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A BIOCULTURAL APPROACH TO THE SKELETAL BIOLOGY OF THE DALLAS PEOPLE FROM TOQUA

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

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ABSTRACT

The purpose of this study was to present osteological information for the skeletal remains from Toqua, a Late Mississippian site representative of the Dallas Focus, and to assess these data from a biocultural perspective. Analytical considerations included aspects of paleodemography (examination of mortality by life table analysis), metrics and morphology (measurements and indices, stature, and cranial deformation), and paleopathology (porotic hyperostosis, periosteal reactions, and other pathological conditions that were simply described).

Analyses were conducted for the total skeletal series (N=439) in order to assess general conditions of mortality and morbidity for the population as a whole and along age and sex lines. Further analyses pertained to differences between archaeologically-defined status groups, that is, between mound (N=139), village (N=285), and Structure 3 (N=15) individuals. Structure 3 is purported to be a late occurring structure in the Dallas occupation at Toqua for which some of the burials exhibit indicators of high status. The status comparisons are predicated on a general chiefdom model in which status is largely ascribed rather than achieved. An adjunct to the hypothesis of ascribed status is that high-status (i.e., mound) individuals may have received preferential treatment in the form of differential access to more nutritionally sound foodstuffs, better health care, etc.

Examination of vital statistics for the total skeletal series showed extremely high infant and childhood mortality. Relatively high frequencies of cribra orbitalia and calvarial porotic hyperostosis among

the total series attested to probable endemic proportions of iron-deficiency anemia, presumably resulting from an intense reliance on maize for subsistence. Tests for differences in the incidence of both types of lesions among infants and children and between younger and older individuals demonstrated the deleterious effects of iron-deficiency anemia on mortality and morbidity of infants and children. Frequencies of bones exhibiting periosteal lesions were significantly greater among young individuals, a feature that probably relates to the effects of acute infectious diseases during the early years of life. Village females showed significantly lower frequencies of cribra orbitalia and calvarial porotic hyperostosis than village males. Males and females for the total series also differed significantly when age, sex, and frequencies of periosteal reactions were considered simultaneously.

Dietary, nutritional, and general health relationships among the Toqua inhabitants revealed that preferential treatment of high-status individuals could not be ascertained from the biological data. Thus, with the exception of the cultural practice of intentional cranial deformation, status comparisons, including aspects of mortality, stature, incidences of porotic hyperostosis, and frequencies of periosteal reactions, suggested that high-status individuals may have achieved status rather than having it conferred upon them at birth, although this does not entirely preclude the possibility of a single high ranking kinship group existing at Toqua.

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CHAPTER 1

INTRODUCTION

Statement of Purpose

Toqua (40MR6) is one of approximately 20 known Late Mississippian sites from the Great Valley of eastern Tennessee and northwest Georgia that are representative of the Dallas Focus. Despite the large number of Dallas sites, little is known about the physical anthropology of the Dallas people. In fact, the only report that contains extensive information about Dallas physical anthropology is Hiwassee Island by Lewis and Kneberg (1946). The skeletal remains from Toqua represent one of the largest burial samples from a Dallas site. The purpose of this report, therefore, is to present osteological information for the Toqua skeletal series and to assess these data within a biocultural framework.

Within the realm of skeletal biology, the biocultural approach examines the interaction between biological factors, culture, and environment. This approach has emerged only recently as a useful alternative to simply providing basic descriptive data for prehistoric skeletal populations.

From this perspective, the Toqua skeletal remains are analyzed with respect to paleodemography, skeletal measurements and indices, stature, cranial deformation, and paleopathology. Emphasis is placed on comparisons between archaeologically defined status groups, that is, between mound and village components.

Archaeological Background

The Mississippian Period

The central core area of Mississippian Period sites extended along the Mississippian River from St. Louis, Missouri to Natchez, Mississippi. The Caddo area of Louisiana, Texas, and Oklahoma and the headwaters of the Tennessee River are also considered prominent Mississippian centers (Spencer et al. 1965:73). As suggested by Newell and Krieger (1949), Spencer et al. (1965:73) date the earliest Mississippian sites at around A.D. 500-600 in east Texas. Archaeological evidence indicates that between A.D. 700-900 Mississippian groups were present in the central core area (Griffin 1967). The final occurrence of what are traditionally considered Mississippian societies date no later than A.D. 1700 (Jennings 1968:216).

In general, Mississippian sites are comprised of fortified villages with large truncated mounds arranged around a central plaza (Spencer et al. 1965; Jennings 1968; Goldstein 1976). These sites usually occur on lands possessing rich agricultural soils (Ward 1965). Dependence on agriculture led Griffin (1967:189) to define the Mississippian as follows:

> The term "Mississippian" is used here to refer to the wide variety of adaptations made by societies which developed a dependence upon agriculture for the basic storable food supply.

Primary domesticated cultigens utilized by Mississippian peoples included the trio of maize (Zea Mays), beans (Phaeseolus sp.), and squash (Curcurbita pepo). Secondary cultigens included sunflower (Helianthus annus), marsh elder (Iva sp.), and gourd (Largenaria siceraria) (Smith 1978:483).

Although agriculture was the primary subsistence strategy of Mississippian societies, other foodstuffs were procured through hunting and gathering. Wild plants and animals that served as food sources for Mississippian peoples included backwater species of fish, migratory waterfowl, the terrestrial trinity of white-tail deer, raccoon, and turkey, various nuts, fruits, and berries, and seed-bearing pioneer plant species such as Polygonum and Chenopodium (Smith 1978:483).

The adaptability of Mississippian subsistence strategies is evident in the material culture. For example, artifacts found at Mississippian sites include shell tempered pottery, a variety of utilitarian vessels, tools indicative of increased specialization for intensified agriculture (e.g., digging sticks, hoes, manos and metates), and refined hunting and fishing implements (Spencer et al. 1965; Jennings 1968; Goldstein 1976).

In terms of social organization, Mississippian societies were stratified. Social rank or status at Mississippian sites is evidenced by burial location and grave goods (Goldstein 1976).

The Dallas Focus

Although excavations into Dallas mounds occurred as early as 1867 (Whiteford 1952), the Dallas Focus remained undefined until Lewis and Kneberg (1946) established this Southeastern Mississippian phase as an archaeological entity (Hatch 1976:128). According to Lewis and Kneberg (1946:10): "The Dallas Focus represents a Middle Mississippi culture that followed the Hiwassee Focus as the dominant culture of the Eastern Tennessee Valley."

The Dallas culture is geographically "confined to the Great Valley, the Tennessee and Georgia segment of an intermontane depression extending from New England to just north of Atlanta, Georgia" (Hatch 1974:1). The few available radiocarbon dates indicate that the Dallas Focus emerged circa A.D. 1250, and possibly lasted as late as A.D. 1600 in most areas, although more southerly manifestations may have existed into the historic period (Hatch 1976:130).

Concerning the origin of the Dallas Focus, Lewis and Kneberg (1946:10) felt that "the Dallas people merged with the earlier Hiwassee Island people" and eventually became the dominant culture." They supported this hypothesis of Dallas intrusion with the earlier work of William S. Webb (1938) who examined 23 threatened sites in the Norris Basin of which several are presently recognized to have Dallas components (Hatch 1974: 13). One of Webb's primary findings pertinent to this hypothesis was the architectural distinction between small-log and large-log structures (i.e., Hiwassee Island Focus and Dallas Focus, respectively).

Today, most students of Southeastern archaeology agree that there is relatively smooth cultural continuity from the Hiwassee Island Focus to the Dallas Focus, the major difference being the advent of an ideological phenomenon that emerged circa A.D. 1200 "during the period of maximum growth and complexity in the Southeast" (Peebles 1974:22). This phenomenon is commonly referred to as the Southern Cult.

The most definitive works dealing with the Southern Cult are those by Waring and Holder (1945) entitled "A Prehistoric Ceremonial Complex in the Southeastern United States," and Waring (1977) entitled "The Southern Cult and Muskhogean Ceremonial." From the latter article Waring (1977:64) provides a general synopsis of the Southern Cult:

> It is obvious that on the one hand that the total complex at the time of the Southern Cult efflorescence was a highly involved affair and is best regarded as the culmination of a complicated developmental process. On the other hand, the sudden archaeological appearance of the Cult suggests a sweeping religious activity.

Archaeologically, the Southern Cult is characterized by certain elements that are usually associated with burials of higher status. Waring and Holder (1945) organized the Southern Cult elements into four groups: (1) motifs; (2) god-animal representations; (3) ceremonial objects; and (4) costume. A concise description of these elements is provided by Peebles (1974:22-23) as follows:

> The motifs, which were used to decorate pottery and which were engraved or embossed on shell, wood and copper, included the cross, circle, bilobed arrow, "weeping" eye, and hand and eye. There were also a number of anthropomorphic animals used as motifs. These included woodpeckers with "speech" symbols coming out of their beaks, rattlesnakes with horns, wings and plumes, feline forms and man-eagle representations.
>
> Some of the ceremonial objects were items of dress and adornment. These included copper and shell gorgets, copper symbol badges and copper hair plumes. Other ceremonial objects included ceremonial celts (spuds), copper axes, monolithic axes, large flints, notched and engraved stone discs, effigy pipes and engraved conch shells.
>
> Many of the ceremonial objects are shown as parts of the dress and in the hands of individuals represented on various shell and copper items. There are figures of men or man-animal figures shown holding axes and trophy heads. These same individuals have copper ear spools in their ears, copper plumes in their hair and other of the ceremonial items adorning their person.

Concerning the evolution of Dallas societies, many ceremonial aspects of the Southern Cult gave rise to theories that Dallas was ancestral to the historic Creek rather than the Cherokee, a debate that remains viable today. With the early work of Cyrus Thomas (1894) and M. R. Harrington (1922), it was originally thought that many of the archaeological sites in the Tennessee River Valley were indeed ancestral

to the historic Cherokee. This argument is currently supported by Dickens (1976) who worked with prehistoric material from the Appalachian Summit of Western North Carolina. He suggests a cultural continuum from the contemporaneous Pisgah Phase of the Appalachian Summit and the Dallas to the historic Overhill Cherokee. While it is true that Overhill Cherokee components supersede many Dallas components in East Tennessee, this argument is predicated on similarities between the Pisgah and Dallas, a factor which can be explained as resulting from propinquity, with trade serving as the mechanism of cultural contact. Any similarities between the Pisgah Phase and the Overhill Cherokee only implies cultural continuity between those two archaeological entities.

