Total Incidences/Total Individuals.

37 Total Affected Individuals / 63 Total Individuals = 58.73% Total Individuals Affected.

Table 45. Observed Incidences of Pathology Classes for the Mouse Creek Site by Sex (n = 56).

Pathology Class	Male n	Female n	I/SubAd n	Total n
General/Unknown Infection	0	3	0	3
Abscess/Lesion	4	5	1	10
Tumor/Exostosis	3	3	0	6
Osteoporosis	5	2	0	7
Osteoarthritis	4	5	0	9
Bone Resorption	1	4	0	5
Porotic Hyperostosis/ Cribra Orbitalia	0	0	14	14
Bone Fusion	2	2	0	4
Fracture	5	0	0	5
Dental Anomaly	0	1	0	1
Periostitis	1	0	0	1
Bone Rarefaction	0	0	0	0
Bone Deformity	0	0	0	0
Trauma	0	0	0	0
Tuberosity	0	0	0	0
Bone Decalcification	0	0	0	0
Total Incidences	25	25	15	65
Total Individuals	17	18	21	56
Disease Ratio*	1.47	1.39	0.71	1.16

*Disease Ratio = Total Incidences/Total Individuals.

34 Individuals Affected / 56 Total Individuals = 60.71% Individuals Affected.

Table 46. Observed Incidences of Pathology Classes for the Mouse Creek Subadults (n = 21).

Pathology Class	0-1 n	1-4 n	5-9 n	10-14 n	Total n
General/Unknown Infection	0	0	0	0	0
Abscess/Lesion	0	0	1	0	1
Tumor/Exostosis	0	0	0	0	0
Osteoporosis	0	0	0	0	0
Osteoarthritis	0	0	0	0	0
Bone Resorption	0	0	0	0	0
Porotic Hyperostosis/ Cribra Orbitalia	0	4	9	1	14
Bone Fusion	0	0	0	0	0
Fracture	0	0	0	0	0
Dental Anomaly	0	0	0	0	0
Periostitis	0	0	0	0	0
Bone Rarefaction	0	0	0	0	0
Bone Deformity	0	0	0	0	0
Trauma	0	0	0	0	0
Tuberosity	0	0	0	0	0
Bone Decalcification	0	0	0	0	0
Total Incidences	0	4	10	1	15
Total Individuals	2	4	12	3	21
Disease Ratio*	0.0	1.0	0.83	0.33	0.71

*Disease Ratio = Total Incidences/Total Individuals.

9 Total Affected Individuals / 21 Total Individuals = 42.86% Total Individuals Affected.

Table 47. Observed Incidences of Pathology Classes for the Mouse Creek Adults (n = 35).

Pathology Class	15-19 n	20-24 n	25-29 n	30-34 n	35-39 n	40-50 n	50+ n	Adult n	Total n
General/Unknown Infection	0	0	1	0	0	1	1	0	3
Abscess/Lesion	0	2	0	0	0	2	5	0	9
Tumor/Exostosis	0	0	0	0	2	1	3	0	6
Osteoporosis	2	1	2	0	0	1	1	0	7
Osteoarthritis	0	0	0	0	1	1	7	0	9
Bone Resorption	0	0	0	0	0	1	4	0	5
Porotic Hyperostosis/ Cribra Orbitalia	0	0	0	0	0	0	0	0	0
Bone Fusion	0	4	0	0	0	0	0	0	4
Fracture	0	1	0	0	3	0	1	0	5
Dental Anomaly	0	0	0	0	0	0	1	0	1
Periostitis	0	0	0	0	1	0	0	0	1
Bone Rarefaction	0	0	0	0	0	0	0	0	0
Bone Deformity	0	0	0	0	0	0	0	0	0
Trauma	0	0	0	0	0	0	0	0	0
Tuberosity	0	0	0	0	0	0	0	0	0
Bone Decalcification	0	0	0	0	0	0	0	0	0
Total Incidences	2	8	3	0	7	7	23	0	50
Total Individuals	3	6	4	3	3	6	10	0	35
Disease Ratio*	0.67	1.3	0.75	0.0	2.33	1.17	2.30	0.0	1.43

*Disease Ratio = Total Incidences/Total Individuals.

25 Total Affected Individuals / 35 Total Individuals = 71.43% Total Individuals Affected.

Figure 40. View of Slight Osteoporosis--Individual 16BY42.

Figure 41. Top View of Severe Infection--Individual 16BY371.

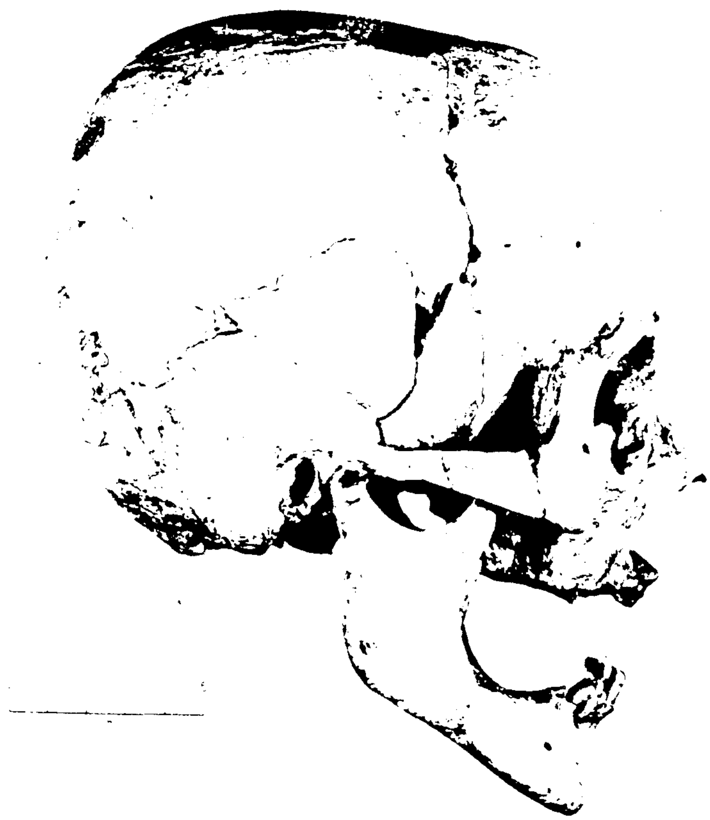


Figure 42. Lateral View of Individual 16BY371.

Frequencies of porotic hyperostosis/cribra orbitalia as well as periostitis are considered more fully in the comparison with Toqua and Averbuch later on in this chapter.

Trauma. An analysis of traumatic injuries of bone can provide much insight into the imprint the external environment leaves upon an individual. The significant involvement of cultural factors (such as scalping, warfare, ritual practices of trephination, etc.) here is undeniable (Brothwell and Sandison 1967; Steinbock 1976; Ortner and Putschar 1981). Table 48 chronicles descriptions of major instances of skeletal traumas for each Mouse Creek Phase site along with pertinent age and sex information. These are based on the author's as well as Kneberg's laboratory notes. Thus, these include incidences of traumatic injury of specimens discarded in the field as well as those observed by the author. For the most part, these incidences are composed primarily of healed fractures mainly of the long bones. However, at least two particular instances at the Ledford Island site suggest the existence of some outside cultural factors. First, Individual 269, an Adult of indeterminate sex, manifested a healed injury involving the right femur and pelvis. A portion of a projectile point remains embedded in the articulation of the two areas. It is unlikely that this is attributable to post-mortem damage, since extensive remodelling of bone around the injured area has occurred resulting in the complete fusion of the right femur to the pelvis. Unfortunately, this description

Table 48. Total Incidences of Trauma at Mouse Creek, Rymer and Ledford Island.

Site/Ind.	Sex	Age	Bone(s)/Side	Description
<u>Mouse Creek</u>				
3MN 67	M	50+	Clavicle (R)	Healed Fracture
4MN 26	M	35-39	Radius (R)	Healed Fracture
			Ulna (R)	Healed Fracture
			Clavicle (L)	Healed Fracture
4MN 57	M	20-24	Ulna (L)	Healed Fracture
<u>Rymer</u>				
15BY 1	F	25-29	Frontal (R)	Possible Contusion
11	I	Adult	Mandible	Possible Healed Fracture
25	I	Adult	Tibia	Fracture w/ Reparative Callus
27	F	15-19	Radii (R+L)	Fractures
			Fibula (R)	Fracture
32	M	30-34	Clavicle	Fracture w/ Resulting Deformed Sternum
62	M	25-29	Tibia (R)	Prominent Exostoses on Summit of Linea
			Femur (R)	Aspera;
			Fibula (R)	Roughened/Deformed area of Muscle/Bone
			Foot (R)	contact of foot--Permanently Flexed Leg?
89	F	35-39	7 Ribs (R)	Healed Fractures
109	M	40-50	2nd + 3rd Thoracic Vertebrae	Healed Fracture and Abscess--Complete Fusion/Bowing of area
118	I	Adult	Femur (R)	Possible Fracture/Periostitis
127	F	15-19	Rib (I)	Healed Fracture
140	F	40-50	Femora (R+L)	Healed Fractures
			Humerus	Healed Fracture
161	F	Adult	Parietal (R+L)	Compression of R. Parietal, Distended L. Parietal (not Cranial Deformation)--Trauma

Table 48 (Continued)

Site/Ind.	Sex	Age	Bone(s)/Side	Description
Ledford Island				
16BY 21	M	40-50	Orbit (L)	Healed Injury above Orbit
			Radius	Healed Fracture
22	F	40-50	Parietal (R)	Flattening--Healed Injury?
27	S	0-1	Femur (R)	Healed Fracture
47	M	35-39	Manubrium	Perforated Manubrium--Trauma?
56	F	50+	Clavicle (R)	Healed Fracture
64	M	Adult	Clavicle (L)	Healed Fracture/Drained Abscess
112	M	40-50	Ulna (R), Radius (R)	Healed Fracture/Deformity
120	M	35-39	Radius (L)	Healed Fracture
122	M	35-39	Tibia (L)	Healed Fracture
128	F	30-34	Clavicle (R)	Healed Fracture
143	F	25-29	Parietal (R)	Circular Depression/Healed Injury?
153	F	50+	Orbit (R)	Injury
269	I	Adult	Femur (R), Pelvis	Embedded Projectile Point
359	M	35-39	Frontal	Irregular, Hyperostotic Tabula Externa/ Osteomyelitis Underlying Bone--Scalping and Recovery?
412	M	30-34	Clavicle (R)	Healed Abscessed Fracture

is based solely on Kneberg's laboratory and field notes--the specimen could not be located by the author. Secondly, Individual 359, a 35-39 year old male, exhibits evidence of possible scalping and subsequent recovery (Figure 43) similar to that seen in the Averbuch population (Berryman 1981). Both of these instances suggest the presence of possible external cultural violence at Ledford Island. A third case, Individual 307 (a 20-24 year old female) (Figures 44-45), displays a rather misleading situation. Laboratory notes by Kneberg diagnose this pathology as a "large stemmed projectile point penetrating left parietal--directly precedent to death." However, after an examination of the specimen, field notes and photographs by the author, as well as fracture patterns by Bill Rodriguez (personal communication 1984), the author believes that the Archaic point intrusion is attributable to post-depositional, not cultural factors.

Comparison with Toqua and Averbuch

Because only limited information concerning Averbuch pathologies was available to the author (an analysis of these pathologies is presently being conducted), only general comparisons could be made between the Mouse Creek Phase sites and Toqua and Averbuch.

Porotic hyperostosis/cribra orbitalia. Porotic hyperostosis is a general descriptive term for osteoporotic lesions occurring mainly on the cranial vault and eye orbits (Angel 1966, 1967), while cribra orbitalia is a more specific term referring to "bilateral

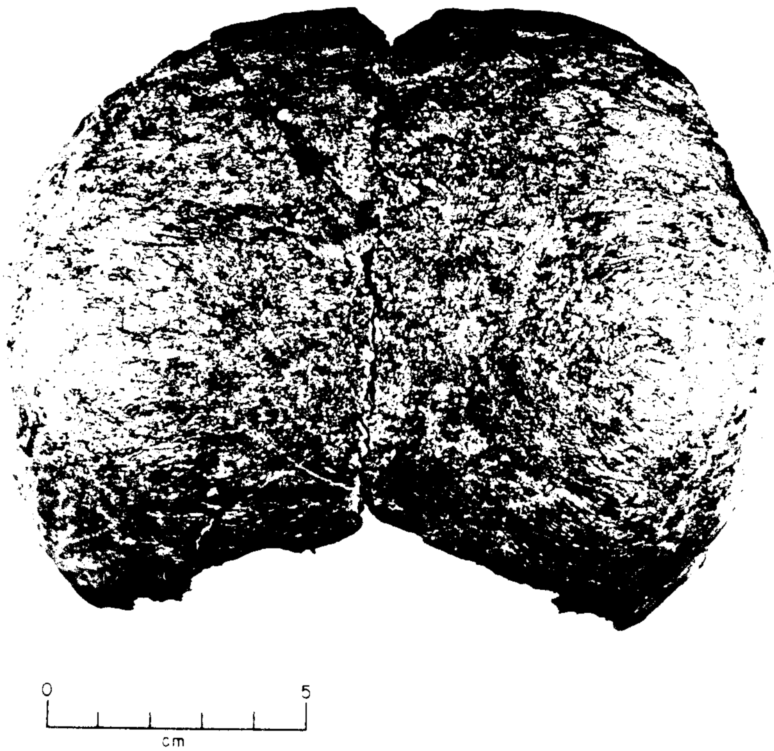


Figure 43. View of Possible Scalped Neurocranium--Individual 16BY359.

Figure 44. Frontal View of Individual 16BY307 with Archaic Projectile Point in Left Parietal.

Figure 45. Lateral View of the Same.

pitting of the orbital portion of the frontal bone" (Steinbock 1976: 213) (see Figures 46 and 47 for examples). In terms of disease etiology, in the Old World porotic hyperostosis distribution has been found to parallel that of malaria as well as other blood-related pathologies (Angel 1967). In the New World, however, most researchers feel that both of the above disease states result from some form of nutritional deficiency, most probably involving iron (El-Najjar and Robertson 1976). High incidences of iron-deficiency anemia have, in turn, been linked to prolific maize consumption by prehistoric groups in the New World (El-Najjar et al. 1975, 1976). Not only is maize naturally low in iron, but it also contains phytic acid which binds to available iron in the body to prevent its absorption and use. Zimmerman and Kelley (1982:75) note the higher prevalence of iron-deficiency anemia in young children (particularly of weaning age) not only because of their increased metabolic needs at this age, but also because of cultural factors. Maize was often times ground and used as a "watery gruel for weanlings" (Milner 1982:233) in many Mississippian populations, serving as their main source of nutrients. Adults regularly experiencing blood loss (young females) also manifest relatively high amounts of iron-deficiency anemia and porotic hyperostosis.