Webb (1938) had earlier addressed the question of Dallas evolution by comparing the Norris Basin Material with the findings of Thomas (1894) and Harrington (1922). He concluded that a Cherokee connection with several of his Norris Basin sites could not be substantiated (Webb 1938: 379). Hatch (1974:18) points out that one of the two major interpretive themes in Lewis and Kneberg's (1946) Hiwassee Island was to prove Webb's hypothesis correct. Using various ethnographic works (e.g., Hicks 1926; Swanton 1911, 1922), Lewis and Kneberg (1946:10-20) provided an elaborate discussion regarding a cultural continuum between the Dallas and the historic Creek. In a much more popularized version of their findings, Tribes That Slumber, Lewis and Kneberg (1958) reconstruct "several Dallas period social institutions by superimposing in toto analogous Creek institutions" (Hatch 1974:19).

Finally, a recent study by Wright (1974) attempted to resolve the problem of Dallas evolution by utilizing multivariate analysis of

craniometrics. Unfortunately, this study was hampered by sampling problems and she could not fully substantiate the hypothesis that the Dallas were ancestral to the historic Creek.

Status Considerations

The Chiefdom Model

Status among Dallas societies is predicated on the generally accepted idea that Mississippian peoples of the southeastern United States were organized at a chiefdom level of sociocultural integration (Peebles 1974; Goldstein 1976; Hatch 1974, 1876). According to Service (1962), chiefdoms are more complex in various aspects of their culture than are the preceding level of tribes; however, they have not yet achieved formal statehood. At the chiefdom level is a hierarchical structure with a high ranking kinship group at the top. Proximity to the "royal" lineage usually determines one's status within the community.

> We might think of this system as an otherwise egalitarian society with but one exalted social position. But because societies are composed of solidary family units united into larger residential groups, it is natural that a chief's high status raised the status of every member of his family above ordinary families, and ultimately that of the families in his local kin group to some extent . . . a chief necessarily has a "nobility," even though they are only his own family. In time, he and his brothers, his sons and their sons, and so on, go on proliferating so that the chiefly lineage becomes very large and has numerous connections of different kinds with other lineages (Service 1962:149).

Fried's (1960) ranked society conforms closely with Service's chiefdom and both are characterized by a redistributive economy. Essentially the redistributive trait of chiefdoms is such that the high ranking group in the hierarchy exhibits centralized, but unformalized,

authority for the distribution of goods and services to other members of the society (Service 1962; Fried 1967). Hatch (1976:2) notes that redistribution is the most pervasive feature of chiefdom societies.

Recently this tenet has been challenged by Peebles and Kus (1977) for its application to Mississippian societies. In establishing certain archaeological correlates of ranked societies, they suggest that measures of mortuary differentiation, ritual-regulatory networks, subsistence autonomy, and part-time craft specialization are more valid indicators of chiefdoms.

Earlier studies dealing with the application of chiefdom models to Mississippian societies were based on ethnographic accounts of early historic groups of the Southeast (Peebles 1974:37). Peebles feels that to properly discern the implications of chiefdoms within an archaeological context, one must first turn to the archaeological record. Thus, more recent studies have examined "the patterned association of attributes within assemblages of artifacts" and "the analysis of the patterned remains of mortuary ceremonialism" (Peebles 1974:37). Theoretical works of this nature by Binford (1971), Saxe (1970), and Tainter (1973) have deduced that the degree of social interaction and the rank of an individual will be reflected by the ceremonial and artifactual components of mortuary patterning as well as by the energy expended in the mortuary ritual. Within the past decade these studies have provided a sound theoretical basis for establishing the archaeological correlates of social organization among Mississippian societies.

The Determination of Status at Dallas Sites

Hatch's (1974) analysis of mortuary patterning among several Dallas sites attempted to demonstrate how Southern Cult items related to

status positions. By observing artifact assemblages from burials in conjunction with age and sex information he concluded:

> Certain artifact types were observed to form redundant sets of associations. Taken in conjunction with age and sex information it was observed that village and most mound burials were symbolized in such a way that specific combinations of age and sex dimensions were key to the mortuary status of the individual. These individuals were in the artifactually low and intermediate ranges. Other combinations of types clearly denote a mound sub-population which in several cases was formed irregardless [sic] of age or sex criteria. These individuals possessed, on the whole, the greatest variety, the greatest number, and the most exotic artifact types. Because all ages and both sexes were accorded this high burial status, accessibility to these positions was most probably based on a limited number of ascriptive statuses attained in life. Pre-eminent burials in nearly all cases were of adult males (Hatch 1974:242-243).

Later in the same work Hatch (1974:251) states:

> The distribution of most Southern cult material in the Dallas sample is seen to directly correspond to the range of preeminent and subordinate status positions at each of the several interacting sites.

Sabol (1977) examined processes of trade with respect to mortuary data among five Dallas sites. He determined that Hatch's (1974:251) assertion that Southern Cult items are suggestive of pre-eminent status received through kinship extension and affiliation "ignores the enormous structural and functional interplay of local sociopolitical forces and ideologies on the social system" (Sabol 1977:66). From his intersite analysis Sabol (1977:65) earlier concluded that:

> . . . different degrees of structural variability exist between and within these settlements. The only major similarity between these sites is preferential treatment for mound burials rather than village burials. Major differences exist between these sites in the type and symbolization of status-specific artifacts, and the degrees of ascribed and achieved status.

In spite of these discordant interpretations as to precisely how

status and rank developed in Dallas societies, both researchers generally concur that individuals interred in mounds were of higher status than those buried in village areas. This mound/village dichotomy is the basis for status comparisons in the present study.

Another aspect of status alluded to by Hatch (1974, 1976) and Sabol (1977) is the degree to which status was ascribed or achieved within Dallas societies. As previously stated, in the general chiefdom model status is considered to be largely ascribed. However, Blakely (1977, 1980) recently observed patterns of mortality and pathology between mound and village burials at the Etowah site and determined that social ranking conformed more closely to an hypothesis of achieved status. Certainly Sabol (1977) agrees that many Dallas sites were probably socially structured in the same way. Hatch and Willey (1974) and Hatch (1976) addressed this question by comparing stature differences of individuals according to burial location and artifact assemblages. In general, they determined that high-status males were taller than low-status males; however, there were no differences among females.

The hypothetical implications of biological differences between status groups are such that if status was largely ascribed among Dallas societies then these differences may be explained by preferential treatment in the form of better nutrition and health care for high-status individuals. This idea is essentially an extension of Buikstra's (1976: 39) "dietary hypothesis." Thus, in this thesis status considerations based on the mound/village dichotomy utilize skeletal information to test the hypothesis that status at Toqua was predominantly ascribed rather than achieved.

The Toqua Site

General Site Information

The Toqua site (40MR6) was located approximately 4.5 miles east of Vonore, Tennessee, and about 32 miles south of Knoxville, Tennessee (Figure 1). It was situated on the south bank of the Little Tennessee River. With the recent completion of the Tellico Dam (Fall, 1979), the site is now completely inundated (Schroedl and Polhemus 1977).

The approximate dimensions of the site were 1100 feet long by 600 feet wide. It consisted of a large surrounding village lying between the 799.0 foot and 801.0 foot contours and two earthen mounds. The larger of the two, Mound A, towered to the 824.0 foot contour. The smaller Mound B stood at the 803.0 foot contour (Schroedl and Polhemus 1977).

Recent estimates based on radiocarbon dates and cultural remains suggest that the Dallas occupation occurred between ca. A.D. 1300 to ca. A.D. 1600, and possibly later (Richard Polhemus, personal communication). In addition, an eighteenth century Overhill Cherokee town overlay the Dallas component in the East Village area of the site. Archaeological investigations indicated that Archaic and "Early" Woodland occupations were virtually absent at Toqua (Schroedl and Polhemus 1977).

Archaeological Investigations at Toqua

In the late nineteenth century, Cyrus Thomas, an entomologist from Illinois, was commissioned by the Bureau of American Ethnology to explore the enigmatic earthen mounds prevalent in the eastern United States. The primary motive behind Thomas' commission was to disaffirm the theory that

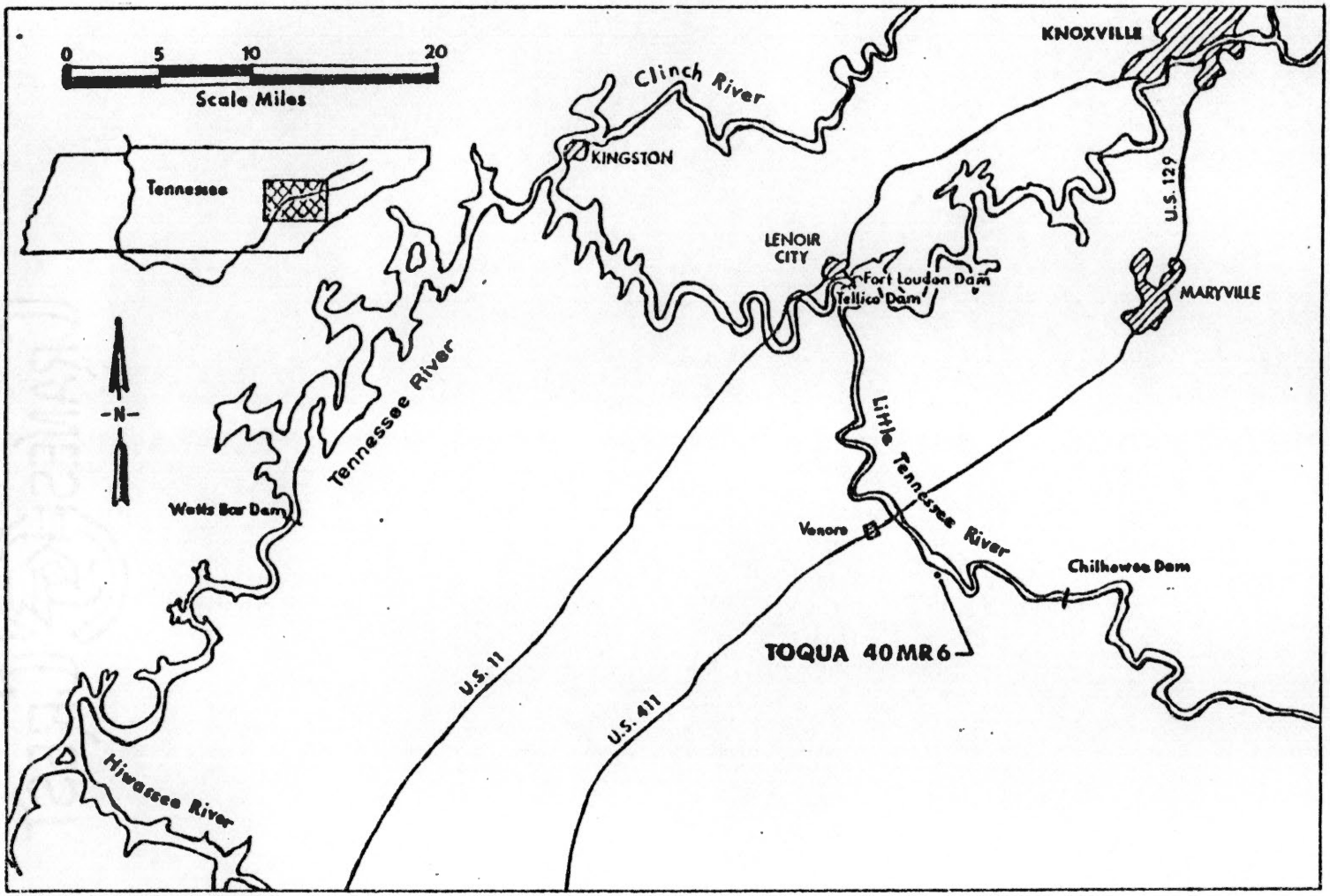

Figure 1. Toqua locality map (after Schroedl and Polhemus 1977).

a "lost race" of moundbuilders was responsible for the structures, thus lending credence to the opinion of the Bureau which felt that ancestors of contemporary Amerindian groups were, in fact, the architects of the mounds (Willey and Sabloff 1974:49).

Thomas' special envoy, John Emmert, traveled extensively in the Tennessee River Valley and its tributaries. On the south bank of the Little Tennessee River in present-day Monroe County, Tennessee, Emmert, in 1884, encountered two earthen mounds. From the larger of the two, the "Big Toco Mound" (Mound A), Emmert's exploratory group exhumed 57 burials and an assortment of burial goods. From the "Callaway Mound" (Mound B) only 14 burials with associated grave goods were unearthed (Thomas 1894:383-384). As far as anyone knows, Emmert left no record of excavation for the surrounding village area. The present whereabouts of the majority of this skeletal material and associated goods is unknown (Richard Polhemus, personal communication).

Since the time of Emmert, the site was left virtually untouched until George Barnes (n.d.) in the 1930's, became the first to extensively excavate in the village area. His efforts consisted primarily of a 500 foot long by eight foot wide trench that began northwest of Mound A. and ran in an eastward direction along the river terrace. The material recovered by Barnes is presently housed at the McClung Museum, University of Tennessee (Schroedl and Polhemus 1977).

Although The University of Tennessee in conjunction with the Works Progress Administration had intentions of beginning large-scale excavations at Toqua in the late 1930's, the project never materialized. It was not until 1975, when the land was purchased by the Tennessee Valley

Authority, that excavation resumed under the auspices of The University of Tennessee Tellico Archaeological Project. The Tellico archaeologists continued excavations at Toqua until late 1977 (Schroedl and Polhemus 1977).

At the time of acquisition, T.V.A. prepared a 10 foot contour map and established a 100 foot grid (Figures 2 and 3). The site was arbitrarily divided at Mound A thus forming East and West Village components. The area between Mound A and the Little Tennessee River and the area south of Mound A were loosely designated as North Village and South Village, respectively (Figure 4). The entire village area, including Mound B, was then plowed over, several test trenches were dug, and a controlled surface collection was conducted. The test trenches and the surface collection revealed the location of palisade lines, the plaza area to the east of Mound A, and numerous structures and features within the village area. Over approximately the next year and a half major excavations were conducted by the Tellico Archaeological Project in select areas of the village. During this time Mound A and Mound B were also systematically reduced to their basal levels of construction (Schroedl and Polhemus 1977).

Archaeological investigations by the Tellico Archaeological Project revealed that the Toqua village area was composed of four major village patterns. The first pattern showed that the Dallas area of occupation covered about 500,000 square feet and was enclosed on three sides by a trench-type palisade. Burials were usually found immediately outside and to the west of structures. The second, third, and fourth village plans differed from the first in that they were marked by a single-post palisade which was roughly 300 feet closer to Mound A on the

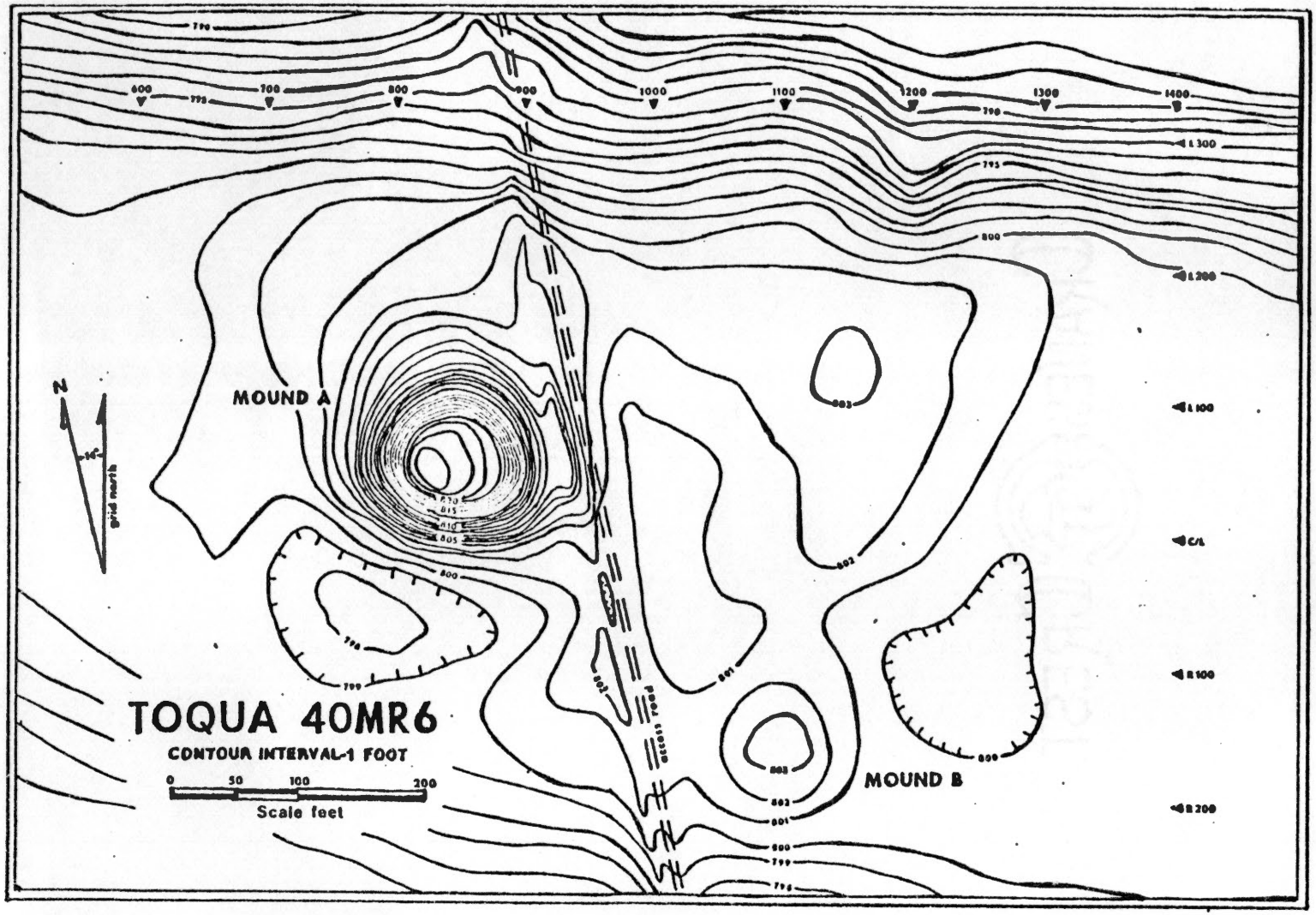

Figure 2. Contour map of the Toqua Site (after Schroedl and Polhemus 1977).