Because the specific relationship between the above two related disease states is unclear (Ortner and Putschar [1981] note that they can occur independently), they were tabulated separately. Table 49 compares frequencies and percentages of both calvarial

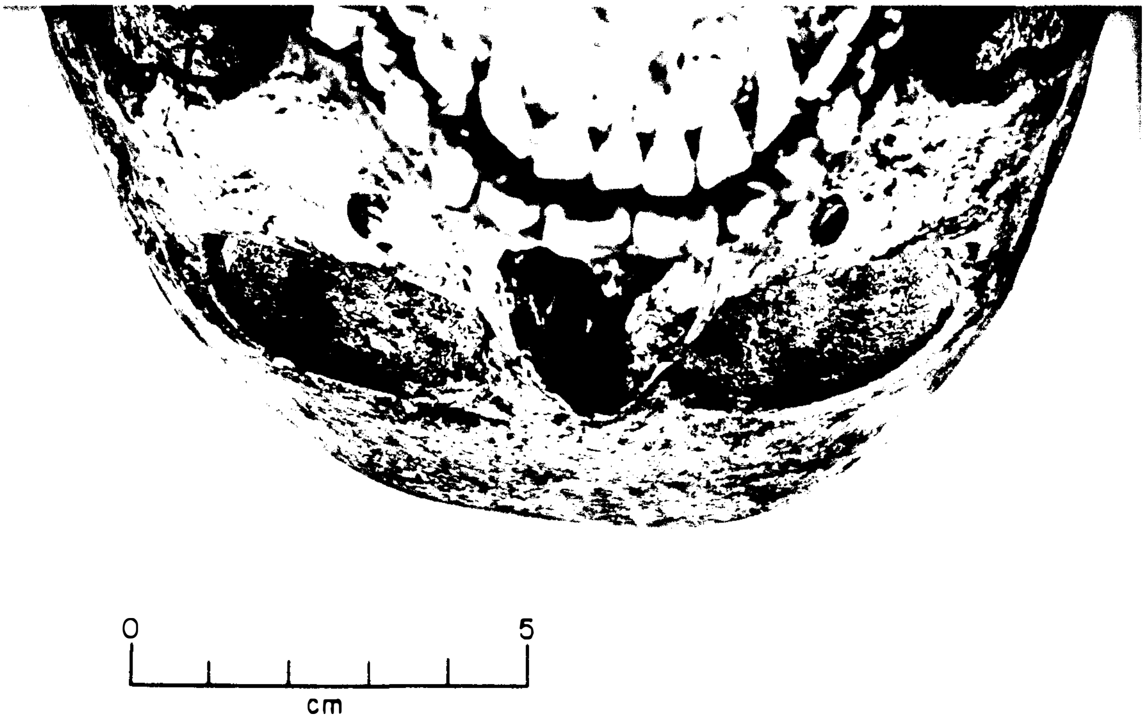


Figure 46. View of Severe Cribra Orbitalia--Individual 16BY42.

Figure 47. View of Calvarial Porotic Hyperostosis--Individual 16BY449.

Table 49. Comparison of Frequencies and Percentages of Calvarial Porotic Hyperostosis and Cribra Orbitalia Across Toqua, Averbuch and the Mouse Creek Phase Site Subadults (Below 10 Years).

	Calvarial P. H.			Cribra Orbitalia		
Population	n	N	%	n	N	%
Toqua	74	86	86.05	55	71	77.46
Averbuch	58	121	47.93	41	93	44.09
Ledford Island	5	54	9.26	17	68	25.00
Rymer	5	28	17.86	4	28	14.29
Mouse Creek	5	20	25.00	8	21	38.10
Mouse Creek Phase Total	15	102	14.71	29	117	24.79

porotic hyperostosis and cribra orbitalia across Toqua (Parham 1982: 106, 107; Parham and Scott 1980), Averbuch and Mouse Creek Phase site subadults (below 10 years). Toqua exhibits the highest percentages of both disease states. Averbuch individuals with both calvarial porotic hyperostosis and cribra orbitalia outnumber all of the Mouse Creek Phase individuals. However, larger sample sizes from the Mouse Creek Phase sites would strengthen these results.

Periostitis. Periostitis is a non-specific infectious inflammation of the periosteum of bone (Steinbock 1976:60) (see Figures 48 and 49 for examples), with a preference for long bones, especially the tibia. In terms of etiology, periostitis cannot generally be attributable to one particular disease process (Ortner and Putschar 1981). Not only do several different disease processes result in periostitis manifestations, but traumatic injuries to the skeleton have been correlated with it as well (Ortner and Putschar 1981).

Table 50 compares frequencies and percentages of periosteal reactions for both femora and tibiae across Toqua (Parham 1982:122), Averbuch and the Mouse Creek Phase sites (combined sex and age). Once again, the Toqua site individuals exhibit the highest prevalence of periosteal infection for both the tibiae and femora. Thereafter, the pattern becomes less clear. Averbuch individuals show a higher incidence of periostitis compared to all of the Mouse Creek Phase site individuals except Rymer. Individuals from this

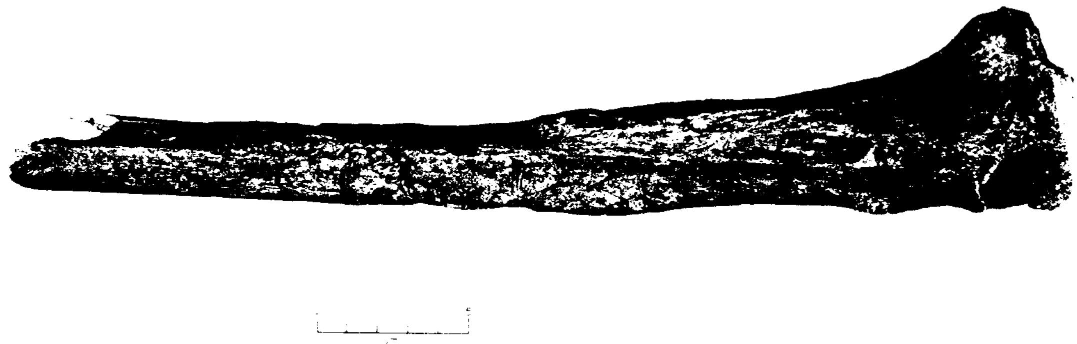


Figure 48. View of Severe Periostitis Along the Tibia of Individual 16BY122.

Figure 49. View of Severe Periostitis Along the Fibula of Individual 16BY371.

Table 50. Comparison of Frequencies and Percentages of Tibial and Femoral Periosteal Reactions for Toqua, Averbuch and the Mouse Creek Phase Sites.

Population	Tibia			Femur		
	n	N	%	n	N	%
Toqua	164	371	44.2	89	394	22.6
Averbuch	221	1060	20.8	68	1138	6.0
Mouse Creek	0	9	0.0	1	17	5.9
Rymer	9	26	24.6	7	36	19.4
Ledford Island	15	75	20.0	2	80	2.5
Mouse Creek Phase Total	24	110	34.8	10	133	7.5

site show significantly higher periostitis percentages compared with the other Mouse Creek Phase skeletons. One possible factor involved here is the proportionately higher amount of fractures per total individuals at Rymer compared to Ledford Island and Mouse Creek (see Table 42, page 147 and Table 48, page 156), resulting in greater related incidences of periostitis for these traumatic areas.

III. DISCUSSION

Mouse Creek Phase Sites

In keeping with Milner's (1982) disease model, explanatory frameworks for the previously discussed disease states will be sought from the related disciplines of archaeology and paleopathology. For example, Palkovich (1978), by comparing results of a paleopathological analysis with paleodemographic data, has successfully correlated stages of high morbidity with occurrences of various disease pathogenic states.

At Ledford Island, the pathological preference for male individuals is reflected in the demographic mortality curve (see Figure 11, page 74), with mortality being higher for males aged 25+. If one examines the sex distribution of incidences of trauma in Table 39 (page 143), a bias is also seen in favor of males (8 males to 5 females). This is reasonable since it is probably this segment of the population which would more likely be susceptible to injury. As far as age is concerned, the subadult incidence of pathologies

(primarily calvarial porotic hyperostosis and cribra orbitalia) seems slightly low when compared to the highly stressed picture seen in the 0-1 and 1-4 age categories of the demographic mortality curve. The increased adult pathology occurrence, especially in the later years, can be explained by the relative greater diversity of disease states affecting the individuals of this age and also the greater length of time lived allowing for accumulation of pathologies. The greatest incidence of pathology here is osteoarthritis, generally accepted as an age-related phenomenon.

Less clear demographic correlations can be made involving the Rymer site. For example, the prevalence of female pathologies is not reflected in the mortality curve of Figure 12, page 75. The very low occurrence of any disease state in the 0-1 age range is also anomalous. And, the higher pathology affliction of the Rymer individuals compared to the Ledford Island ones is incongruous with the relatively higher mortality experience of Ledford Island. But, the type of pathologies exhibited between the two are different. The highest incidences of pathology classes at Rymer are periostitis and bone deformity, not age-related osteoarthritis.

At Mouse Creek, the general health equality of males and females is reflected in the mortality curve. Once again, porotic hyperostosis/cribra orbitalia account for the majority of the subadult pathologies, with the 0-1 age category conspicuously absent of incidences of disease. Osteoarthritis leads the adult categories, with the high pathology incidences in the 50+ ages corresponding to the elevated mortality level for this same age range.

While some general patterns concerning Mouse Creek Phase health status have been discerned through a comparison of paleopathological and paleodemographic data, poor preservation and small sample sizes (especially with the Mouse Creek site) may have clouded this analysis. However, based on the results of this analysis as well as those of demography and stature, the Mouse Creek Phase individuals appear non-stressed.

Comparison with Toqua and Averbuch

The high incidence of calvarial porotic hyperostosis and cribra orbitalia at Toqua led Parham (1982:105) to state: "On a population basis both of these relatively high frequencies attest to probable endemic proportions of iron-deficiency anemia at the site." Paleobotanical evidence in the form of a multitude of maize remains supported this claim. For the Averbuch site, very little floral remains were recovered in spite of the extensive flotation conducted. This was in terms of both frequency of occurrence and diversity of species: "Scattered Northern Flint maize, only two beans and no squash remains were identified from Averbuch" (Klippel 1984:14.4). No paleobotanical data exists from Mouse Creek, since systematic flotation was not conducted at this time. However, some corn, beans and squash were noted by Lewis and Kneberg (1941:7) as being generally present, along with numerous animal bones (deer, rabbit, squirrel, etc.). Thus, while paleobotanical data from the three populations is unequal, no existing archaeological evidence

indicates any difference in maize consumption across these sites. But porotic hyperostosis/cribra orbitalia frequencies are very different. Two alternative interpretations can be given for this observed variation. First is the possibility that some type of differential maize consumption did, in fact, exist across these three groups. Second is the possibility that porotic hyperostosis and cribra orbitalia are not as directly correlated with iron deficiency anemia and intense maize consumption as is currently thought. Owsley (1984:127), in his calvarial porotic hyperostosis and cribra orbitalia frequency comparison of Dallas (Toqua) and Historic Overhill Cherokee crania, has promoted the second interpretation. He found a reduction in osteoporotic vault pitting through time. These results seemed anomalous, since Owsley expected increases in porotic hyperostosis frequencies through time based on the reported increased dependence on maize by the Historic Cherokee. Owsley interpreted these results as possibly reflective of the differential social organization of the Dallas and Cherokee. The ranked chiefdom organization level at Toqua might result in differential access to meat sources, leaving many social classes more solely dependent on maize than others. Bogan's (1980) analysis of Toqua faunal remains generally supported this premise. However, Owsley also suggested that frequencies of porotic hyperostosis and cribra orbitalia are perhaps not as directly reflective of intense nutritional deficiency in this region as has been reported elsewhere in the New World. Instead, he proposed that infectious diseases might play a more

important role. However, Owsley's assumption of increased dependence on maize through time (Dallas to the Cherokee) may have been unfounded. Trace element analyses of bone from Toqua and Cherokee skeletal material, as well as from Averbuch and Mouse Creek Phase remains would help resolve this issue. Analyses of incidences of periostitis and subsequent correlation of these data with the porotic hyperostosis information may also help in the future by providing more insight into the relationships between these two disease classes. It is interesting to note, however, that periostitis frequencies at Toqua, like the porotic hyperostosis frequencies, are by far the highest of the three populations.

Periostitis comparisons of these sites can also give one an idea of the relative susceptibility of each population to general infection. Milner (1982:36) promotes a consideration of archaeological settlement data in relation to pathology occurrence, particularly in reference to infectious diseases. The length of occupation of an area as well as the total population size and density can have a significant effect on the relative contamination of available soil and water in the area. This will subsequently affect the bioavailability of enteric parasites and bacteria.

Toqua individuals experience the highest frequency of this pathological class, with Averbuch and the Mouse Creek Phase site individuals substantially less affected. Given the estimated 300 years of occupation at Toqua (Parham 1982:51) along with a relatively dense settlement mode, it is not surprising that general infection

susceptibility was greater at this site. Although the calculated population size of Averbuch is greater (Berryman 1981:73), the time interval of occupation is only estimated at 15-25 years, with the settlement structure more diffuse in contrast to the mainstream Middle Cumberland habitations. Mouse Creek Phase site occupation size and time is estimated as intermediate between the two sites above, with settlement patterning generally consisting of palisaded villages. Less propensity toward infectious disease possibly resulted within the Averbuch and Mouse Creek Phase groups.

In conclusion, the biological variables of demography, stature and paleopathology have now been documented for the Mouse Creek Phase site individuals. These, in turn, have been compared with corresponding data from the Toqua and Averbuch populations. However, the biological (genetic) relationships between these three groups have yet to be explored. These will be considered in the following chapter.

CHAPTER VII

CRANIOMETRICS AND MULTIVARIATE STATISTICS

I. INTRODUCTION

W. W. Howells (1973:47) defines craniometry as the "description of, and differentiation of, populations in terms of [cranial] measurements." As Key (1979:1) notes, the cranium is well suited for these types of analyses because of the ease of defining and taking these measurements. And, in contrast to studies based on "epigenetic," "non-metric" or "discrete" (Berry and Berry 1967; Buikstra 1976; Chevrud and Buikstra 1981; Ossenberg 1977) characteristics, the clearer correlation between metric (mainly involving the cranium) variation and true inter- and intra-population differences has been demonstrated (Jantz 1977; Rightmire 1972). However, since the beginnings of this type of study along with the related discipline of anthropometry in the 19th century, the expression of variation between human populations in terms of metrics has often been intuitive and subjectively biased. Individual measurements have, at times, been considered singularly and have been taken as representative of the variation between populations. Howells (1973) notes the end result as being a study of the measurement itself, not the population. However, with the advent of statistical techniques in the early 1900s, and, even more significant, the increase in computer-assisted analyses from the 1960s through

the present, the manipulation of cranial metric data has become more and more precise, objective and informative.