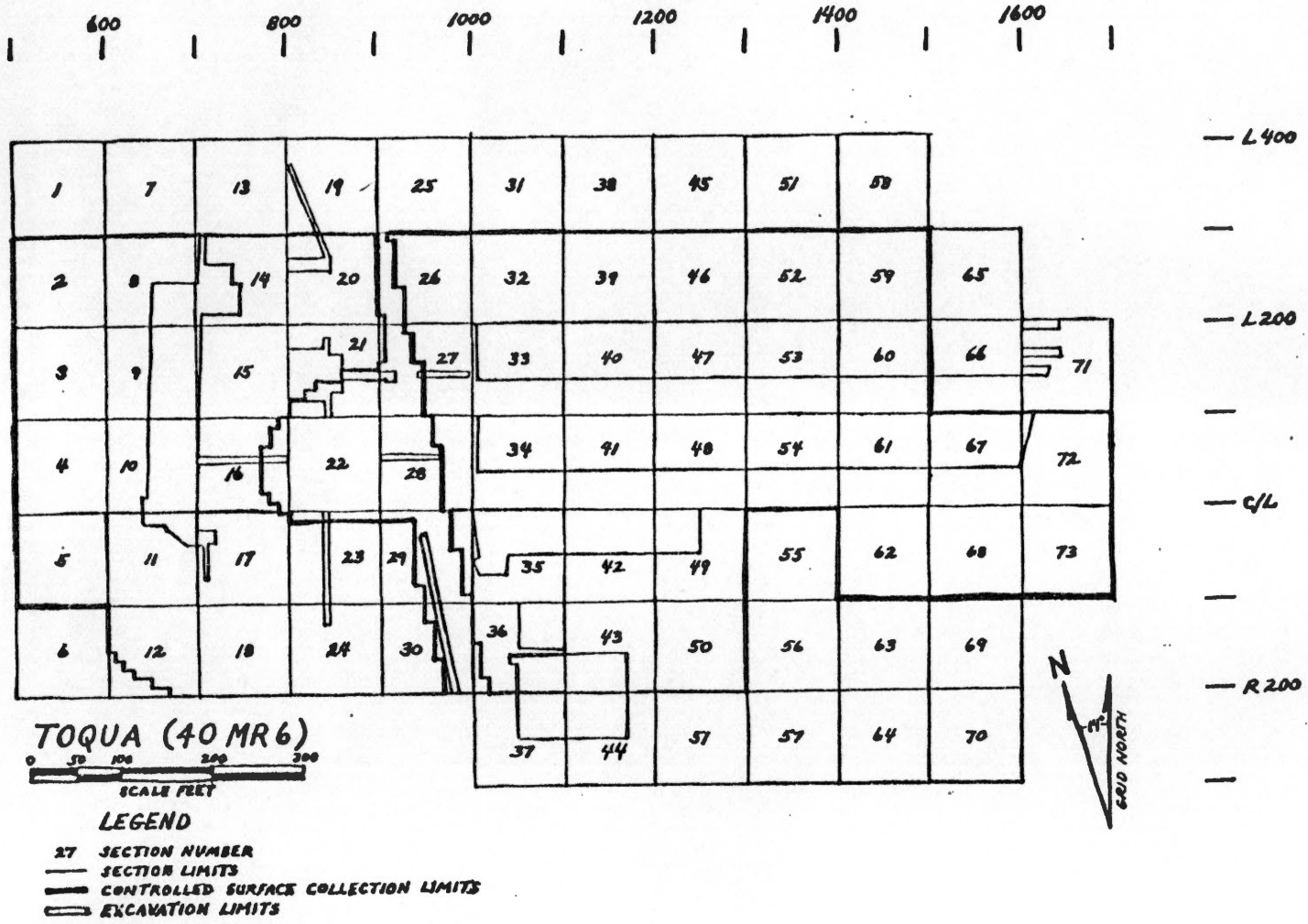

Figure 3. Location of 100 foot mapping sections for the Toqua Site (after Schroedl and Polhemus 1977).

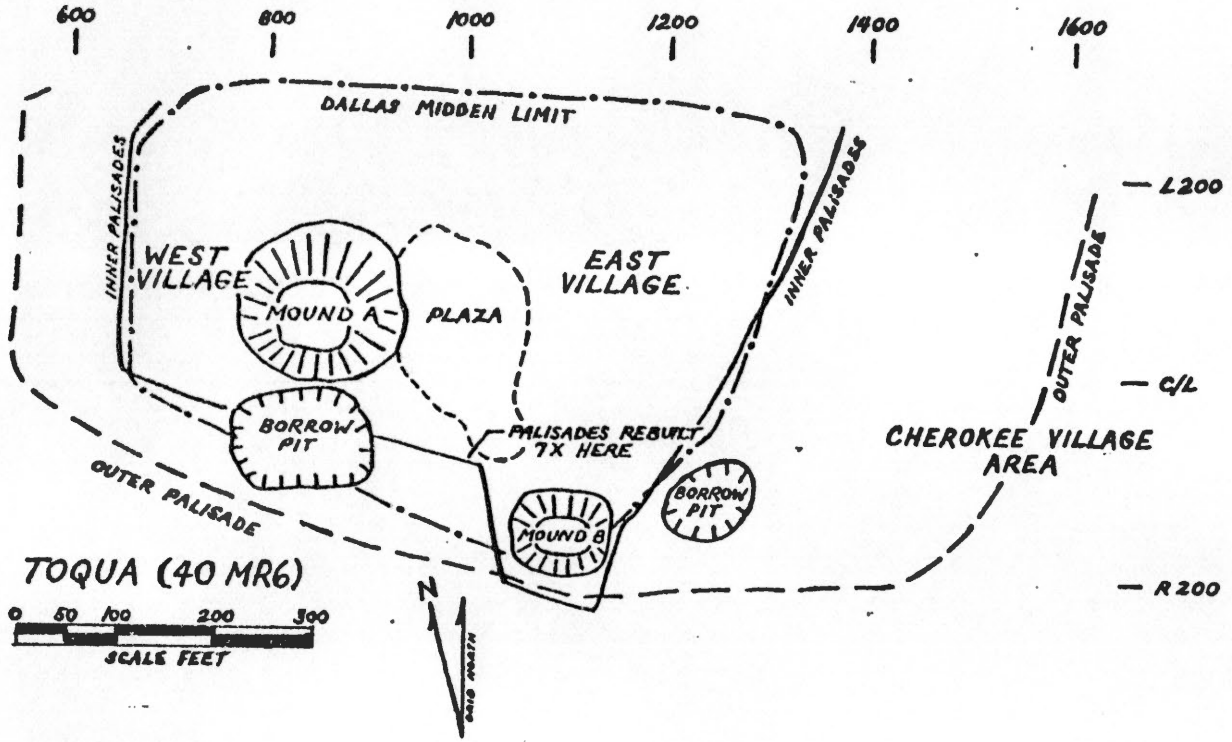

Figure 4. Mound, plaza, palisade, and dense midden concentration locations (after Schroedl and Polhemus 1977).

east side and about 100 feet closer on the west side. Although the reduction of the village area initially suggested a concomitant reduction in population size and density, the reverse was more likely. This is because structure size and spacing were also reduced and structure density may have been more than double during the latter village phases. Another difference in the last three village plans was that burials were usually found inside rather than outside structures (Schroedl and Polhemus 1977).

Mound A excavations revealed nine different construction phases. The first phase was comprised of a square, level platform. Succeeding phases of construction were rectangular in shape and were characterized by a higher west summit and lower east summit. In addition, the latter phases had a ramp on the southeast side which faced the village plaza and Mound B. Interestingly, burials were found in association with only the final three construction phases, but, unfortunately, Emmert's team removed the majority of the material from the two uppermost phases.

Mound B, having been much smaller than Mound A, consisted of just two construction phases which overlay two structures and numerous burials at the mound base. Other burials were found in the summit and side slopes of the mound. It is again unfortunate that much of the upper construction phase and part of the initial phase were disturbed by Emmert and by more recent cultivation of the land.

The Skeletal Material from Toqua

The Tellico archaeologists excavated a total of 477 burials from the Dallas component. These burials yielded approximately 500 individuals

of which 439 were utilized in the present study. Six burials were multiple inhumations of three or more individuals. Because it was impossible to determine individuality and assess demographic variables, these burials are excluded from the analysis presented here. Due to the fact that many of the skeletons excavated by Emmert (Thomas 1894) and Barnes (n.d.) are missing or have spurious proveniences, they are also omitted from consideration.

Of the 439 individuals considered for analysis, 200 were exhumed from the East Village (including East Village Midden and Plaza). The West Village yielded 85 individuals. No skeletal remains were recovered from the South Village. The combined total of 285 individuals from the East and West Villages comprise what is designated in this report as the village component.

Another 62 individuals were recovered from Mound A, and Mound B yielded 77 individuals. The combined Mound A and Mound B interments (N=139) comprise the mound component.

Fifteen individuals associated with Structure 3 from the North Village were analyzed as a separate entity. This structure was comprised of an elevated platform that abutted Mound A on the north side. Several of the individuals were interred in shaft-and-chamber pits which are seemingly indicative of high status. -or Cherokee Curiously, no high-status artifacts were found with these burials. Additionally, Structure 3 and associated burials date to the terminal Dallas occupation at Toqua. For these reasons it is unjustified to assign the Structure 3 individuals to either the mound or village components (Richard Polhemus, personal

communication). They are discussed relative to the results of status comparisons between mound and village components.

Analytical Considerations

Paleodemography

This analysis comprises a discussion of the proper demographic technique utilized for the Toqua skeletal series, methodological considerations for the determination of age and sex, and the presentation of vital statistics.

Paleodemographic status relationships include a comparison of mortality between the mound and village components at Toqua, and an intersite comparison with Etowah mortality among similar societal components (Blakely 1977).

Metric Data

Means and standard deviations of descriptive measurements and indices are presented for the Toqua adult males and females.

Stature

Individual and mean stature estimates are presented for the Toqua adults.

Raw femur lengths as a measure of stature are compared between mound and village components. Genetic and environmental determinants of stature are discussed, and the results of the analysis are compared to similar studies by Hatch and Willey (1974) and Hatch (1976).

Cranial Deformation

Incidences of intentional and unintentional cranial deformation are presented for the Toqua skeletal series. Males and females are compared.

A comparison between status components is presented.

Paleopathology

Porotic hyperostosis is discussed in view of existing hypotheses regarding its origin and occurrence among prehistoric populations of the New World. Frequencies of porotic hyperostosis are presented for the total skeletal series, and differences between age and sex categories are compared.

Periosteal reactions for the skeletal series are presented on a bone-by-bone basis. Frequencies for age and sex categories are compared and discussed in terms of mortality and general health.

Status comparisons are presented for the pathological conditions of porotic hyperostosis and periosteal reactions.

Incidences of trauma, congenital and developmental defects, and tumors and tumor-like processes are presented. Osteomyelitis and arthritic conditions are briefly discussed.

CHAPTER 2

PALEODEMOGRAPHY OF TOQUA

Introduction

Of paramount importance to an understanding of the lifeway of any prehistoric population is the determination of its vital statistics. However, paleodemography has only recently received sufficient attention for New World prehistoric populations because adequately large sample sizes are the exception rather than the norm (Owsley and Bass 1979).

If it is determined that an archaeological sample is large enough for consideration of paleodemographic analysis, a choice of the proper technique must be made. Bennett (1973) used United Nations model life tables to determine vital statistics of the Point of Pines (Arizona) skeletal population. Angel (1947, 1971) determined demographic parameters of certain Mediterranean populations by observing age at death as well as the number of children produced by each female of reproductive age. The former study is criticized because a factor called "the intrinsic rate of increase for a population" must be known or very closely approximated and this could result in considerable error (Owsley 1975:57). The Angel method is criticized for its estimation of fecundity as determined by observation of damage to the os pubis during childbirth (Owsley 1975:57-58). Various researchers have discussed the tenuous relationship between parturitional pits and childbearing (e.g., Stewart 1970; Gilbert 1973; Holt 1978; Kelley 1979).

Because of the inherent problems with these paleodemographic

techniques, a third method, examination of mortality by life table analysis, was chosen for application to the Toqua population. This method has been employed by Owsley (1975), Ubelaker (1974) and others who have demonstrated its excellent utility in prehistoric archaeological contexts. Major discussions of the specifics of life table analysis can be found in Barclay (1958), Weiss (1973, 1975) and particularly Acsádi and Nemeskéri (1970).

Before continuing with the computation of life table functions and the presentation of vital statistics for the Toqua series, it is necessary to address certain assumptions and preconditions that are essential for application of life table methodology to archaeological populations.

Assumptions and Preconditions

Sample Completeness

Regarding sample completeness, Cook (1972) poses two questions: (1) Is the sample a true index of the total number of interred bodies in the entire area? (2) Does the total number of burials in the site coincide with the actual number of deaths?

For the Toqua sample the first question cannot be answered positively. To begin with, the entire site was not fully excavated. Second, looting and disturbance of burials occurred at the site. Third, preservation of skeletal material at Toqua was often quite poor due to the acidic soil conditions in the area. It is thought that perhaps only between 10 and 20 percent of the entire population was recovered (Richard Polhemus, personal communication). On this basis one might make a case for rejecting the use of life table analysis on the Toqua sample.

On the other hand, the burial sample size is quite large and archaeological sampling of the Toqua site was conducted in a systematic manner. Thus, life table analysis, to a large degree, reflects the mortality experience of the entire population throughout its existence.

The second of Cook's questions primarily refers to sociocultural practices that would have prevented interment within the site. This would include both differential treatment of certain infants and stillborns and those adults dying from accidental death, disease, or warfare at a distance from a site. As far as Toqua is concerned, we can only speculate about these possibilities. However, it is generally assumed that such incidences would have only negligibly affected the cemetery structure (Richard Polhemus, personal communication).

Assumption of a Stationary Population

Paleodemographic analysis through life tables requires that a stationary population be assumed. This assumption implies that birth and death rates are equal (i.e., zero growth rate) and that the relative age distribution and the census count remain unchanged (i.e., fixed age-specific mortality rates) (Weiss 1973:8; Owsley 1975:59).

Owsley (1975:60) notes that among modern populations "the concept of stationary populations with zero growth rates seems invalid." On the other hand, for prehistoric populations and even historic populations prior to the mid-seventeenth century, the incidence of high birth rates was held in check by high death rates. Acsádi and Nemeskéri (1970:45) state:

> According to estimates, the number of world populations grew during these sixteen centuries from about 210-250 million to nearly 550 millions, so the annual growth may have been only 0.05-0.1 per thousand . . . the size of the primordial

> population must have changed very little and its rate of growth must have been extremely low.

Furthermore, Weiss (1973:10) states: "Even if growth rates are not zero but very close to zero, the stationary population model will not be greatly in error. Certainly this is reasonable for many archaeological populations."

Another factor that may influence growth rates and age-specific mortality is migration. Acsádi and Nemeskéri (1970:61) point out that in-migration may increase life expectancy values, and out-migration may induce the reverse. In response to this possibility, Weiss (1973:10) feels that: "If migration is of a reciprocal kind, such as with reciprocal mate exchange between clan groups, the stationary population assumptions are not violated."

If the assumptions of the stationary model are accepted, it allows a skeletal sample to be treated as a "single cohort throughout its existence and as such treats the cemetery series as though representing a single generation" (Owsley 1975:59). But the stationary model is not without criticism by others. For example, Angel (1969:428) feels that life tables of prehistoric populations assume, perhaps erroneously:

> . . . that the cemetery represents a single generation cohort, that death rates are even at all ages after infancy and hence directly reflected in cemetery age frequencies, and that the population is virtually stable biologically and socially over the period of cemetery use.

Owsley (1975:61) notes that the first of Angel's criticisms, treating the cemetery as a single generation cohort, is unavoidable in that "this principle forms the basis of all skeletal-demographic methodologies." The second and third of Angel's criticisms essentially relate to population stability. In addition to Angel, others (e.g., Cook

1972) have maintained that populations undergo changes in mortality and fertility rates over long periods of time. However, as previously stated, the growth rate of archaeological populations usually approximates zero. Thus population instability may be a factor to consider for more modern populations, but for archaeological populations such as Toqua it is of minor consequence unless a major disease epidemic or some other natural catastrophe can be documented. There is no evidence of any such occurrence at Toqua.

Knowledge of Time Span and Archaeological Associations

Preconditions relating to time span and archaeological associations at Toqua are essentially met. Refer back to Chapter 1 for a more detailed discussion of these factors.

Determination of Sex and Age

The determination of sex and age is essential in demographic analysis. According to Owsley (1975:27): "Accuracy of any interpretations concerning vital statistics is dependent upon criteria selected for ageing and sexing skeletons." Thus, the ensuing sections will discuss the methods employed for assessing sex and age of the Toqua skeletal series.

Subadult Sexing Methods

The determination of sex among subadult skeletons is extremely problematical in that sexually dimorphic characteristics do not begin to manifest themselves until the onset of puberty. Nevertheless, several researchers have attempted to determine subadult sex primarily

based on pelvic morphology. For example, Reynolds (1945) took measurements on roentgenograms of infant pelves and showed significant differences. Boucher (1955, 1957) found significant differences in the subpubic angle and dimensions of the sciatic notch of fetal pelves. However, she was reluctant to promote this method for application to all populations until further research could be conducted. More recently, y'Edynak (1976), Sundick (1977) and Weaver (1980) examined ilia of fetuses and infants. In each of these studies the elevation of the auricular surface was shown to be the most promising characteristic, but Weaver (1980) implies that more study is needed for larger populations in order to use this method.

A study which attempted to sex subadults based on differential rates of dental eruption is that of Bailit and Hunt (1964). They observed the degree of canine eruption relative to premolar eruption but, unfortunately, only achieved an accuracy of 58%.

Perhaps the most promising method for sexing older children is that of Hunt and Gleiser (1955). They tested the hypothesis that differences in dental maturation of males and females is not as pronounced as differences in skeletal development. Their results were quite favorable. However, it is extremely difficult to apply their technique to archaeological populations because skeletal development is determined by comparing hand bones to radiographic standards, and in an archaeological population these bones are often deteriorated or lost in the process of recovery.

Because of the tenuous reliability of the aforementioned methods for sexing subadults, it was deemed necessary to utilize another

technique--multivariate discriminant analysis of dental measurements. Garn et al. (1965, 1966) have demonstrated that there exist significant differences in tooth dimensions between males and females. However, due to the range of overlap of mean measurements for particular teeth, univariate comparisons are ineffective for sex determination (Owsley 1975: 30). This problem is averted by simultaneously considering dental measurements in a multivariate analysis.

Ditch and Rose (1972) were perhaps the first to employ discriminant function analysis of dental measurements on an archaeological population. They achieved a success rate of 88.4% to 95.5% for the respective derived formulas. Although the intentions of Ditch and Rose were to apply this technique to morphologically undiagnostic adult skeletons, the same application can be made to subadults. The primary consideration for using discriminant analysis on subadults is that specific permanent tooth crowns must be fully developed and available. This precludes the use of this technique for any subadults below the age of six, at best. It is also important to note that even for the younger individuals with unerupted adult dentitions, the permanent tooth crowns must be separated from the alveolar processes of the jaws in order to obtain measurements. Due to the poor preservation at Toqua this was frequently the case for many of the subadults.

A recent study by Black (1978a) dealt with a discriminant analysis of deciduous teeth. Although sexual dimorphism was evident in tooth crown dimensions, the only derived function that correctly sexed over 75% of the sample required nine measurements on seven teeth. The remaining functions with fewer measurements on fewer teeth never

achieved an accuracy greater than 70%. Black (1978a) cautions against the use of these discriminant functions on other populations.

When applying discriminant analysis for sexing it is more accurate to develop formulae from the population in question. This alleviates potential error in assuming that sexual dismorphism is similar in two, perhaps distinct, populations. Thus the formulae are derived by utilizing dental measurements of morphologically sexable adults (i.e., as determined by innominate morphology) from the population at hand. Such a procedure was performed for the Toqua sample in which a BMDP7M Stepwise Jacknife Discriminant Function Program (Jennrich and Sampson 1977) was used to derive the discriminant formulae (Scott and Parham 1979). Table 1 provides the formulae, variables, sectioning points, and degree of accuracy for each formula derived by the analysis.

Adult Sexing Methods

Because of the more obvious sexual dimorphism exhibited by adult skeletons, the task of determining adult sex is enhanced by observation of various morphological criteria. The most accurate area of the skeleton to morphologically sex adults is the pelvic region. Sexually dimorphic criteria of the innominates include the ventral arc, the subpubic concavity and angle, the medial aspect of the ischiopubic ramus, the width of the sciatic notch, the presence of a preauricular sulcus, and the elevation of the sacroiliac articular facet (Phenice 1969a; Krogman 1962; Bass 1971; Stewart 1979). In addition, scars of parturition may also support sexual assessment of the pelvis (Stewart 1970).