Multivariate Statistical Studies

The above stated problem with analyses of individual measurements represents the limitations encountered in most univariate statistical analyses. In contrast, multivariate statistics consider all measurements simultaneously. In fact, an individual can be envisioned as a combination of the many different vectors resulting from all of the various measurements, and can be represented as a point in multidimensional space. Variability between and among populations can also be effectively represented this way by looking at congregations of all of these points in space.

Key (1979:1-2) outlines five approaches to the multivariate study of craniometric data utilized by past researchers: (1) The definition of relationships among different groups. Examples of these studies include Crichton (1966), Jantz (1977), Rightmire (1970) and Howell's (1973) classic, global-wide exploration of craniometric variation (via Discriminant and Factor analyses) of relatively modern populations; (2) The extrapolation of craniometric data to inferences concerning microevolutionary processes. Jantz's (1972 and 1973) and Key and Jantz's (1981) analyses of Arikara cranial variation through time are notable here; (3) The application of craniometric variation data to the solving of specific archaeological or evolutionary problems (Berryman 1975; Corruccini 1974, 1976; Howells

1976; Jantz 1974; Rightmire 1975; Wright 1974); (4) The forensic classification of unknowns by means of primarily the discriminant functions of Giles and Elliot (1962, 1963) for race and sex categorization; and (5) Exploratory craniometric studies of which Key (1979) is an excellent example. Inherent in all of these approaches is the assumption that cranial variation reflects biological (more specifically, genetic) variation. While environmental factors cannot be ruled out, the genetic basis of craniometric variation has been aptly demonstrated (Nakata et al. 1974).

This analysis determines the biological relationships (as indicated by cranial data) between Mouse Creek Phase, Toqua and Averbuch individuals and extrapolates these results toward the archaeological problem of Mouse Creek origins and affiliations. Berryman (1975) has also addressed this issue. He employed the statistical methods of Mahalanobis' generalized distance or D^2 (1936) as modified by Goodman (1972) as well as principal coordinate analysis (Gower 1972) to ascertain the biological relationships between the Mouse Creek, Dallas and Middle Cumberland populations. He considered 22 craniofacial measurements taken from skeletons from 17 different sites in Middle and East Tennessee representing the above populations in order to examine the archaeological hypothesis set forth by Lewis and Kneberg (1955) regarding Mouse Creek origins. Results of the biological distance analysis indicated a homogeneous relationship between Mouse Creek and Middle Cumberland and Dallas males as well as the Mouse Creek and Middle Cumberland females,

but significant heterogeneity between the Mouse Creek and Dallas females. Berryman saw these findings as generally supportive of Lewis and Kneberg's Mouse Creek-Middle Cumberland archaeological association hypothesis and cited the matrilocal kinship system of many Mississippian Indian groups of the area as a possible explanation for the female variation. However, he also noted (1975:70) that gene flow resulting from trade or travel cannot be excluded as a factor in this biological variability.

The present study is similar to Berryman's in its use of cranial measurements and multivariate statistics in the analysis of the relationship between skeletal populations from the Mouse Creek, Middle Cumberland and Dallas cultures. However, there are major differences. Different sites and skeletal specimens are used--at the time of Berryman's analysis, the very large skeletal populations of Toqua and Averbuch were not yet available for study. And, the measurements chosen for use in the multivariate comparison are for the most part different from those selected by Berryman. Three measurements common to both studies are Orbital Height, Nasal Breadth and Nasal Height. Other measurements used by Berryman are discussed elsewhere (Berryman 1975, 1980) and will not be repeated here. Thus, this study uses new data sets to reevaluate the relationships between Dallas, Mouse Creek and Middle Cumberland cultures suggested by Lewis and Kneberg and Berryman.

II. RESULTS

Mouse Creek Phase Descriptive Data

Table 51 lists the original 24 measurements taken by the author on 204 measurable Mouse Creek Phase crania. Tables 52, 53 and 54 present means and standard deviations, separated as to sex and site, for these measurements. Definitions of the code names as well as the measurements themselves can be found in Appendix C.

The Canonical Discriminant Analysis

Eight of the total 24 cranial measurements are utilized in the statistical comparison of the Mouse Creek Phase crania with those of Toqua and Averbuch:

1. Minimum Frontal Breadth (WFB)
2. Orbital Height (OBH)
3. Orbital Breadth (OBB)
4. Nasal Height (NLH)
5. Nasal Breadth (NLB)
6. External Alveolar Breadth (EAB)
7. Mandibular Symphysis Height (MSH)
8. Height of Ascending Ramus (HAR)

A Canonical Discriminant Analysis is conducted using both Mouse Creek Phase combined as well as separate sites in the comparison with Averbuch and Toqua. For the separate site analysis, ten groups representing each sex of individuals from each of the five sites (Mouse Creek, Rymer, Ledford Island, Toqua and Averbuch) are

Table 51. Cranial Measurements Taken on the Mouse Creek Phase Site Individuals.

Cranial Measurement	Source	Instrument/Caliper
Glabello-Occipital Length (GOL)	Howells (1973:170)	Spreading
Maximum Cranial Breadth (XCB)	Howells (1973:172)	Spreading
Basion-Bregma Height (BBH)	Howells (1973:172)	Spreading
Minimum Frontal Breadth (WFB)	Hrdlička (1952)	Spreading/Sliding
Orbital Height (OBH)	Howells (1973:175)	Sliding
Orbital Breadth (OBB)	Howells (1973:175)	Sliding
Nasal Height (NLH)	Howells (1973:175)	Sliding
Nasal Breadth (NLB)	Howells (1973:176)	Sliding
Nasion-Gnathion (NGN)	Bass (1971:63)	Sliding
External Alveolar Length (EAL)	Hrdlička (1952); Bass (1971:70)	Sliding
External Alveolar Breadth (EAB)	Hrdlička (1952); Bass (1971:70)	Sliding
Auricular Height (AUH)	Bass (1971:67)	Western Reserve Head Spanner
Basion-Gnathion (BGN)	Zimmerman et al. (1981:126)	Spreading
Basion-Biporion (BPO)	Bass (1971:66)	Coordinate
Mandibular Symphysis Height (MSH)	Bass (1971:72)	Sliding
Bigonial Diameter/Breadth (BIG)	Bass (1971:72)	Sliding
Bicondylar Diameter/Breadth (BIC)	Bass (1971:72)	Sliding
Bizygomatic Breadth (ZYB)	Howells (1973:173)	Spreading/Sliding
Height of Ascending Ramus (HAR)	Bass (1971:72)	Sliding
Nasion-Bregma Chord (FRC)	Howells (1973:181)	Coordinate
Nasion-Bregma Subtense (FRS)	Howells (1973:181)	Coordinate
Bregma-Lambda Chord (PAC)	Howells (1973:182)	Coordinate
Bregma-Lambda Subtense (PAS)	Howells (1973:182)	Coordinate
Bregma-Subtense Fraction (PAF)	Howells (1973:182)	Coordinate

Table 52. Means and Standard Deviations for 24 Cranial Measurements Taken on the Ledford Island Individuals by Sex.*

Variable	N	N Missing	Mean	Standard Deviation	Range
- - - - - - - - - - - - Site = 16BY			Sex = 1 - - - - - - - - - - - - -		
GOL	18	37	166.889	11.458	44.000
XCB	18	37	152.222	11.899	43.000
BBH	5	50	139.400	3.209	8.000
WFB	27	28	96.148	3.958	18.000
ZYB	7	48	138.571	7.743	21.000
OBH	12	43	34.667	2.309	8.000
OBB	12	43	41.250	1.603	5.000
NLH	10	45	51.400	4.195	15.000
NLB	10	45	25.200	1.619	5.000
NGN	7	48	117.857	2.734	8.000
EAL	10	45	58.900	4.606	15.000
EAB	12	43	65.167	3.927	15.000
MSH	43	12	35.930	2.404	10.000
BIG	28	27	102.071	7.483	31.000
BIC	20	35	127.250	7.629	27.000
HAR	38	17	58.289	5.775	21.000
AUH	6	49	89.833	3.920	9.000
BGN	5	50	110.600	3.782	9.000
BPO	5	50	19.400	2.608	7.000
FRC	11	44	111.727	6.958	17.000
FRS	11	44	22.091	5.262	14.000
PAC	11	44	105.818	8.256	22.000
PAS	11	44	25.091	4.505	17.000
PAF	11	44	58.000	5.215	13.000
- - - - - - - - - - - - Site = 16BY			Sex = 2 - - - - - - - - - - - - -		
GOL	22	47	157.364	7.088	28.000
XCB	24	45	150.833	8.661	36.000
BBH	5	64	134.000	4.743	13.000
WFB	31	38	91.968	4.771	21.000
ZYB	5	64	127.600	3.975	11.000
OBH	14	55	35.357	1.906	7.000
OBB	12	57	39.000	1.758	5.000
NLH	12	57	48.000	3.516	9.000
NLB	11	58	23.909	1.446	4.000
NGN	9	60	112.000	7.399	20.000
EAL	4	65	55.000	5.228	11.000
EAB	5	64	64.800	3.347	8.000
MSH	53	16	32.736	2.536	12.000
BIG	40	29	93.850	4.891	18.000
BIC	25	44	121.440	5.165	20.000

Table 52 (Continued)

Variable	N	N Missing	Mean	Standard Deviation	Range
HAR	42	27	52.190	4.092	18.000
AUH	7	62	82.286	3.988	10.000
BGN	3	66	100.667	10.116	18.000
BPO	4	65	15.250	3.096	7.000
FRC	18	51	103.889	6.370	20.000
FRS	18	51	20.278	3.427	13.000
PAC	12	57	97.417	4.166	14.000
PAS	12	57	24.250	3.415	13.000
PAF	12	57	53.083	5.931	21.000
- - - - - - - - - - - - - Site = 16BY Sex = 3 - - - - - - - - - - - - -					
GOL	0	1	.	.	.
XCB	0	1	.	.	.
BBH	0	1	.	.	.
WFB	0	1	.	.	.
ZYB	0	1	.	.	.
OBH	0	1	.	.	.
OBB	0	1	.	.	.
NLH	0	1	.	.	.
NLB	0	1	.	.	.
NGN	0	1	.	.	.
EAL	0	1	.	.	.
EAB	0	1	.	.	.
MSH	0	1	.	.	.
BIG	1	0	88.000	.	0
BIC	1	0	116.000	.	0
HAR	1	0	45.000	.	0
AUH	0	1	.	.	.
BGN	0	1	.	.	.
BPO	0	1	.	.	.
FRC	0	1	.	.	.
FRS	0	1	.	.	.
PAC	0	1	.	.	.
PAS	0	1	.	.	.
PAF	0	1	.	.	.

*Sex 1 = Male, 2 = Female, 3 = Indeterminate; . = Missing Data.

Table 53. Means and Standard Deviations for 24 Cranial Measurements Taken on the Rymer Individuals by Sex.*

Variable	N	N Missing	Mean	Standard Deviation	Range
- - - - - - - - - - - -		Site = 15BY	Sex = 3 - - - - - - - - - - - - -		
GOL	0	2	.	.	.
XCB	0	2	.	.	.
BBH	0	2	.	.	.
WFB	0	2	.	.	.
ZYB	0	2	.	.	.
OBH	0	2	.	.	.
OBB	0	2	.	.	.
NLH	0	2	.	.	.
NLB	0	2	.	.	.
NGN	0	2	.	.	.
EAL	0	2	.	.	.
EAB	1	1	61.000	.	0
MSH	0	2	.	.	.
BIG	0	2	.	.	.
BIC	0	2	.	.	.
HAR	1	1	52.000	.	0
AUH	0	2	.	.	.
BGN	0	2	.	.	.
BPO	0	2	.	.	.
FRC	0	2	.	.	.
FRS	0	2	.	.	.
PAC	0	2	.	.	.
PAS	0	2	.	.	.
PAF	0	2	.	.	.
- - - - - - - - - - - -		Site = 15BY	Sex = 1 - - - - - - - - - - - - -		
GOL	12	10	162.083	8.754	27.000
XCB	10	12	154.100	11.100	40.000
BBH	5	17	139.600	6.309	15.000
WFB	12	10	96.917	5.054	17.000
ZYB	1	21	152.000	.	0.000
OBH	7	15	34.429	0.787	2.000
OBB	7	15	40.286	1.976	6.000
NLH	4	18	50.500	3.317	7.000
NLB	3	19	26.667	0.577	1.000
NGN	2	20	121.000	2.828	4.000
EAL	6	16	54.833	6.047	15.000
EAB	7	15	66.143	3.132	9.000
MSH	15	7	35.800	2.678	9.000
BIG	10	12	100.500	7.948	27.000
BIC	8	14	128.000	7.329	22.000

Table 53 (Continued)

Variable	N	N Missing	Mean	Standard Deviation	Range
HAR	16	6	60.375	4.717	18.000
AUH	3	19	85.333	3.512	7.000
BGN	0	22	.	.	.
BPO	4	18	20.000	1.414	3.000
FRC	6	16	104.833	5.076	14.000
FRS	6	16	20.167	3.869	9.000
PAC	2	20	102.500	0.707	1.000
PAS	2	20	24.000	1.414	2.000
PAF	2	20	57.000	0.000	0.000
- - - - - - - - - - - - Site = 15BY			Sex = 2 - - - - - - - - - - - - -		
GOL	8	13	151.000	4.928	14.000
XCB	11	10	155.182	8.352	26.000
BBH	5	16	137.000	4.950	13.000
WFB	12	9	92.083	4.481	17.000
ZYB	4	17	132.750	4.349	10.000
OBH	7	14	36.286	1.976	6.000
OBB	7	14	38.429	1.813	5.000
NLH	7	14	50.429	2.299	6.000
NLB	7	14	26.143	1.773	5.000
NGN	6	15	116.500	3.728	11.000
EAL	7	14	54.000	4.123	12.000
EAB	8	13	63.750	2.188	7.000
MSH	17	4	35.118	2.369	9.000
BIG	12	9	92.917	6.999	28.000
BIC	9	12	120.000	6.874	23.000
HAR	20	1	52.600	3.378	12.000
AUH	6	15	82.167	1.602	4.000
BGN	2	19	105.500	3.536	5.000
BPO	3	18	19.667	2.517	5.000
FRC	9	12	103.111	5.645	16.000
FRS	9	12	19.111	4.106	13.000
PAC	2	19	96.500	0.707	1.000
PAF	2	19	22.500	4.950	7.000

*Sex 1 = Male, 2 = Female, 3 = Indeterminate; · = Missing Data.