Skull morphology is also quite useful for adult sex determination. Sexually dimorphic criteria of the skull include general size and

TABLE 1

Discriminant Formulae Derived from Toqua Dental Measurements (After Scott and Parham 1979)

Function	Sample Size Male	Sample Size Female	Formula Based On:	Sectioning Point	Percent Correctly Classified Jacknife	Percent Correctly Classified w/o Jacknife
			Mandibular Dimensions			
1	20	21	-3.59040(a)+2.76961(d)+2.11170(e)-16.30831	0.029160	87.8	90.2
2	20	20	-2.64327(a)-1.21524(c)+2.86085(d)+2.05453(e)-14.61860	0.000000	87.5	90.0
3	21	25	-2.53065(c)+2.35678(d)+1.77952(e)-15.57546	0.096335	87.0	87.0
4	15	18	-2.69194(a)-1.53405(c)+3.28773(d)+2.58006(e)-0.74351(h)-11.03242	0.118520	84.8	87.9
5	24	27	1.60189(d)+1.96729(e)-0.71033(f)-20.57155	0.052205	80.4	86.3
6	24	27	1.30740(d)+1.71322(e)-22.29996	0.050355	80.4	82.4
			Maxillary Dimensions			
7	21	29	1.08488(k)+2.69376(l)-30.92071	0.107360	78.0	78.0
			Mandibular and Maxillary Dimensions			
8	14	20	-1.69124(a)+3.51915(d)+2.29818(e)-1.15188(f)-	0.243225	88.2	94.1
9	10	17	-1.98240(a)+0.98833(b)-1.80473(c)+4.65113(d)+1.16487(e)-1.54775(h)-1.18767(i)-1.14559(k)+3.37357(l)+0.94618(m)-28.33330	0.406740	81.5	92.6
10	19	27	2.73267(d)-0.26132(k)+2.22981(l)+0.68458(n)-1.61581(o)-24.19770	0.169595	78.3	82.6

Key to Measurements

Mandible:
(a) B-L Incisor 1
(b) M-D Incisor 1
(c) B-L Incisor 2
(d) B-L Cabine
(e) M-D Canine
(f) B-L Premolar 1
(g) B-L Premolar 2
(h) B-L Molar 1

Maxilla:
(i) B-L Incisor 1
(j) B-L Incisor
(k) B-L Canine
(l) M-D Canine
(m) B-L Premolar 1
(n) B-L Premolar 2
(o) B-L Molar 1

rugosity, the degree of nuchal muscle marking, the size of the mastoid process, the extent of the root of the zygomatic arch over the external auditory meatus, the size of the supraorbital ridges, the configuration of the upper borders of the eye orbits, and the configuration of the chin (Krogman 1962; Bass 1971; Stewart 1979).

Other supportive criteria of the post cranial skeleton include the diameter of the femur head (Thieme and Schull 1957), the diameter of the humerus head (Stewart 1979), the presence of septal apertures of the distal humerus (Krogman 1962; Bass 1971), and femoral shaft circumference (Black 1978b).

Multivariate discriminant analyses may also prove useful for adult sex determination. These types of studies have been performed on the cranium (Giles and Elliot 1963; Giles 1970), the mandible (Giles 1964), and talus and calcaneus (Steele 1976). Because of poor preservation at Toqua, and because of the marked cranial deformation of many of the intact skulls, only the talus and calcaneus were occasionally used, and then only in a supportive sense. In fact, many of the adults were so poorly preserved that the previously mentioned discriminant analysis of dental measurements was utilized extensively.

Subadult Aging Methods

Chronological age determination of immature skeletons was accomplished by the following methods: (1) dental eruption and calcification; (2) longitudinal bone growth; and (3) epiphyseal union. Of these three methods, dental eruption and calcification are the most reliable (Ubelaker 1974; Owsley 1975).

Researchers in the past have put a great deal of emphasis on the tooth eruption standards of Schour and Massler (1941). However, those standards have received considerable criticism in the literature (e.g., Garn, Lewis, and Polachek 1959; Sundick 1972; Ubelaker 1974), mainly due to the size and nature of their samples. Ubelaker (1979) recently compiled a new dental development chart. He consulted a number of published standards but relied most heavily on those pertaining to American Indian groups. Ubelaker (1979:46) notes that this chart "is probably the best approximation available for inferring age from dental development in prehistoric subadults."

When looking at dental calcification specifically, the standards of Moorrees, Fanning and Hunt (1963a,b) are the most appropriate. In essence, these studies provide means and standard deviations of various stages of development for particular teeth, both deciduous and permanent. Standards are also provided for each sex, but it is necessary to pool them for sexually undiagnostic individuals. Due to the poor preservation at Toqua, teeth were often loose from their crypts and those that were not could be extracted with minimal effort. Therefore, no periapical x-rays were considered necessary for the Toqua subadults.

The second method for aging subadults is based on the growth standards of long bones as correlated with chronological age. Studies dealing with North American Indian populations include Johnston (1962) and Sundick (1972) for the Indian Knoll Archaic population, Walker (1969) for Late Woodland skeletons from Illinois, and Merchant and Ubelaker (1977) for protohistoric Arikara from South Dakota. Ubelaker (1979:47) feels that the Arikara study is probably the most appropriate

for application to prehistoric Indian populations because age determination was based on the "most exact" method of dental calcification according to Moorrees, Fanning and Hunt (1963a,b). Ubelaker's advice was taken and these long bone standards were applied to the Toqua subadults.

The third method of subadult sexing, epiphyseal union, is most applicable for older subadults (i.e., over approximately 12 years) in that it is based on the termination of long bone growth and/or the union of epiphyses in other parts of the postcranial skeleton. The standards employed for the Toqua sample were primarily those of McKern and Stewart (1957) although Johnston (1962) and Krogman (1962) were also consulted. Because the standards of McKern and Stewart (1957) are based on males, adjustments were made for females which are developmentally more precocious than males.

Adult Aging Methods

For early adulthood, it is still possible to utilize rates of epiphyseal closure (i.e., up to approximately 25 years). For middle age adults (i.e., 20-40 years), the metamorphisis of the pubic symphysis (McKern and Stewart 1957; Gilbert and McKern 1973) is considered the most reliable method although a recent study by Suchey (1979) questions its accuracy. For older adults, the best method to determine age is analysis of rates of internal bone remodeling (Kerley 1965; Ubelaker 1974; Kerley and Ubelaker 1978).

Unfortunately, the state of preservation for the Toqua sample precluded the use of pubic symphysis as an age indicator in all but a few of the adult skeletons. Additionally, unavailability of necessary

equipment precluded the use of osteon counting at the time the skeletons were aged.

For these reasons it was necessary to turn to other less reliable aging techniques for many of the Toqua adults. These methods include cranial suture closure (Todd and Lyon 1924; McKern and Stewart 1957; Krogman 1962), relative rates of dental attrition (Brothwell 1972), osteophytic lipping (Stewart 1958), and ossification of rib cartilage (Kerley 1970). In defense of utilizing these methods when none of the better techniques can be employed, a researcher who studies an extensive skeletal sample, such as that at Toqua, obtains a "feel" for his population. Each skeleton is evaluated relative to the others. If any bias occurs, it is most likely in a systematic direction. The major drawback is that fixed age-specific mortality rates for adults could be affected; however, this is an unavoidable problem.

Vital Statistics of the Toqua Skeletal Series

Construction of the Life Table

The life tables for the Toqua skeletal series are constructed from the age and sex composition of 439 individuals. This basic information is provided in Table 2. Actual computation of life table statistics parallels the procedures described by Acsádi and Nemeskéri (1970).

The first column of the life table represents the age intervals (x) used in the analysis. With the exception of the first two age categories (i.e., 0-1 years and 1-5 years) and the final category (i.e., 45+ years), all intermediate categories are in five-year increments.

Column two (Dx) presents the actual number of individuals dying

TABLE 2

Age and Sex Distribution of Skeletons from Toqua

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
Sample Total	228	211	439

at each age interval. This element requires that each individual be assigned to one of the sexes and placed into one of the respective age categories. Thus, it is necessary to deal with those individuals that cannot be sexed according to prescribed methods, as well as those that have only been given a subadult (n=3) or adult (n=30) age designation.

Regarding sexual assessment, the most equitable way to distribute individuals in the early age categories (i.e., 0-1 and 1-5) is to divide by half the total number in each of these categories. Since the total in the 0-1 category is an odd number, the extra individual was arbitrarily placed in the male column. Because the adult sex ratio does not significantly deviate from a 1:1 ratio, it should not be expected that childhood mortality was biased in favor of one of the sexes (Owsley 1975:67). Unsexed individuals in the remaining age categories were apportioned according to the percentage of "known" individuals in each age category.

With respect to subadult and adult age designations, these individuals were similarly apportioned into age categories according to the percentages of "known" individuals in each age interval.

It must also be noted that the final age category, 45+, was established at the discretion of the author. More specific age designations for these older individuals could not be reasonably considered given the available aging techniques and the poor state of preservation for many of them.