Table 54. Means and Standard Deviations for 24 Cranial Measurements Taken on the Mouse Creek Individuals by Sex.*

Variable	N	N Missing	Mean	Standard Deviation	Range
- - - - - - - - - - - - Site = 3MN			Sex = 1 - - - - - - - - - - - -		
GOL	3	5	164.667	5.686	11.000
XCB	3	5	156.333	9.452	18.000
BBH	1	7	145.000	.	0.000
WFB	4	4	95.250	2.500	6.000
ZYB	0	8	.	.	.
OBH	2	6	33.500	3.536	5.000
OBB	2	6	40.000	1.414	2.000
NLH	2	6	53.000	2.828	4.000
NLB	2	6	22.500	2.121	3.000
NGN	2	6	117.500	9.192	13.000
EAL	1	7	54.000	.	0.000
EAB	2	6	66.500	4.950	7.000
MSH	7	1	31.857	4.562	14.000
BIG	2	6	98.000	9.899	14.000
BIC	2	6	124.000	2.828	4.000
HAR	4	4	59.000	6.055	14.000
AUH	2	6	86.000	0.000	0.000
BGN	1	7	100.000	.	0.000
BPO	1	7	24.000	.	0.000
FRC	3	5	101.000	6.245	12.000
FRS	3	5	21.000	3.606	7.000
PAC	2	6	106.500	4.950	7.000
PAS	2	6	26.500	3.536	5.000
PAF	2	6	54.500	12.021	17.000
- - - - - - - - - - - - Site = 3MN			Sex = 2 - - - - - - - - - - - -		
GOL	4	0	161.000	3.162	7.000
XCB	4	0	155.250	9.979	23.000
BBH	2	2	135.500	2.121	3.000
WFB	4	0	96.250	3.775	8.000
ZYB	0	4	.	.	.
OBH	1	3	31.000	.	0.000
OBB	0	4	.	.	.
NLH	1	3	43.000	.	0.000
NLB	1	3	21.000	.	0.000
NGN	1	3	106.000	.	0.000
EAL	0	4	.	.	.
EAB	0	4	.	.	.
MSH	3	1	32.333	2.517	5.000
BIG	3	1	92.667	8.505	16.000
BIC	3	1	119.333	10.504	21.000
HAR	4	0	51.500	1.732	4.000
AUH	2	2	78.000	0.000	0.000
BGN	0	4	.	.	.
BPO	2	2	17.000	8.485	12.000
FRC	3	1	106.667	5.774	10.000
FRS	3	1	24.000	4.000	8.000
PAC	3	1	95.667	5.033	10.000
PAS	3	1	23.000	1.732	3.000
PAF	3	1	56.667	7.024	14.000

Table 54 (Continued)

Variable	N	N Missing	Mean	Standard Deviation	Range
- - - - - - - - - - - - Site = 3MN			Sex = 3 - - - - - - - - - - - -		
GOL	0	3	.	.	.
XCB	0	3	.	.	.
BBH	0	3	.	.	.
WFB	0	3	.	.	.
ZYB	0	3	.	.	.
OBH	0	3	.	.	.
OBB	0	3	.	.	.
NLH	0	3	.	.	.
NLB	0	3	.	.	.
NGN	0	3	.	.	.
EAL	0	3	.	.	.
EAB	0	3	.	.	.
MSH	3	0	30.333	3.512	7.000
BIG	1	2	94.000	.	0.000
BIC	0	3	.	.	.
HAR	2	1	50.500	2.121	3.000
AUH	0	3	.	.	.
BGN	0	3	.	.	.
BPO	0	3	.	.	.
FRC	0	3	.	.	.
FRS	0	3	.	.	.
PAC	0	3	.	.	.
PAS	0	3	.	.	.
PAF	0	3	.	.	.
- - - - - - - - - - - - Site = 4MN			Sex = 1 - - - - - - - - - - - -		
GOL	1	4	152.000	.	0.000
XCB	2	3	158.500	3.536	5.000
BBH	0	5	.	.	.
WFB	3	2	95.000	1.000	2.000
ZYB	0	5	.	.	.
OBH	3	2	36.000	2.646	5.000
OBB	2	3	41.000	1.414	2.000
NLH	2	3	52.500	3.536	5.000
NLB	1	4	25.000	.	0.000
NGN	1	4	124.000	.	0.000
EAL	0	5	.	.	.
EAB	1	4	63.000	.	0.000
MSH	4	1	33.750	4.500	10.000
BIG	3	2	98.333	6.028	12.000
BIC	0	5	.	.	.
HAR	1	4	53.000	.	0.000
AUH	0	5	.	.	.
BGN	0	5	.	.	.
BPO	0	5	.	.	.
FRC	1	4	110.000	.	0.000
FRS	1	4	23.000	.	0.000
PAC	0	5	.	.	.
PAS	0	5	.	.	.
PAF	0	5	.	.	.

Table 54 (Continued)

Variable	N	N Missing	Mean	Standard Deviation	Range
- - - - - - - - - - - - - Site = 4MN			Sex = 2 - - - - - - - - - - - -		
GOL	3	6	154.000	11.136	22.000
XCB	4	5	145.500	1.000	2.000
BBH	3	6	137.000	4.583	9.000
WFB	4	5	90.250	4.573	10.000
ZYB	3	6	129.667	3.055	6.000
OBH	3	6	35.333	2.517	5.000
OBB	3	6	37.000	2.000	4.000
NLH	1	8	49.000	.	0.000
NLB	1	8	25.000	.	0.000
NGN	1	8	113.000	.	0.000
EAL	0	9	.	.	.
EAB	1	8	64.000	.	0.000
MSH	5	4	32.800	2.168	5.000
BIG	4	5	91.500	7.234	15.000
BIC	1	8	126.000	.	0.000
HAR	5	4	51.000	4.583	12.000
AUH	3	6	80.667	4.726	9.000
BGN	1	8	109.000	.	0.000
BPO	3	6	22.333	3.055	6.000
FRC	3	6	103.667	8.622	17.000
FRS	3	6	20.000	4.000	8.000
PAC	3	6	96.333	3.512	7.000
PAS	3	6	23.667	5.508	10.000
PAF	3	6	52.667	5.686	11.000
- - - - - - - - - - - - - Site = 4MN			Sex = 3 - - - - - - - - - - - -		
GOL	0	4	.	.	.
XCB	0	4	.	.	.
BBH	0	4	.	.	.
WFB	1	3	90.000	.	0.000
ZYB	0	4	.	.	.
OBH	0	4	.	.	.
OBB	0	4	.	.	.
NLH	0	4	.	.	.
NLB	0	4	.	.	.
NGN	0	4	.	.	.
EAL	0	4	.	.	.
EAB	0	4	.	.	.
MSH	2	2	28.000	2.828	4.000
BIG	1	3	87.000	.	0.000
BIC	0	4	.	.	.
HAR	2	2	55.500	4.950	7.000
AUH	0	4	.	.	.
BGN	0	4	.	.	.
BPO	0	4	.	.	.
FRC	0	4	.	.	.
FRS	0	4	.	.	.
PAC	0	4	.	.	.
PAS	0	4	.	.	.
PAF	0	4	.	.	.

*Sex 1 = Male, 2 = Female, 3 = Indeterminate; . = Missing Data.

utilized in the investigation of site in relation to the eight aforementioned cranial measurements. Sexual variation is standardized by setting the mean equal to zero for each measurement respective to sex. Table 55 details Mahalanobis distances between each of the ten classes in addition to probability estimates of a value being greater than the corresponding Mahalanobis distance (Prob. > Mahalanobis). The greatest Mahalanobis distances (>3.0) differentiate the Mouse Creek site females (and males, to a lesser extent) from Rymer and Toqua females. However, the small Mouse Creek cranial sample size (female n=2; male n=4) makes these results questionable. At the .05 level of significance, the Probability > Mahalanobis Distance figures denote significant relationships between the majority of site crania in terms of the eight measurements. However, notable exceptions include correlations between Rymer males and females and Toqua females, Rymer females and Toqua females, Ledford Island males and Toqua males, and Ledford Island females and Toqua males. The overall Wilks' Lambda <u>F</u> approximation of 2.60 for the relationship between site (or group) and the measurements is very significant. The canonical correlations data indicate that two canonical components (CAN1 and 2) are significantly (at the .05 level) responsible for the observed differences, accounting for approximately 72.89% (combined) of the total variance (Table 56). When these components are analyzed even further, CAN1 (accounting for 48.70% of the total variance) manifests high loadings on the measurements of the upper face--Orbital Height and Breadth and, to a lesser extent, Minimum

Table 55. Mahalanobis Distances and Significance Probabilities for the Averbuch, Toqua, Ledford Island, Rymer and Mouse Creek Sites (Separate Sex).

MAHALANOBIS DISTANCES BETWEEN CLASSES

SITE[a]	OMR	1MN	2MN	3BY	4BY	5BY	6BY	7DV	8DV	9MR
OMR	.	1.7052	3.1676	2.6510	1.9821	1.7709	2.0113	2.2514	2.3330	1.3657
1MN	1.7052	.	2.7622	3.3511	2.3334	2.5343	2.1740	2.2604	2.4327	1.9706
2MN	3.1676	2.7622	.	3.2316	3.2113	2.8752	1.9840	1.8147	1.8825	2.9566
3BY	2.6510	3.3511	3.2316	.	2.2264	1.2002	2.3821	2.6456	2.0917	2.5292
4BY	1.9821	2.3334	3.2113	2.2264	.	2.0367	1.6060	1.8841	1.9584	1.5537
5BY	1.7709	2.5343	2.8752	1.2002	2.0367	.	1.8665	2.3265	1.8517	1.7078
6BY	2.0113	2.1740	1.9840	2.3821	1.6060	1.8665	.	1.4798	1.6114	1.2735
7DV	2.2514	2.2604	1.8147	2.6456	1.8841	2.3265	1.4798	.	0.8184	2.1204
8DV	2.3330	2.4327	1.8825	2.0917	1.9584	1.8517	1.6114	0.8184	.	2.1325
9MR	1.3657	1.9706	2.9566	2.5292	1.5537	1.7078	1.2735	2.1204	2.1325	.

PROB > MAHALANOBIS DISTANCE

SITE	OMR	1MN	2MN	3BY	4BY	5BY	6BY	7DV	8DV	9MR
OMR	.	0.972954	0.976309	0.447230	0.446949	0.064384	0.007133*	0.000000*	0.000000*	0.447968
1MN	0.972954	.	0.774856	0.000677*	0.005794*	0.000000*	0.000005*	0.000000*	0.000000*	0.000649*
2MN	0.976309	0.774856	.	0.000101*	0.000000*	0.000000*	0.000011*	0.000000*	0.000000*	0.000000*
3BY	0.447230	0.000677*	0.000101*	.	0.019506*	0.184936	0.000001*	0.000000*	0.000000*	0.000003*
4BY	0.446949	0.005794*	0.000000*	0.019506*	.	0.000627*	0.012243*	0.000000*	0.000000*	0.062635
5BY	0.064384	0.000000*	0.000000*	0.184936	0.000627*	.	0.007186*	0.000000*	0.000000*	0.080176
6BY	0.007133*	0.000005*	0.000011*	0.000001*	0.012243*	0.007186*	.	0.000000*	0.000000*	0.464624
7DV	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	.	0.217282	0.216300
8DV	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.000000*	0.217282	.	0.196462
9MR	0.447968	0.000649*	0.000000*	0.000003*	0.062635	0.080176	0.464624	0.216300	0.196462	.

MULTIVARIATE TEST STATISTICS AND F APPROXIMATIONS

STATISTIC	VALUE	F	NUM DF	DEN DF	PROB>F
Wilks' Lambda	0.2620911	2.605626	72	761.8419	1.39131E-10
Pillai's Trace	1.120025	2.36957	72	1048	4.86610E-09
Hotelling-Lawley Trace	1.642169	2.788266	72	978	1.91975E-12
Roy's Greatest Root	0.7997604	11.64096	9	131	2.64170E-13

NOTE: F Statistic for Roy's Greatest Root is an Upper Bound

[a]1MN = Mouse Creek Males; 2MN = Mouse Creek Females; 3BY = Rymer Males; 4BY = Rymer Females; 5BY = Ledford Island Males; 6BY = Ledford Island Females; 7DV = Averbuch Males; 8DV = Averbuch Females; 9MR = Toqua Males; OMR = Toqua Females.

*Denotes a significant difference at the .05 level.

Table 56. Canonical Correlations, Structures and Class Means on Canonical Variables for the Averbuch, Toqua, Ledford Island, Rymer and Mouse Creek Sites (Separate Sex).