The third column (dx) of the life table expresses the percentage of individuals dying in each age category and is computed as follows:

$$dx = \frac{Dx}{w}$$

$$Dx_{0-1}$$

w = maximum age attainable (i.e., 45+)

x = first age category (i.e., 0-1)

Column four (1x) shows the percentage of survivors at each age interval. The first age category is assigned an 1x value of 100% and succeeding values are computed by subtracting the percentage dying (dx) in each age interval:

$$l_{0-1} = 100$$

$$l_{1-5} = l_{0-1} - d_{0-1}$$

$$l_{5-10} = l_{1-5} - d_{1-5}$$

Column five (qx) expresses the probability of dying at each age interval:

$$qx = \frac{dx}{lx}$$

The next value, Lx, reflects the number of years lived in each age category. For all but the first two intervals, the Lx value is computed as follows:

$$Lx = \frac{5\ (lx + lx + 5)}{2}$$

Acsádi and Nemeskéri (1970:64) point out that deaths are not evenly distributed during the first year of life. For this reason and because of the uneven time distributions for the first two age categories, the Lx value is calculated as follows:

$$L_{0-1} = (10.2)l_{0-1} + (0.8)\ l_{1-5}$$

$$L_{1-5} = (0.34)\ l_{0-1} + (1.184)l_{1-5} + (2.782)\ l_{5-10}$$

Column seven (Tx) shows the number of years lived by survivors at

each age interval. Tx for the first age category is computed as follows:

$$T_{0-1} = \sum_{x=0.1}^{w} L_x$$

Subsequent Tx values are determined by subtracting Lx from Tx:

$$T_{1-5} = T_{0-1} - L_{0-1}$$

$$T_{5-10} = T_{1-5} - L_{1-5}$$

The final column ($e^{o}x$) of the life table expresses the life expectancy of individuals in each age category and is calculated as follows:

$$e^{o}x = \frac{Tx}{lx}$$

Table 3 presents the combined sex life table statistics for the Toqua skeletal series. Life table functions for the individual sexes are presented in Tables 4 and 5.

Mortality Curves

Figure 5 presents the mortality curves (dx) for the combined sexes and for each sex. As is common in many archaeological populations, the highest mortality rate, 22.6%, occurs during the first year of life. Childhood mortality steadily declines but is still relatively high at five years when compared to adolescent and adult mortality. Adolescent mortality drastically decreases to 5.5% between 10 and 15 years. This interval represents the least stressed and healthiest segment for the Toqua inhabitants. From early adulthood on there is an increase in mortality that ultimately peaks at the 20-25 year interval (i.e., 13.9%). Adult mortality decreases thereafter although it remains fairly constant (approximately 8%) between 25 and 35 years.

TABLE 3

Abridged Life Table for the Toqua Series (Sexes Combined; N=439)

Age (x)	No. (Dx)	Percent (dx)	Survivors (lx)	Probability of Death (qx)	Total No. of Years Lived in Each Age Category (Lx)	Total After Lifetime (Tx)	Life Expectancy (e^0x)
0-1	99	22.55	100.00	.226	81.96	1611.96	16.12
1-5	57	12.98	77.45	.168	305.06	1530.00	19.75
5-10	37	8.43	64.47	.131	301.28	1224.94	19.00
10-15	24	5.47	56.04	.098	266.53	923.66	16.48
15-20	41	9.34	50.57	.185	229.50	657.13	12.99
20-25	61	13.90	41.23	.337	171.40	427.63	10.37
25-30	35	7.97	27.33	.292	116.73	256.23	9.38
30-35	36	8.20	19.36	.424	76.30	139.50	7.21
35-40	26	5.92	11.16	.530	41.00	63.20	5.66
40-45	15	3.42	5.24	.653	17.65	22.20	4.24
45+	8	1.82	1.82	1.000	4.55	4.55	2.50

TABLE 4

Abridged Life Table for Toqua Males (N=228)

Age (x)	No. (Dx)	Percent (dx)	Survivors (lx)	Probability of Death (qx)	Total No. of Years Lived in Each Age Category (Lx)	Total After Lifetime (Tx)	Life Expectancy ($e^{o}x$)
0-1	50	21.93	100.00	.219	82.41	1705.12	17.05
1-5	29	12.72	78.01	.163	308.17	1662.71	20.80
5-10	14	6.14	65.35	.094	311.40	1314.54	20.16
10-15	20	8.77	59.21	.148	274.13	1003.14	16.94
15-20	14	6.14	50.44	.122	236.85	729.01	14.45
20-25	31	13.60	44.30	.307	187.50	492.16	11.11
25-30	16	7.02	30.70	.229	135.95	304.66	9.92
30-35	23	10.09	23.68	.426	93.18	168.71	7.12
35-40	17	7.46	13.59	.549	49.30	75.53	5.56
40-45	9	3.95	6.13	.644	20.78	26.23	4.28
45+	5	2.19	2.18	1.005	5.45	5.45	2.50

TABLE 5

Abridged Life Table for Toqua Females (N=211)

Age (x)	No. (Dx)	Percent (dx)	Survivors (lx)	Probability of Death (qx)	Total No. of Years Lived in Each Age Category (Lx)	Total After Lifetime (Tx)	Life Expectancy (e^0x)
0-1	49	23.22	100.00	.232	81.42	1510.89	15.11
1-5	28	13.27	76.78	.173	301.59	1429.47	18.62
5-10	23	10.90	63.51	.172	290.30	1127.88	17.76
10-15	4	1.90	52.61	.036	258.30	837.58	15.92
15-20	27	12.80	50.71	.252	221.55	579.28	11.42
20-25	30	14.22	37.91	.375	154.00	357.73	9.44
25-30	19	9.00	23.69	.380	95.95	203.73	9.00
30-35	13	6.16	14.69	.419	58.05	107.78	7.34
35-40	9	4.27	8.53	.501	31.98	49.73	5.83
40-45	6	2.84	4.26	.667	14.20	17.75	4.17
45+	3	1.42	1.42	1.000	3.55	3.55	2.50

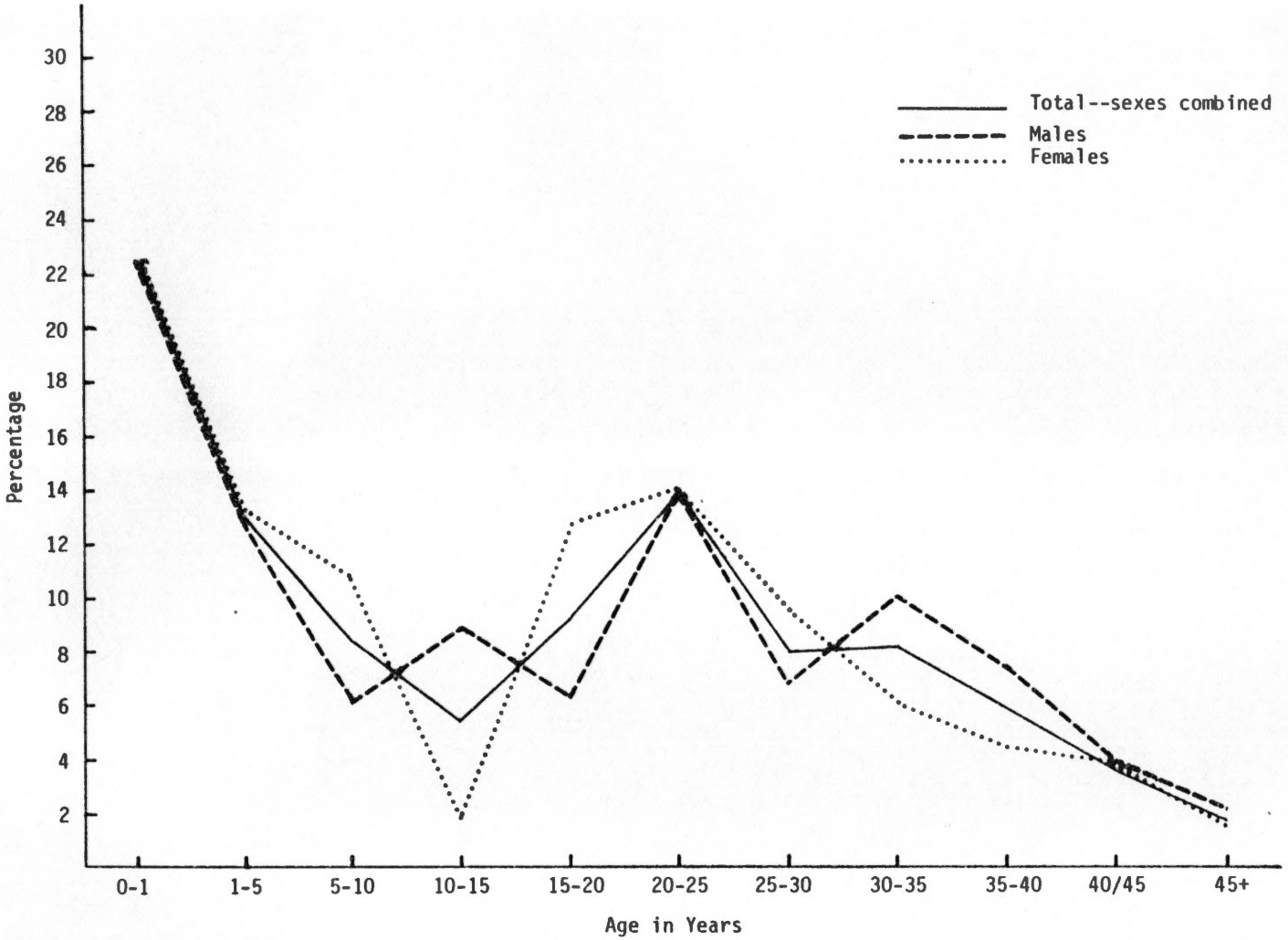

Figure 5. Age distribution of male and female mortality at Toqua.

Comparison of the male and female curves clearly show differences in mortality between five and 40 years. However, both curves peak and are similar (nearly 14% at the 20-25 year interval). Female mortality is somewhat higher than male (10.9% versus 6.1%) between five and 10 years. The reverse is true between 10 and 15 years as male mortality is considerably higher than female (8.8% versus 2%). Although there is undoubtedly some reality represented in this disparity, it must be remembered that these individuals were sexed by use of the dental discriminant analysis for which there is a margin of error.

Male mortality declines to 6.1% at the 15-20 year interval but then rises and peaks between 20 and 24 years. Unlike the males, female mortality drastically increases at the 15-20 year interval (12.8%) but also peaks at the 20-25 year interval. This increase in female mortality between 15 and 25 years may likely be attributed to the rigors and complications incurred during childbirth. As for the increase in male mortality between 20 and 25 years, this age increment may represent prime years for participation in warfare and hunting activities. Although it may be expected that traumatic injury would be manifested in higher frequencies for these males, this cannot be documented for the Toqua skeletons.