TOTAL CANONICAL STRUCTURE

	CAN1	CAN2	CAN3	CAN4	CAN5	CAN6	CAN7	CAN8
WFB	0.4210	0.0409	-0.3671	0.1235	-0.0500	0.4405	-0.2049	0.6577
OBH	0.6531	-0.3550	-0.3470	0.3428	0.2345	0.2207	0.0857	-0.3138
OBB	0.6300	-0.1002	0.3143	-0.0944	0.5835	0.2876	0.1194	0.2189
NLH	-0.0365	-0.1962	0.2609	0.5287	-0.1196	0.6866	0.1737	-0.3109
NLB	0.2964	0.3946	0.3012	0.6106	0.1990	-0.1923	-0.4650	-0.0098
EAB	-0.5722	-0.2795	-0.1606	0.1326	0.5822	0.3115	-0.3393	0.0007
MSH	-0.4004	-0.0025	0.0303	0.5268	0.3699	0.0110	0.4708	0.4500
HAR	-0.3105	0.5767	-0.2245	0.1262	0.4000	0.4971	0.1963	-0.2431

STANDARDIZED CANONICAL COEFFICIENTS

	CAN1	CAN2	CAN3	CAN4	CAN5	CAN6	CAN7	CAN8
WFB	0.2098	0.1610	-0.4398	0.0740	-0.3544	0.4863	-0.3129	0.6835
OBH	0.5737	-0.4080	-0.8616	0.4204	0.2549	-0.3156	0.2319	-0.4687
OBB	0.4826	-0.0492	0.7562	-0.5079	0.6079	0.2588	0.1603	0.1731
NLH	-0.1484	-0.2782	0.6533	0.3329	-0.5075	0.7271	0.0257	-0.1450
NLB	0.2116	0.4651	0.2947	0.6070	0.1220	-0.2916	-0.5547	-0.0547
EAB	-0.5872	-0.5975	-0.0941	-0.0558	0.5042	0.1638	-0.6908	-0.0110
MSH	-0.2703	-0.1323	-0.0802	0.5882	0.2009	-0.3769	0.6823	0.4647
HAR	-0.0590	1.0085	-0.3930	-0.1614	0.2769	0.3409	0.2492	-0.3221

CLASS MEANS ON CANONICAL VARIABLES

SITE[a]	CAN1	CAN2	CAN3	CAN4	CAN5	CAN6	CAN7	CAN8
OMR	1.3516	-0.5101	0.6401	0.0647	0.2339	-0.1346	-0.0174	-0.0007
1MN	0.7441	-1.1438	0.5548	-0.3785	-1.1511	-0.0156	-0.0218	-0.0312
2MN	-1.1808	-0.2045	-0.1205	-1.5430	-0.1866	-0.5170	-0.1761	0.1268
3BY	0.5316	1.8479	-0.1008	0.2581	-0.0571	-0.4132	-0.2313	-0.0283
4BY	0.5315	-0.0842	-0.6692	1.0732	-0.3475	-0.1442	0.0427	0.0379
5BY	0.9440	1.0748	0.1612	-0.2712	-0.0273	0.0088	0.1470	0.0140
6BY	0.1738	-0.2368	-0.8826	-0.4123	0.0635	-0.1924	0.0454	-0.0289
7DV	-0.8151	-0.3766	0.0616	0.1228	0.1088	-0.0896	0.0127	-0.0006
8DV	-0.7212	0.3497	0.1759	-0.0029	-0.0503	0.1914	-0.0074	-0.0038
9MR	1.1256	-0.3641	-0.5334	-0.0858	0.1181	0.4771	-0.0889	0.0109

CANONICAL CORRELATIONS AND TESTS OF HO: THE CANONICAL CORRELATION IN THE CURRENT ROW AND ALL THAT FOLLOW ARE ZERO

	CANONICAL CORRELATION	ADJUSTED CAN CORR	APPROX STD ERROR	VARIANCE RATIO	CANONICAL R-SQUARED	LIKELIHOOD RATIO	F STATISTIC	NUM DF	DEN DF	PROB>F
1	0.666611184	0.601446587	0.046959266	0.7998	0.444370471	0.262091065	2.6056	72	761.84	0.0000
2	0.533197048	0.445052190	0.060487767	0.3972	0.284299092	0.471701108	1.8141	56	678.46	0.0004
3	0.405575032	0.272324069	0.070613390	0.1969	0.164491106	0.659075744	1.3157	42	594.44	0.0921
4	0.343408276	0.250808867	0.074548585	0.1337	0.117929244	0.788831512	1.0386	30	510	0.4122
5	0.237577502	.	0.079745115	0.0598	0.056443069	0.894295052	0.7288	20	425.48	0.7970
6	0.215537090	.	0.080589157	0.0487	0.046456237	0.947791302	0.5828	12	341.59	0.8560
7	0.074422118	.	0.084047324	0.0056	0.005538652	0.993967281	0.1313	6	260	0.9923
8	0.022289427	.	0.084473437	0.0005	0.000496819	0.999503181	0.0326	2	131	0.9680

[a] 1MN = Mouse Creek Males; 2MN = Mouse Creek Females; 3BY = Rymer Males; 4BY = Rymer Females; 5BY = Ledford Island Males; 6BY = Ledford Island Females; 7DV = Averbuch Males; 8DV = Averbuch Females; 9MR = Toqua Males; OMR = Toqua Females.

Frontal Breadth. High negative loadings exist on the lower facial measurements of External Alveolar Breadth, Mandibular Symphysis Height and Height of Ascending Ramus. The opposite relationship is seen with the CAN2 data (comprising 24.19% of the total variance), with high positive loadings on the Height of Ascending Ramus dimensions and high negative values for the Orbital Height measurements. The standardized canonical coefficients present a similar picture, with, once again, the upper facial dimensions loading highly on the first canonical component. CAN2 again shows very high positive Height of Ascending Ramus loadings and high negative values for the Orbital Breadth and External Alveolar Breadth measurements.

Graphic representation of these relationships (based on the class means on the first two canonical variables) is presented in Figure 50. The most significant first canonical variate (CAN1) lies along the horizontal axis and distributes the populations accordingly based primarily on the above high positive loaded variables. The greatest horizontal separation is generally between Averbuch and Toqua males and females. Mouse Creek Phase sites generally lie in the middle with a closer relationship to Toqua suggested. The only exception is the Mouse Creek site female crania which align themselves near the Averbuch crania far from their male counterparts. However, the previously mentioned small total sample size (n=2) for this group makes these results very questionable. The second, less important, canonical component lies along the vertical axis and separates the sites in this manner based primarily on the high

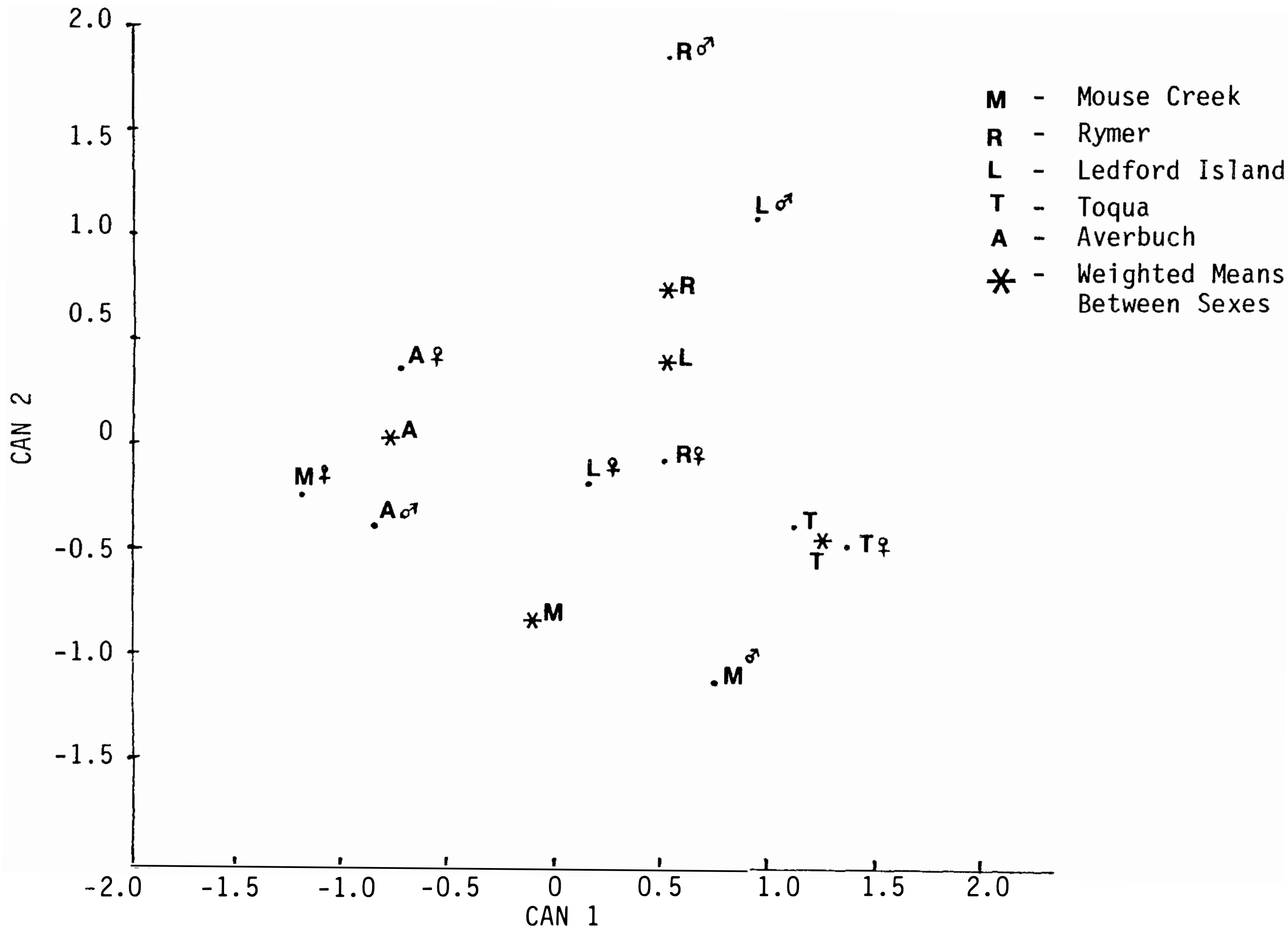


Figure 50. Graphic Representation of the Canonical Discriminant Analysis Results (Derived from Class Means on Canonical Variables).

positive loaded CAN2 variables. The greatest separation involves the Rymer and the Mouse Creek males. If the weighted class means (based on combined sex) from the five sites are compared, an even clearer picture emerges. Averbuch and Toqua crania are separated in the left and right halves of the graph, respectively. The Mouse Creek Phase crania lie between these two, with Rymer and Ledford Island slightly closer to Toqua crania.

Before the combined Mouse Creek Phase site comparison can be conducted, the relationship between the crania from Ledford Island, Rymer and Mouse Creek must be investigated. This is accomplished via a Multiple Analysis of Variance (MANOVA) of the eight measurements with regard to Mouse Creek Phase site, with the understanding being that if any major differences are found between crania from these sites (sex differences are standardized), then the three samples of Ledford Island, Rymer and Mouse Creek should not be combined. The Wilks' Lambda F approximation of 2.32 (Prob. 7F.=.0022) indicates significant differences at the .05 level with respect to the cranial measurements and the three Mouse Creek Phase sites. When the previously aberrant small sample of Mouse Creek male and female crania is deleted from the combined sample, the MANOVA Wilks' Lambda F approximation of 1.73 (Prob. > F=0.1340) indicates no significant differences at the .05 level between the Rymer and Ledford Island crania. It is these crania, then, which are utilized in the combined site comparison with Toqua and Averbuch. The combined site canonical analysis is conducted for male and female

crania separately (with sexual variation standardized by setting the mean equal to zero).

Males. Mahalanobis distances between each of the three samples utilized (Ledford Island/Rymer=1BY; Averbuch=8DV; and Toqua=9MR) are listed in Table 57 along with estimations of the significance of these values (Prob. > Mahalanobis). It can be seen that Mahalanobis cranial distances between Mouse Creek and Averbuch males are rather large (2.1903). The Probability > Mahalanobis figures also reflect this relationship at the .05 level. The Wilks' Lambda value of 4.02 indicates significant differences in the overall site and cranial measurement relationship. Both canonical components are significantly (at the .05 level) responsible for the observed differences, accounting for approximately 100% of the total variance. The CAN1 Total Canonical Structure (accounting for 76.81% of the total variation) reveals that relatively high loadings are associated with the facial breadth measurements (Minimum Frontal Breadth, Orbital Breadth and Nasal Breadth), with a high negative loading on the External Alveolar Breadth measurement. Conversely, Orbital Height loads highly on CAN2 (accounting for 23.19% of the total variation), with Nasal Breadth exhibiting a rather high negative loading. Graphic representation of these results are presented in Figure 51. The first canonical variate (CAN1) primarily separates out Averbuch and Mouse Creek male crania on the horizontal axis, with Toqua males lying in the middle (with some overlap with the Mouse

Table 57. Canonical Discriminant Analysis Results for the Combined Mouse Creek Phase, Toqua and Averbuch Males.

MAHALANOBIS DISTANCES BETWEEN CLASSES

SITE*	1BY	8DV	9MR
1BY	.	2.1903	1.7371
8DV	2.1903	.	1.8945
9MR	1.7371	1.8945	.

CANONICAL DISCRIMINANT ANALYSIS

PROB > MAHALANOBIS DISTANCE

SITE*	1BY	8DV	9MR
1BY	.	0.000000	0.200297
8DV	0.000000	.	0.430679
9MR	0.200297	0.430679	.

CANONICAL CORRELATIONS AND TESTS OF HO: THE CANONICAL CORRELATION IN THE CURRENT ROW AND ALL THAT FOLLOW ARE ZERO

	CANONICAL CORRELATION	ADJUSTED CAN CORR	APPROX STD ERROR	VARIANCE RATIO	CANONICAL R-SQUARED	LIKELIHOOD RATIO	F STATISTIC	NUM DF	DEN DF	PROB>F
1	0.701411121	0.630290192	0.064004811	0.9684	0.491977561	0.393126317	4.0156	16	108	0.0000
2	0.475566481	0.360509350	0.097494238	0.2923	0.226163478	0.773836522	2.2963	7	55	0.0398

MULTIVARIATE TEST STATISTICS AND F APPROXIMATIONS

STATISTIC	VALUE	F	NUM DF	DEN DF	PROB>F
Wilks' Lambda	0.3931263	4.015587	16	108	0.0000062242
Pillai's Trace	0.718141	3.851609	16	110	0.0000114081
Hotelling-Lawley Trace	1.26068	4.176001	16	106	.00000349128
Roy's Greatest Root	0.968417	6.657867	8	55	.00000463782

Note: F Statistic for Roy's Greatest Root is an Upper Bound
F Statistic for Wilks' Lambda is exact

TOTAL CANONICAL STRUCTURE

	CAN1	CAN2
WFB	0.4142	0.4897
OBH	0.2843	0.8163
OBB	0.4258	0.3837
NLH	-0.2193	0.2646
NLB	0.4340	-0.3321
EAB	-0.6650	0.1834
MSH	-0.4635	-0.2247
HAR	0.1509	-0.2205

* 1BY = Mouse Creek Phase (Ledford Island and Rymer), 8DV = Averbuch and 9MR = Toqua.

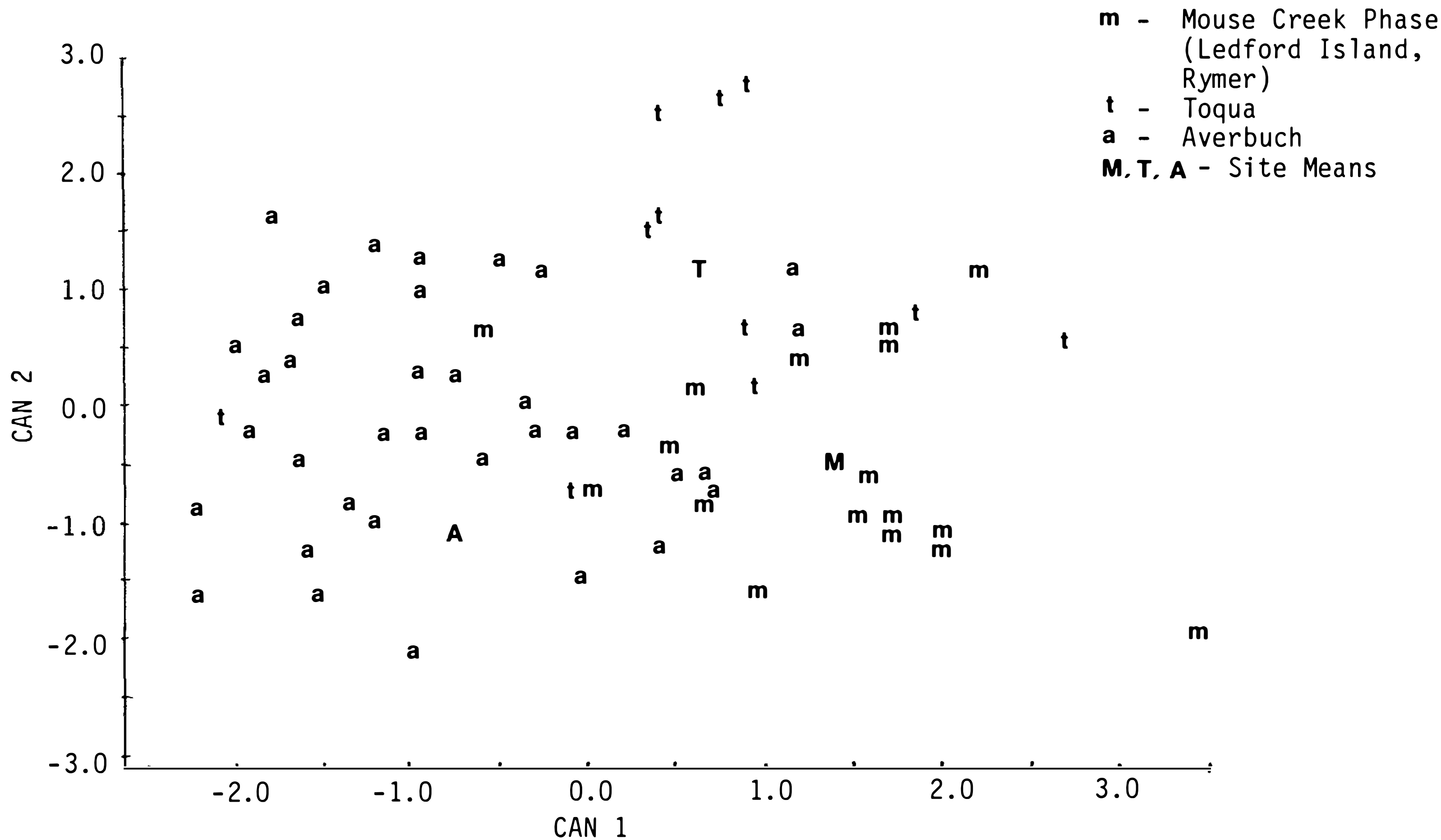


Figure 51. Graphic Representation of the Canonical Discriminant Analysis Results for the Mouse Creek Phase (Combined Site), Toqua and Averbuch Males.

Creek males). CAN2 vertically separates Toqua from the other two samples based on the aforementioned high CAN2 loadings.

Females. Table 58 contains Mahalanobis D^2 values and significance probabilities for the Ledford Island/Rymer, Averbuch and Toqua females. The greatest D^2 distances are between Averbuch and Toqua females (D^2=3.0469); however, all of the Probability > Mahalanobis distances are significant at the .05 level. The overall Wilks' Lambda F approximation of 6.41 also indicates significant variation in the crania. Once again, both CAN1 and CAN2 are significant, accounting for 83.14% and 16.86% of the total variation, respectively. Orbital Height and Breadth load highly on CAN1, with Height of Ascending Ramus exhibiting a high negative loading. CAN2 exhibits a high positive loading on the Orbital Breadth measurement. Figure 52 illustrates these relationships. CAN1 primarily separates Toqua and Averbuch females horizontally, with Mouse Creek Phase crania falling in the middle. The less important CAN2 vertically appears to differentiate Mouse Creek Phase and Toqua females.

III. DISCUSSION

The results of the canonical discriminant analyses generally indicate the following: (1) a slightly closer relationship between Mouse Creek Phase and Toqua male individuals as compared to the more distant Averbuch individuals is suggested; and (2) distinct differences are noted between the females from the Mouse Creek Phase, Toqua and Averbuch populations.

Table 58. Canonical Discriminant Analysis Results for the Combined Mouse Creek Phase, Toqua and Averbuch Females.

MAHALANOBIS DISTANCES BETWEEN CLASSES

SITE*	1BY	8DV	9MR
1BY	.	1.9386	2.0125
8DV	1.9386	.	3.0469
9MR	2.0125	3.0469	.

CANONICAL DISCRIMINANT ANALYSIS

PROB > MAHALANOBIS DISTANCE

SITE*	1BY	8DV	9MR
1BY	.	0.000000	0.003983
8DV	0.000000	.	0.000054
9MR	0.003983	0.000054	.

CANONICAL CORRELATIONS AND TESTS OF HO: THE CANONICAL CORRELATION IN THE CURRENT ROW AND ALL THAT FOLLOW ARE ZERO

	CANONICAL CORRELATION	ADJUSTED CAN CORR	APPROX STD ERROR	VARIANCE RATIO	CANONICAL R-SQUARED	LIKELIHOOD RATIO	F STATISTIC	NUM OF	DEN OF	PROB>F
1	0.781743165	0.739469055	0.046479766	1.5715	0.611122377	0.294918499	6.4157	16	122	0.0000
2	0.491544685	0.389607835	0.090644204	0.3186	0.241616177	0.758383823	2.8218	7	62	0.0128

MULTIVARIATE TEST STATISTICS AND F APPROXIMATIONS

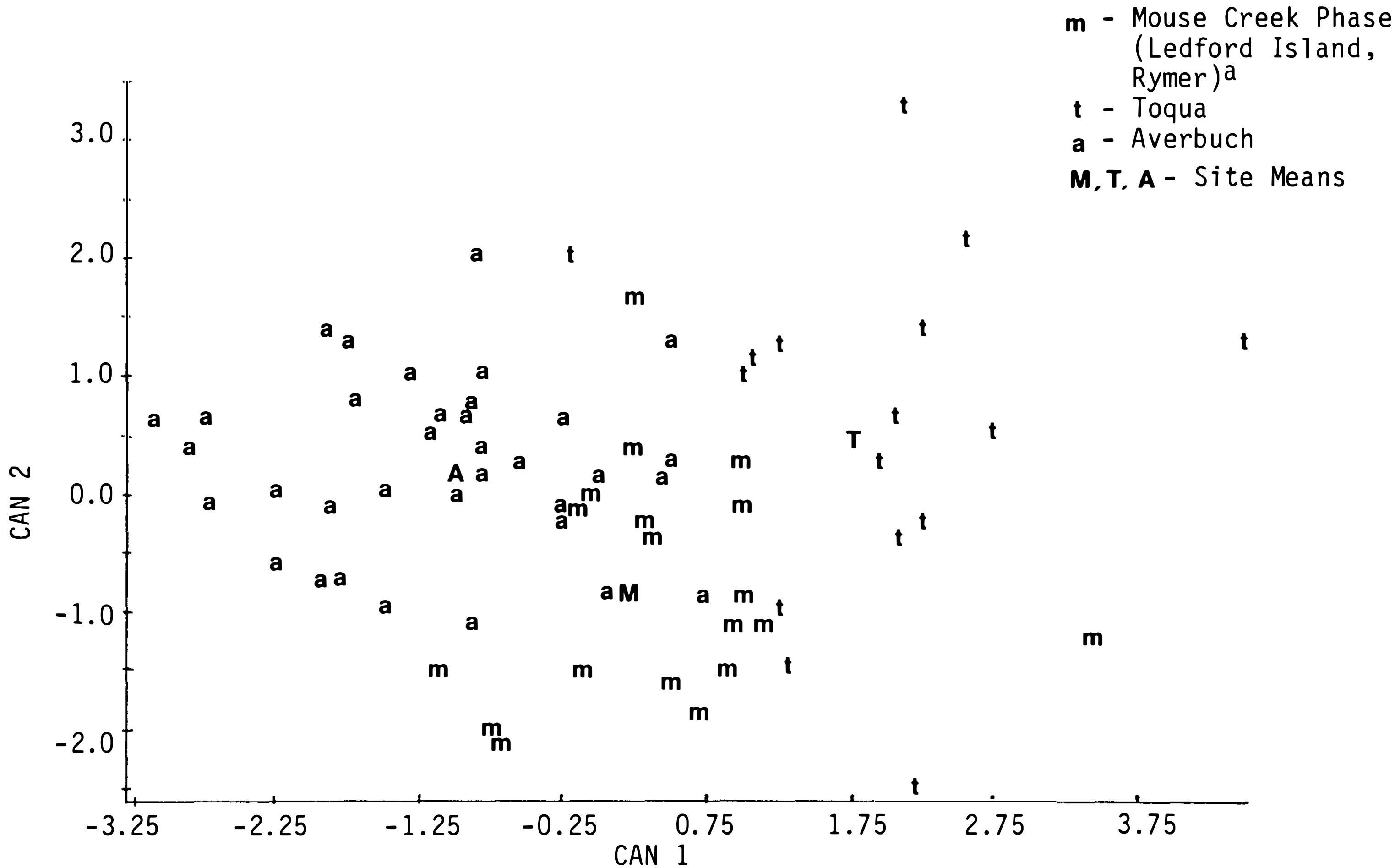
STATISTIC	VALUE	F	NUM OF	DEN OF	PROB>F
Wilks' Lambda	0.2949185	6.415703	16	122	3.10782E-10
Pillai's Trace	0.8527386	5.760434	16	124	3.50791E-09
Hotelling-Lawley Trace	1.890097	7.087862	16	120	2.91188E-11
Roy's Greatest Root	1.571503	12.17915	8	62	2.79063E-10

NOTE: F Statistic for Roy's Greatest Root is an Upper Bound
F Statistic for Wilks' Lambda is Exact

TOTAL CANONICAL STRUCTURE

	CAN1	CAN2
WFB	0.2400	-0.3105
OBH	0.6749	-0.3050
OBB	0.6388	0.5399
NLH	-0.0643	0.3272
NLB	0.1961	0.3389
EAB	-0.4208	-0.0669
MSH	-0.3020	0.0162
HAR	-0.6634	-0.1005

* 1BY = Mouse Creek Phase (Ledford Island and Rymer), 8DV = Averbuch and 9MR = Toqua.



[a]1 Observation Hidden

Figure 52. Graphic Representation of the Canonical Discriminant Analysis Results for the Mouse Creek Phase (Combined Site), Toqua and Averbuch Females.

It must also be stated that further analyses conducted by the author peripheral to this study supported these findings. Results of a cluster analysis (employing an agglomerative methodology as opposed to the discriminant analysis' divisive one) based on the same specimens and measurements also grouped many of the Toqua male individuals with the Mouse Creek Phase males. The female pattern, however, was less clear.

Berryman's (1975) study found no differences with respect to Mouse Creek Phase, Middle Cumberland and Dallas males or Mouse Creek Phase and Middle Cumberland females, but significant differences between Mouse Creek and Dallas females. In the present study, the similarities between Toqua and Mouse Creek male crania are in partial agreement with Berryman's results. The observed female variability also is seen in the present analysis. Berryman (1975:60) suggested possible matrilineal kinship systems resulting in matrilocal residence structures within the three cultures as a feasible explanation for the sexual differences observed in his study. In support of this contention, Swanton (1922) has noted such a kinship system for many early historic Indian manifestations in the southeast. And, Wright (1974) encountered a similar relationship in her multivariate comparison of Dallas and Historic Cherokee skeletons. While the residence system may also explain the observed differences between the Mouse Creek Phase, Toqua and Averbuch females, many factors may complicate this picture. For example, length of time and frequency of male exogamy, trade or migration may cause variability in the resultant skeletal population.

Most importantly, however, no support was found for Berryman's Mouse Creek-Middle Cumberland biological association. None of the Mouse Creek Phase male or female cranial samples were aligned with the Averbuch crania (excluding the small Mouse Creek site female sample), with most exhibiting a slightly closer biological similarity to the Toqua crania instead. These results strongly question the Lewis and Kneberg hypothesis of a Middle Cumberland-Mouse Creek connection. While archaeological comparisons are needed to fully evaluate the hypothesis, no comparative synthesis of recent archaeological data on the three cultures is yet available. However, preliminary results of a reanalysis of the three Mouse Creek site archaeological collections (L. Peters, personal communication 1984), in conjunction with existing information on the Toqua and Averbuch sites, supports the results of the biological analysis presented here.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

As stated in the introduction, the goals of this thesis were twofold: (1) an analysis of Mouse Creek Phase site biological variables; and (2) a comparison of these findings to similar data from the Toqua and Averbuch sites. Results are thus summarized along these lines.

I. MOUSE CREEK PHASE, TOQUA AND AVERBUCH SKELETAL BIOLOGY

The Mouse Creek Phase Analyses

The Late Mississippian, eastern Tennessee archaeological phase denoted as Mouse Creek was discussed in relation to spatial and temporal boundaries, as well as its relationship to neighboring archaeological manifestations from the same general time period. Mouse Creek Phase type sites were also considered with respect to temporal and spatial variables, in addition to information regarding site and burial morphology and patterning. The skeletal data base utilized from these sites was outlined in conjunction with methods of analysis. Methodologies relating to the aging and sexing techniques, demographic calculations, stature estimation, pathology identification, cranial metric analysis and statistical techniques (including analysis of variance and discriminant analysis) used in this study were described.

Paleodemographic analysis. The Mouse Creek Phase skeletal age and sex distribution was utilized in the paleodemographic analysis.

Mouse Creek Phase sites were first considered in light of preliminary demographic prerequisites and assumptions. Life tables for combined as well as separate sex were then calculated for each of the three sites. These contained information regarding mortality, survivorship, probability of dying and life expectancy. Graphic illustration of these four statistics was also provided. From the life expectancy at birth value, crude mortality rates were calculated and compared to those of other Amerindian skeletal populations. Population size was also computed. Results of the paleodemographic comparison of the Mouse Creek Phase sites indicated a moderately low stressed environment (as reflected by rather low mortality, probability of death, and crude mortality rates and high survivorship and life expectancy values) for the Ledford Island and Rymer sites similar to corresponding demographic data recorded for other low-stressed Amerindian skeletal populations. In contrast, the lower mortality, probability of dying and crude mortality rates along with high survivorship and life expectancy figures for the Mouse Creek individuals suggested an even lower stress level at this site. One of the major differences in the two scenarios appeared to result from the proportionately greater percentage of infant and early child stress-related mortalities at Ledford Island and Rymer. Whether this is a biological (i.e., actual reduced stress at Mouse Creek), cultural (differential burial of infants) or simply a taphonomic phenomenon (poorer preservation at Mouse Creek) is unknown. However, low stressed patterning similar to that noted above was reinforced in the remaining age

ranges. Because of the unknown and uncontrollable factors operating in the early subadult age ranges (such as those stated above), it is recommended by the author that less emphasis on demographic statistics focusing on these age categories is needed by anthropologists in the future. Instead, the general morphology of the entire demographic curves should be considered and compared.

Stature analysis. In the Mouse Creek Phase stature analysis, maximum femur and tibia length measurement means and standard deviations as well as resulting height estimates were presented, separate as to site and sex. These means were then compared to other similar archaeological populations. Evidences of reduced stature as indicative of environmental (nutritional) population stress were investigated. An Analysis of Variance procedure and Duncan Multiple Range test were performed to determine the relationship between Mouse Creek Phase stature (as manifested by femur long bone lengths) in relation to site. Maximum femur mean lengths from all of the Mouse Creek Phase sites (with the only exception being the Ledford Island females) were among the highest noted for Amerindian skeletal populations. No indications of significantly reduced stature possibly suggestive of heavy environmental (specifically, nutritional) stress were found. The ANOVA procedure delineated no significant differences between Mouse Creek Phase stature and site. Similar results were obtained from the Duncan Multiple Range test.

Pathology analysis. Mouse Creek Phase pathologies, grouped according to related disease manifestation classes, were analyzed

within a systemic health model emphasizing the interactive dimensions of the host, the natural environment and culture. Pathology class incidences from the three sites were compared in terms of age and sex variables, and these demographic patterns were compared to the previous ones. Specific cases of infection and trauma were considered in greater detail. In agreement with previous analyses, the Mouse Creek site manifested rather low pathology class incidences. However, pathology figures for Ledford Island were even lower and designated this site as the least stressed in terms of disease. In contrast, Rymer exhibited a very high pathology incidence, although of a different type than at Ledford Island (infectious disease- and trauma-related rather than age-related pathologies). It is possible that the less severe nature of many of the traumatic pathologies did not cause death. Pathology incidence for all three sites was not nearly as high as expected for the young subadult ages (based on the demographic results), but increased as predicted with age. Ledford Island males were significantly more disease stressed than the females, as is seen in the Ledford Island mortality curve. However, the reverse situation at Rymer was not seen in that demographic curve. Also as indicated in the mortality curve, Mouse Creek sexual dimorphism (in terms of pathologies) was minimal.

Thus, the author believes that the health-related results of the demographic, stature and paleopathological analyses are not incongruent. No indications of any major events of stress (environmental or otherwise) were found. And, in comparison, it appears

that the Mouse Creek individuals enjoyed a relatively healthier environment than those of Ledford Island and Rymer.

The Comparative Analyses

The Dallas Phase was defined and described in terms of spatial and temporal variables. Site description as well as history of investigation was provided for the Toqua site. Similar information was presented for the Middle Cumberland culture and the Averbuch site.

Demographic analysis. The demographic results obtained for Toqua and Averbuch by previous researchers (Parham 1982 and Berryman 1981, respectively) were compared to the age-standardized demographic curves of Ledford Island for both combined as well as separate sex. Life expectancy at birth values in addition to crude mortality rates were also compared across the three sites. The paleodemographic curves of the Toqua and Averbuch populations exhibited slight differences in terms of the early child ages (1-5 or 1.5-5.5) in that Averbuch mortality remained essentially high at this point, while Toqua began to descend. Also, like the previously examined Mouse Creek site males, Toqua males exhibited a higher mortality in the late teen years than males or females from the other sites. However, the two populations were similar in that both exhibited significantly greater amounts of stress than seen in any of the Mouse Creek Phase site curves. The greater percentages of infant and early child mortality experiences in combination with fewer late adult deaths

at Averbuch and Toqua in contrast to the opposite scenario at all the Mouse Creek Phase sites appeared to account for the observed discrepancies. Although biasing of the data as a result of sampling error, taphonomic differences or differential archaeological methods of recovery and biological methods of analysis (or any combination of the above factors) was possible, it is believed that the demographic results obtained are reliable.

Stature analysis. Averbuch and Toqua maximum mean femur lengths as well as adult stature estimates were compared with similar previously mentioned data from Mouse Creek. An ANOVA procedure along with a Duncan Multiple Range test were performed on the Averbuch, Toqua and pooled Mouse Creek Phase site femora to determine the relationship between stature and site. These results showed that Averbuch females were significantly different (taller) from all other groups in terms of stature. This was also the case for Mouse Creek Phase females (shorter), with the Ledford Island females accounting for the observed variation. However, the other groups were shown to be similar to one another in stature.

Pathology analysis. Porotic hyperostosis/cribra orbitalia frequencies from Averbuch and Toqua were compared to those of the Mouse Creek Phase sites. Explanatory frameworks involving consideration of the aforementioned health model were utilized. Porotic hyperostosis/cribra orbitalia frequencies were substantially higher at Toqua (especially among subadults) than at Averbuch or the Mouse

Creek Phase sites. Alternative interpretations in the form of possible differential utilization of maize across these three groups or erroneous correlations of the disease class to iron deficiency anemia and intense maize consumption were offered. Periostitis frequencies showed similar patterns as noted above, with Toqua by far leading the way in disease occurrence. Explanations for this difference were suggested in terms of the greater length of occupation, more dense settlement distribution and more central location of the Toqua site, resulting in greater probabilities of enteric parasitic- and bacterial-induced infections.

Craniometric analysis. Finally, a multivariate statistical study of eight measurements from Mouse Creek Phase site, Averbuch and Toqua crania was conducted to test archaeological hypotheses regarding Mouse Creek Phase origins and affiliations. A Canonical Discriminant Analysis utilizing the separate Mouse Creek Phase sites was employed to investigate the biological relationships between Averbuch, Toqua, Mouse Creek, Ledford Island, and Rymer individuals. Then, the Mouse Creek Phase sites were combined in a second canonical comparison with Toqua and Averbuch. Precedent to this was a Multiple Analysis of Variance of the selected eight measurements, conducted to investigate the relationship between the measurements and the Mouse Creek Phase sites to determine if the Mouse Creek Phase data could be pooled.

Like Berryman's (1975) study, both canonical discriminant analyses suggested similarities between Toqua and Mouse Creek Phase

males. And, isolation of Mouse Creek Phase, Toqua and Averbuch females from each other and the rest of the individuals was also reminiscent of Berryman's study. However, the distinct dissimilarity of the Mouse Creek Phase and Middle Cumberland crania in combination with the observed slightly closer biological relationship of most of the Mouse Creek crania with those of Toqua challenged the Mouse Creek-Middle Cumberland connection hypothesized by Lewis and Kneberg and supported by Berryman's previous craniometric analysis. Other findings of this thesis (stature relationships), as well as existing archaeological data, support these results.

In conclusion, this thesis has used the holistic approach and comparative method to direct a study of biological variables. This direction has produced important information about the biological relationships and health status of three prehistoric groups.

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APPENDICES

APPENDIX A

Table A-1. Ages and Sexes of Mouse Creek Phase Individuals.

Individual	Age	Sex[a]	Individual	Age	Sex[a]
Ledford Island					
16BY 1	0-1	S	16BY 43	25-29	F
2	0-1	S	44	50+	M
3	Adult	I	45	25-29	M
4	25-29	F	46	Adult	M
5	20-24	F	47	35-39	M
6	1-4	S	48	1-4	S
7	Adult	F	49	40-50	M
8	Fetal	S	50	20-24	F
9	0-1*	S	51	0-1	S
10	0-1	S	52	0-1	S
11	20-24	M	53	1-4	S
12	5-9	S	54	0-1	S
13A	Adult	I	55	20-24	F
13B	1-4	S	56	50+	F
14	25-29	M	57	35-39	M
15	0-1	S	58	1-4	S
16	1-4	S	59	Adult	M
17	0-1	S	60	0-1	S
18	10-14	S	61	20-24	F
19	35-39	M	62	35-39	F
20	Adult	I	63	40-50	M
21	40-50	M	64	Adult	M
22	40-50	F	65	25-29	M
23	30-34	F	66	10-14	S
24	25-29	F	67	Adult	M
25	0-1	S	68	Adult	I
26	35-39	F	69	20-24	F
27	0-1	S	70	0-1*	S
28	10-14	S	71	0-1*	S
29	1-4	S	72	1-4	S
30	40-50	F	73	5-9	S
31	1-4	S	74	0-1	S
32	10-14	S	75	0-1	S
33	50+	F	76	1-4	S
34	25-29	F	77	1-4	S
35	20-24	F	78	1-4	S
36	1-4	S	79	0-1	S
37	50+	F	80	0-1	S
38	Fetal	S	81	SubAd	S
39	0-1	S	82	Fetal	S
40	5-9	S	83	1-4	S
41	20-24	I	84	0-1	S
42	15-19	F	85	5-9*	S

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
16BY 86	20-24	F	16BY 130	20-24	M
87	35-39	M	131	25-29	M
88	0-1	S	132	30-34	F
89	1-4	S	133	0-1	S
90	30-34	F	134	35-39	F
91	Adult	M	135	40-50	F
92	Adult	M	136	20-24	F
93	1-4	S	137	30-34	F
94	SubAd	S	138	1-4	S
95	40-50	M	139	5-9	S
96	5-9	S	140	40-50	F
97	25-29	F	141	25-29	F
98	5-9	S	142	Fetal	S
99A	Adult	I	143	25-29	F
99B	10-14	S	144	0-1	S
99C	5-9	S	145	1-4	S
100	1-4	S	146	Fetal	S
101	1-4	S	147	20-24	M
102	10-14	S	148	0-1	S
103	0-1	S	149	0-1	S
104	35-39	F	150	0-1*	S
105	0-1	S	151	0-1	S
106	10-14	S	152	5-9	S
107	25-29	F	153	50+	F
108	Adult	I	154	1-4	S
109	0-1	S	155	Adult	I
110	25-29	M	156	SubAd	S
111	0-1	S	157	0-1	S
112	40-50	M	158	20-24	F
113	0-1	S	159	35-39	F
114	25-29	F	160	Adult	I
115	30-34	F	161	30-34	M
116	0-1	S	162	5-9	S
117	35-39	F	163	20-24	F
118	10-14	S	164	Adult	M
119	40-50	M	165	Adult	I
120	35-39	M	166	1-4	S
121	20-24	F	167	10-14	S
122	35-39	M	168	1-4	S
123	25-29	M	169	Adult	M
124	Adult	F	170	35-39	M
125	40-50	M	171	Adult	I
126	40-50	M	172	0-1	S
127	Adult	F	173	Adult	I
128	30-34	F	174	5-9	S
129	0-1	S	175	Fetal	S

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
16BY176	0-1	S	16BY221	Adult	I
177	Adult	M	222	Adult	M
178	40-50	M	223	Adult	I
179	40-50	M	224	Adult	I
180	5-9	S	225	Adult	I
181	1-4	S	226	Adult	I
182	Fetal	S	227	Adult	F
183	0-1*	S	228	Adult	M
184	0-1*	S	229	Adult	I
185	Adult*	I	230	Adult	I
186	Fetal	S	231	40-50	F
187	Adult	M	232	Adult	I
188	Adult	I	233	20-24	F
189	Adult	I	234	1-4	S
190	1-4	S	235	Adult	I
191	1-4	S	236	40-50	F
192	Adult	F	237	1-4	S
193	0-1*	S	238	0-1	S
194	0-1*	S	239	0-1	S
195	5-9*	S	240	5-9	S
196	Adult	I	241	Adult	M
197	5-9*	S	242	0-1	S
198	1-4	S	243	1-4	S
199	Adult	I	244	Adult	I
200	Adult	I	245	Adult	M
201	Adult	I	246	0-1	S
202	35-39	M	247	Fetal	S
203	Adult	I	248	Adult	F
204	Adult	M	249	5-9	S
205	0-1*	S	250	0-1	S
206	Adult	I	251	5-9	S
207	Adult	I	252	Adult	M
208	Adult	I	253	5-9	S
209	Adult	I	254	1-4	S
210	Adult	I	255	Adult	F
211	Adult	I	256	Adult	I
212	Adult	I	257	0-1*	S
213	40-50	I	258	Adult	M
214	Adult	M	259	Adult	I
215	Adult	I	260	Adult	M
216	Adult	I	261	25-29	M
217	Adult	M	262	35-39	F
218	Adult	I	263	Adult	I
219	Adult	I	264	Adult	F
220	Adult	M	265	Adult	I
			266	1-4	S

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
16BY267	5-9	S	16BY313	Adult	I
268	Adult	M	314	Adult	I
269	Adult	I	315	1-4	S
270	Adult	M	316	1-4	S
271	40-50	M	317	1-4	S
272	Adult	M	318	Adult	I
273	Adult	I	319	Adult	I
274	35-39	M	320	Adult	M
275	Adult	F	321	Adult	I
276	40-50	M	322	Adult	I
277	5-9	S	323	Adult	I
278	Adult	I	324	Adult	I
279	1-4	S	325	Adult	I
280	30-34	F	326	Adult	I
281	Adult	M	327	Adult	I
282	Adult	I	328	Adult	I
283	Adult	F	329	25-29	M
284	5-9*	S	330	0-1	S
285	0-1	S	331	Adult	I
286	Adult	I	332	Adult	M
287	20-24	F	333	Adult	I
288	Adult	F	334	20-24	F
289	Adult	M	335	Adult	M
290	40-50	F	336	Adult	I
291	30-34	F	337	Adult	M
292	1-4	S	338	Adult	I
293	5-9	S	339	0-1	S
294	5-9	S	340	Adult	M
295	Adult	I	341	0-1	S
296	20-24	F	342	25-29	F
297	10-14	S	343	0-1	S
298	Adult	M	344	1-4	S
299	30-34	M	345	20-24	F
300	1-4	S	346	20-24	F
301	30-34	I	347	5-9	S
302	30-34	F	348	0-1	S
303	20-24	F	349	1-4	S
304	10-14	S	350	10-14	S
305	SubAd	S	351	0-1	S
306	30-34	M	352	0-1	S
307	20-24	F	353	20-24	M
308	40-50	F	354	0-1	S
309	Adult	F	355	Adult	M
310	5-9	S	356	5-9	S
311	Adult	I	357	5-9	S
312	Adult	I	358	0-1	S

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
16BY359	35-39	M	16BY405	Adult*	I
360	25-29	M	406	5-9	S
361	0-1	S	407	1-4	S
362	1-4	S	408	30-34	M
363	0-1	S	409	0-1	S
364	0-1	S	410	35-39	F
365	20-24	I	411	0-1	S
366	15-19	I	412	30-34	M
367	35-39	F	413	25-29	F
368	Adult	I	414	50+	M
369	Adult	I	415	5-9	S
370	Adult	I	416	50+	M
371	50+	F	417	50+	F
372	25-29	F	418	10-14	S
373	50+	M	419	1-4	S
374	30-34	M	420	Adult	F
375	0-1	S	421	40-50	F
376	0-1	S	422	25-29	M
377	Adult	F	423	5-9	S
378	0-1*	S	424	25-29	M
379	Fetal	S	425	40-50	M
380	30-34	M	426	20-24	F
381	15-19	F	427	Adult	F
382	10-14	S	428	0-1	S
383	0-1	S	429	40-50	I
384	1-4	S	430	25-29	F
385	30-34	F	431	40-50	F
386	35-39	F	432	35-39	M
387	Adult	M	433	50+	F
388	Adult	I	434	0-1	S
389	5-9	S	435	35-39	F
390	30-34	M	436	0-1	S
391	30-34	M	437	30-34	F
392	25-29	F	438	0-1	S
393	30-34	M	439	35-39	F
394	10-14	S	440	40-50	F
395	0-1	S	441	15-19	F
396	20-24	M	442	1-4	S
397	35-39	M	443	0-1	S
398	5-9	S	444	0-1	S
399	25-29	F	445	0-1	S
400	25-29	M	446	35-39	F
401	35-39	M	447	1-4	S
402	40-50	M	448	10-14	S
403	50+	M	449	5-9	S
404	15-19	F	450	25-29	M

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
16BY451	30-34	M	15BY 36	0-1	S
452	35-39	M	37	1-4	S
453	35-39	M	38	10-14	S
454	25-29	F	39	5-9	S
455	25-29	M	40	SubAd	S
456	30-34	F	41	0-1	S
457	25-29	F	42	1-4	S
458	35-39	M	43	5-9	S
459	0-1	S	44	15-19	M
			45	5-9	S
Rymer			46	20-24	F
15BY 1	25-29	F	47	25-29	M
2	0-1	S	48	Adult	M
3	1-4	S	49	15-19	M
4	0-1	S	50	5-9	S
5	0-1	S	51	35-39	F
6	40-50	F	52	Adult	M
7	15-19	F	53	25-29	M
8	5-9*	S	54	50+	M
9	1-4	S	55	1-4	S
10	Adult	I	56A	Adult	I
11	Adult	I	56B	SubAd	S
12	Adult	I	57	0-1	S
13	Adult	I	58A	Adult	I
14	Adult*	I	58B	5-9	S
15	0-1	S	59	SubAd	S
16	20-24	F	60	0-1	S
17	30-34	M	61	1-4	S
18	5-9	S	62	25-29	M
19	Adult	I	63	25-29	M
20	40-50*	F	64	Adult	I
21	1-4	S	65	0-1	S
22	1-4	S	66	40-50	M
23	20-24	F	67	5-9	S
24	1-4	S	68	0-1	S
25	Adult	I	69	Adult	I
26	0-1*	S	70	25-29	M
27	15-19	F	71	0-1	S
28	40-50	F	72	0-1	S
29	10-14	S	73	25-29	F
30	Adult	I	74	5-9	S
31	30-34	F	75	40-50	F
32	30-34	M	76	Adult	F
33	50+	M	77	Adult	F
34	1-4	S	78	Adult	M
35	5-9	S	79	Adult	I

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
15BY 80	40-50	M	15BY126	Adult	I
81	Adult	M	127	15-19	F
82	Adult	M	128	0-1	S
83	Adult	I	129	50+	M
84	Adult	I	130	10-14	S
85	50+	M	131	20-24	F
86	40-50	M	132	50+	F
87	25-29	F	133	1-4	S
88	30-34	F	134	40-50	M
89	35-39	F	135	25-29	M
90	1-4	S	136	40-50	M
91	0-1	S	137	0-1	S
92	5-9	S	138	25-29	M
93	Adult	I	139	10-14	S
94	10-14	S	140	40-50	F
95	40-50	M	141	Adult	I
96	5-9	S	142	30-34	M
97	35-39	M	143	35-39	M
98	35-39	M	144	35-39	M
99	25-29	F	145	Adult	M
100	Adult	M	146	Adult	F
101	Adult	I	147	Adult	F
102	Adult	M	148	40-50	F
103	Adult	M	149	0-1	S
104	25-29	F	150	0-1	S
105	Adult	M	151	Indet	I
106	0-1	S	152	Adult	M
107	0-1	S	153	0-1	S
108	Adult	I	154	20-24	F
109	40-50	M	155	0-1	S
110	50+	M	156	1-4	S
111	1-4	S	157	25-29	F
112	10-14	S	158	Fetal	S
113	Adult	I	159	1-4	S
114	40-50	F	160	Adult	I
115	35-39	M	161	Adult	F
116	1-4	S	162	40-50	F
117	Adult	M	163	5-9	F
118	Adult	I	164	25-29	F
119	Adult	M	165	50+	F
120	Adult	I	166	25-29	F
121	Adult	I	167	15-19	F
122	1-4	S	168	0-1	S
123	Adult	F			
124	Adult	M			
125	10-14	S			

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
Mouse Creek					
3MN 1	Adult	I	3MN 45	Adult*	I
2	40-50	F	46	5-9	S
3	Adult	I	47	20-24	M
4	Adult	I	48	25-29	F
5	19-39*	I	49	25-29	F
6	19-39*	M	50	1-4	S
7	14-39*	I	51	Adult*	I
8	19-39*	I	52	7-13*	S
9	5-9	S	53	Indet	I
10	25-29	M	54	Adult	I
11	Adult*	I	55	40-50	M
12	10-14	S	56	40-50	M
13	Adult	I	57	Adult	I
14	Adult	I	58	Adult	I
15	Adult*	I	59	1-4	S
16	Adult*	I	60	20-24	F
17	30-34	M	61	SubAd	S
18A	Adult	I	62	Adult	I
18B	Adult	I	63	Adult	I
19	Adult	I	64	Fetal*	S
20	Adult*	I	65	5-9	S
21	Adult	I	66	0-1	S
22	30-34	M	67	50+	M
23	19-39*	I	68	5-9	S
24	Adult	I	69	5-9	S
25	Adult	I	70	5-9	S
26	Adult	I	71	Adult	I
27	5-9	S	72	Adult	I
28	50+	M	73	5-9	S
29	20-24	M	74	Adult	I
30	Adult	I	75	19-39*	M
31	50+	F	76	50+	M
32	40-50	M	77	10-14	S
33	Adult	I	78	Adult	I
34	Adult	I	79	Adult	I
35	5-9	S	80	Adult	I
36	Adult	I	81	0-1	S
37	Adult	I			
38	14-18*	I	4MN 1	40-50	F
39	8-9*	S	2	50+	F
40	Adult	I	3	40-50	F
41	Adult	I	4	50+	F
42	25-29	M	5	Adult	I
43	1-4	S	6	Adult	I
44	Adult	I	7	10-14	S

Table A-1 (Continued)

Individual	Age	Sex[a]	Individual	Age	Sex[a]
4MN 8	SubAd	S	4MN 54	0-1	S
9	10-14	S	55	0-1	S
10	Adult	I	56	5-9	S
11	Adult	I	57	20-24	M
12	20-24	F	58	10-14	S
13	Adult	I	59	10-14	S
14	Indet	I	60	50+	M
15	5-9	S	61	5-9	S
16	5-9	S	62	25-29	F
17	35-39	F	63	50+	F
18	Adult	I	64	0-1	S
19	Adult	I	65	30-34	F
20	Adult	I	66	5-9	S
21	35-39	F	67	Adult	I
22	Adult	I	68	50+	F
23	Adult	I	69	15-19	F
24	Adult	I	70	Adult	I
25	15-19	M	71	Adult	I
26	35-39	M	72	Adult	I
27	Adult	I	73	1-4	S
28	5-9	S	74	SubAd	S
29	1-4	S	75	SubAd	S
30	Adult	I	76	5-9	S
31	Adult	I	77	0-1	S
32	0-7*	S	78	0-1	S
33	Adult	I	79	0-7*	S
34	5-9	S	80	30-40	M
35	Adult*	I	81	Fetal*	S
36	Indet	I	82	Adult	I
37	Adult	I	83	SubAd	S
38	10-14	S	84	0-7*	S
39	Adult	I	85	1-4	S
40	Adult	I			
41	Adult	I			
42	Adult	I			
43	Adult	I			
44	50+	M			
45	15-19	M			
46	Adult	I			
47	5-9	S			
48	20-24	F			
49	10-14	S			
50	1-4	S			
51	0-7*	S			
52	1-4	S			
53	Adult	I			

[a]M = Male

F = Female

I = Indeterminate

S = Subadult (Unsexed)

*Discarded in Field.

APPENDIX B

Table B-1. Pathology Coding Format.

Column	Variable	Code
1-4	Site	16BY 15BY 3MN 4MN
5-7	Individual	
9	Sex	1 = Male 2 = Female 3 = Subadult 4 = Indeterminate
11-12	Age	1 = Fetal 2 = 0-1 3 = 1-4 4 = 5-9 5 = 10-14 6 = 15-19 7 = 20-24 8 = 25-29 9 = 30-34 10 = 35-39 11 = 40-50 12 = 50+ 13 = Adult 14 = Subadult 15 = Indeterminate
14-15	Disease Class	1 = General/Unknown Infection 2 = Abscess/Lesion 3 = Tumor/Exostosis 4 = Osteoporosis 5 = Osteoarthritis 6 = Bone Resorption 7 = Porotic Hyperostosis/ Cribra Orbitalia 8 = Bone Fusion 9 = Fracture 10 = Dental Anomaly 11 = Periostitis 12 = Rarefaction 13 = Bone Deformity 14 = Trauma 15 = Tuberosity 16 = Decalcification

Table B-1 (Continued)

Column	Variable	Code
17	Severity	1 = Slight 2 = Medium 3 = Severe
19	State	1 = Healed 2 = Unhealed 3 = Indeterminate
21-22	Location	1 = Frontal 2 = Parietal 3 = Tibia 4 = Vertebral Column 5 = Mandible 6 = Orbit 7 = Cranium--general 8 = Rib 9 = Clavicle 10 = Mastoid 11 = Radius 12 = Ulna 13 = Sacrum 14 = Nasal 15 = Occipital 16 = Femur 17 = Pubis 18 = Fibula 19 = Foot--general 20 = Sternum 21 = Long Bones--general 22 = Maxilla 23 = Ear 24 = Humerus 25 = Hand--general 26 = Sphenoid 27 = Temporal 28 = Manubrium 29 = Zygomatic 30 = Pelvis--general 31 = Scapula
24	Side	1 = Right 2 = Left 3 = Middle 4 = Both 5 = Unknown 6 = Internal

APPENDIX C

CRANIAL MEASUREMENT DEFINITIONS

Glabello-Occipital Length (GOL) - "Greatest length, from the glabellar region, in the median sagittal plane" (Howells 1973: 170).

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

Basion-Bregma Height (BBH) - "Distance from bregma to basion, as defined" (Howells 1973:172).

Minimum Frontal Breadth (WFB) - "The minimum breadth between the two temporal ridges" (Hrdlička 1952:142).

Bizygomatic Breadth (ZYB) - "The maximum breadth across the zygomatic arches, wherever found, perpendicular to the median plane" (Howells 1973:173).

Orbital Height (OBH) - "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).

Orbital Breadth (OBB) - "Breadth from ectoconchion to dacryon, as defined, approximating the longitudinal axis which bisects the orbit into equal upper and lower parts" (Howells 1973:175).

Nasal Height (NLH) - "The average height from nasion to the lowest point on the border of the nasal aperture on either side" (Howells 1973:175).

Nasal Breadth (NLB) - "The distance between the anterior edges of the nasal aperture at its widest extent" (Howells 1973:176).

Nasion-Gnathion (NGN) - Bass (1971:63): Diagram only.

External Alveolar Length (EAL) - "The anterior-posterior diameter, in the median line, from . . . alveolare point to the midpoint of a line connecting the posterior limits of the arch" (Hrdlička 1952:147). Also Bass (1971:70) - diagram.

External Alveolar Breadth (EAB) - "The maximum breadth of the greatest bulge of the process above the molar teeth" (Hrdlička 1952:147). Also Bass (1971:70) - diagram.

Auricular Height (AUH) - "From porion to the apex" (Bass 1971:67).

Basion-Gnathion (BGN) - ". . . measured from the endobasion to the lowest median point on the lower border of the mandible" (Zimmerman et al. 1981:126).

Basion-Biporion or Biporion Height (BPO) - "From basion to porion" (Bass 1971:66).

Mandibular Symphysis Height (MSH) - "From gnathion to infra-dentale. Height in the midline from lowest point (gnathion) to the tip of bone between lower central incisors (infradentale)" (Bass 1971:72).

Bigonial Diameter or Breadth (BIG) - "From gonion to gonion. The maximum distance between the external surfaces of the gonial angles" (Bass 1971:72).

Bicondylar Diameter or Breadth (BIC) - "From condylion to condylion (lateral). The maximum distance between the lateral surfaces of the condyles" (Bass 1971:72).

Height of Ascending Ramus (HAR) - "From gonion to the upper-most part of the condyle" (Bass 1971:72).

Nasion-Bregma Chord (Frontal Chord) (FRC) - "The frontal chord, or direct distance from nasion to bregma, taken in the mid-plane and at the external surface" (Howells 1973:181).

Nasion-Bregma Subtense (Frontal Subtense) (FRS) - "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).

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

Bregma-Lambda Subtense (Parietal Subtense) (PAS) - "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) - "The distance along the bregma-lambda chord, recorded from bregma, at which the bregma-lambda, or parietal, subtense falls" (Howells 1973:183).

VITA

Donna Catherine Markland Boyd was born June 15, 1960, in Johnson City, Tennessee. She graduated from University High School in Johnson City in June 1977, and after visiting Europe entered The University of Tennessee in September, 1977. She graduated *magna cum laude* with a Bachelor of Arts degree in Anthropology in December 1981. In the following January of 1982, she began the graduate program in Anthropology at The University of Tennessee, Knoxville, receiving a Master of Arts degree during the fall of 1984.

While working toward her Master's degree, she was the recipient of the Anthropology Department Scholarship in January of 1983. She also has worked as a field and laboratory assistant and data processor for the Tellico and Watauga Archaeological Projects at The University of Tennessee McClung Museum from 1979 to present.

Her research interests include skeletal biology, human paleontology, primate studies, archaeological method and theory, archaeology of the southeastern United States, and the application of quantitative methods to problems in anthropology.

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