After 25 years there is a rather steady decrease in female mortality. It does exceed male mortality (9.0 % versus 7.0%) at the 25-30 year interval but then drops lower than male mortality for the remaining age intervals. This is particularly exemplified by a sudden rise in male mortality (10.1%) at the 30-35 year interval.

Survivorship Curves

As Ubelaker (1974:60) notes, "A curve of survivorship is merely the reverse of the mortality curve and plots the percentage of the original population surviving after each five year interval." The plot of the lx values are presented in Figure 6.

For the most part, female survivorship is relatively less than that of males after five years of age. At the 10-15 year interval 52.6% of the females were still alive as compared with 59.2% for males. At 15-20 years both survivorship values are approximately equal (50.4% versus 50.7% for males and females, respectively). After 20 years male survivorship again exceeds female. For example, at the 30-25 year interval male survivorship is 23.7% as compared with 14.7% for females. By the final age interval male and female survivorship are essentially equal.

Probability of Death

Probabilities of death (qx) are presented in Figure 7. The combined sex curve basically shows a high probability of death before five years of age. The lowest qx value (0.10) is at the 10-15 year interval. Again this indicates the relative well-being of this segment of the population. After 15 years the curve increases with age although there is a slight dip at the 25-30 year interval.

A comparison of the male and female curves shows that, with the exception of the 10-15 year interval, female probabilities of death between five and 35 years exceed those of males. At 35-40 years the female probability of death (0.50) is lower than the male (0.55). However, by the next age interval female probability of death again rises slightly above the male.

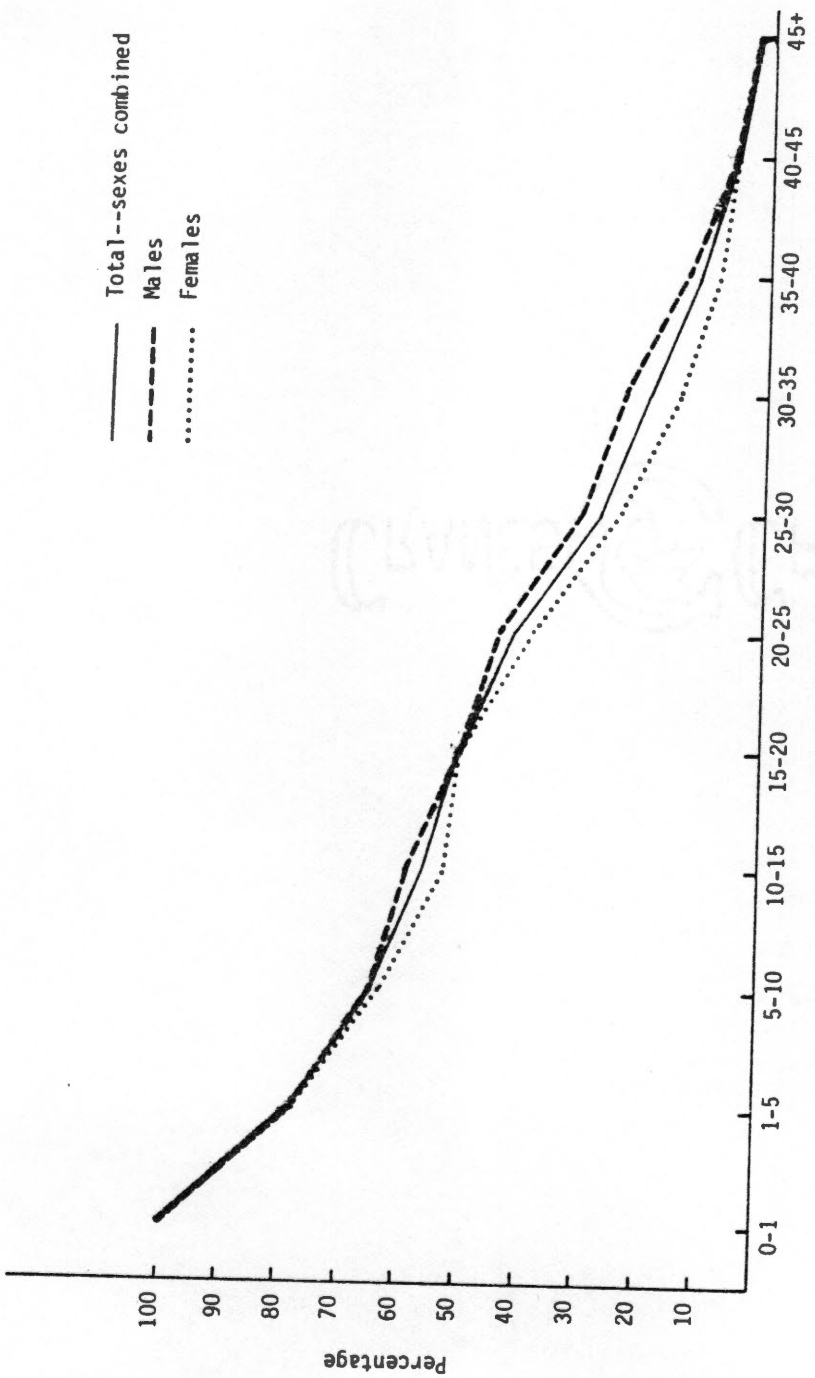

Figure 6. Survivorship of the Toqua population.

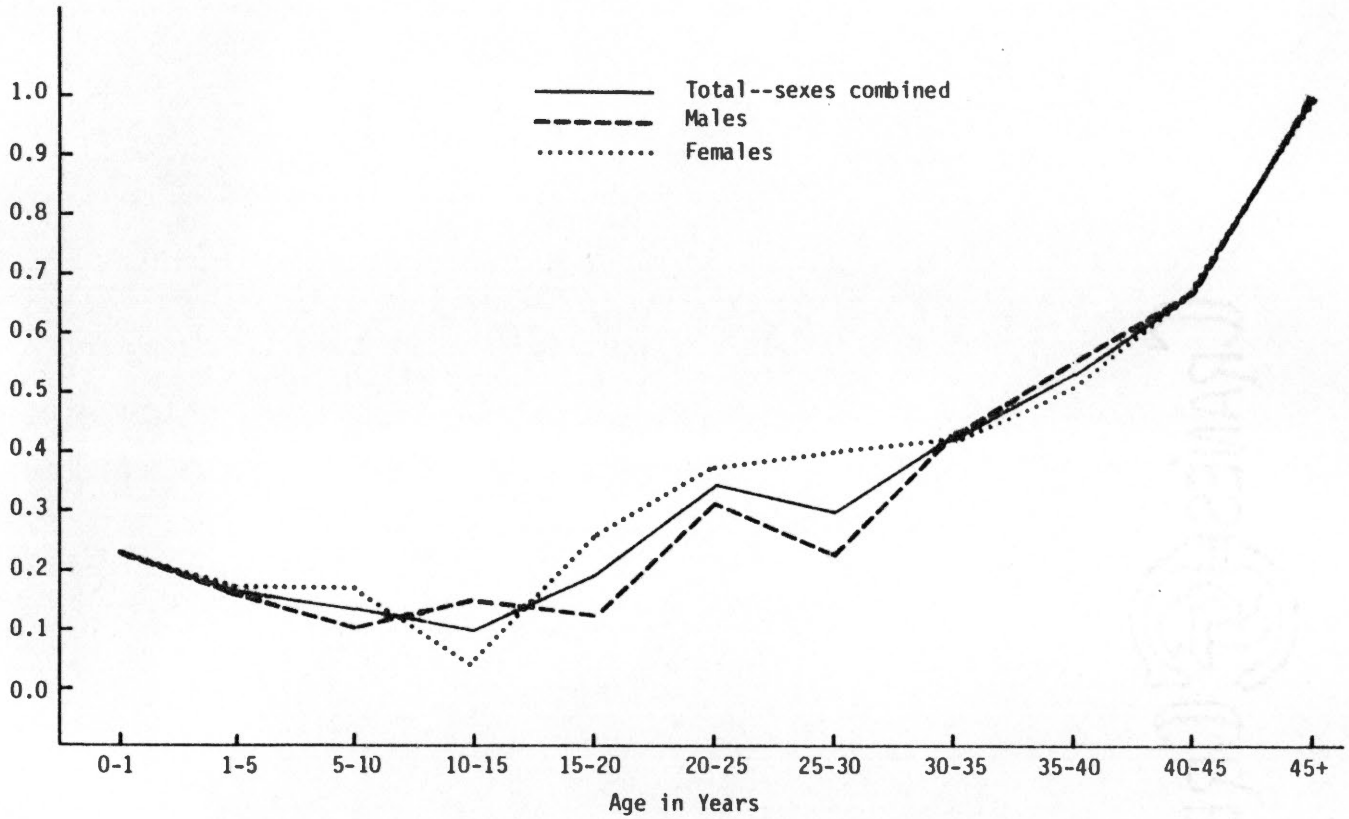

Figure 7. Probabilities of death in the Toqua population.

Life Expectancy

Figure 8 presents the life expectancy ($e^{o}x$) curves. Male life expectancy (17.1) is two years higher than female (15.1) during the first year of life. This trend basically continues until 30 years of age after which life expectancy values are similar for both sexes. The overall pattern for the curves shows that life expectancy rises once an individual has withstood the stresses of early childhood. By the 10-15 year interval, life expectancy is about the same as that at the 0-1 year interval. After 15 years the life expectancy values decline with increasing age.

Life expectancy at birth may be considered a measure of population longevity and health status (Owsley 1975:84). As such, it is useful to make comparisons with other aboriginal Amerindian populations. Table 6 presents the life expectancy values in increasing order for several Amerindian groups. The values show that life expectancy at birth at Toqua (16.1) is less than all but the historic Leavenworth site and the protohistoric Larson site. This suggests that the Dallas people from Toqua experienced tremendous stress throughout their existence, perhaps as a result of disease and nutritional deficiencies. These possibilities will be discussed more extensively in a later chapter.

Crude Mortality Rates

According to Acsádi and Nemeskéri (1970:67), under stationary conditions the crude mortality rate of a population can be derived as the reciprocal of life expectancy at birth:

$$m = \frac{1}{e^{o}_{o-1}}$$

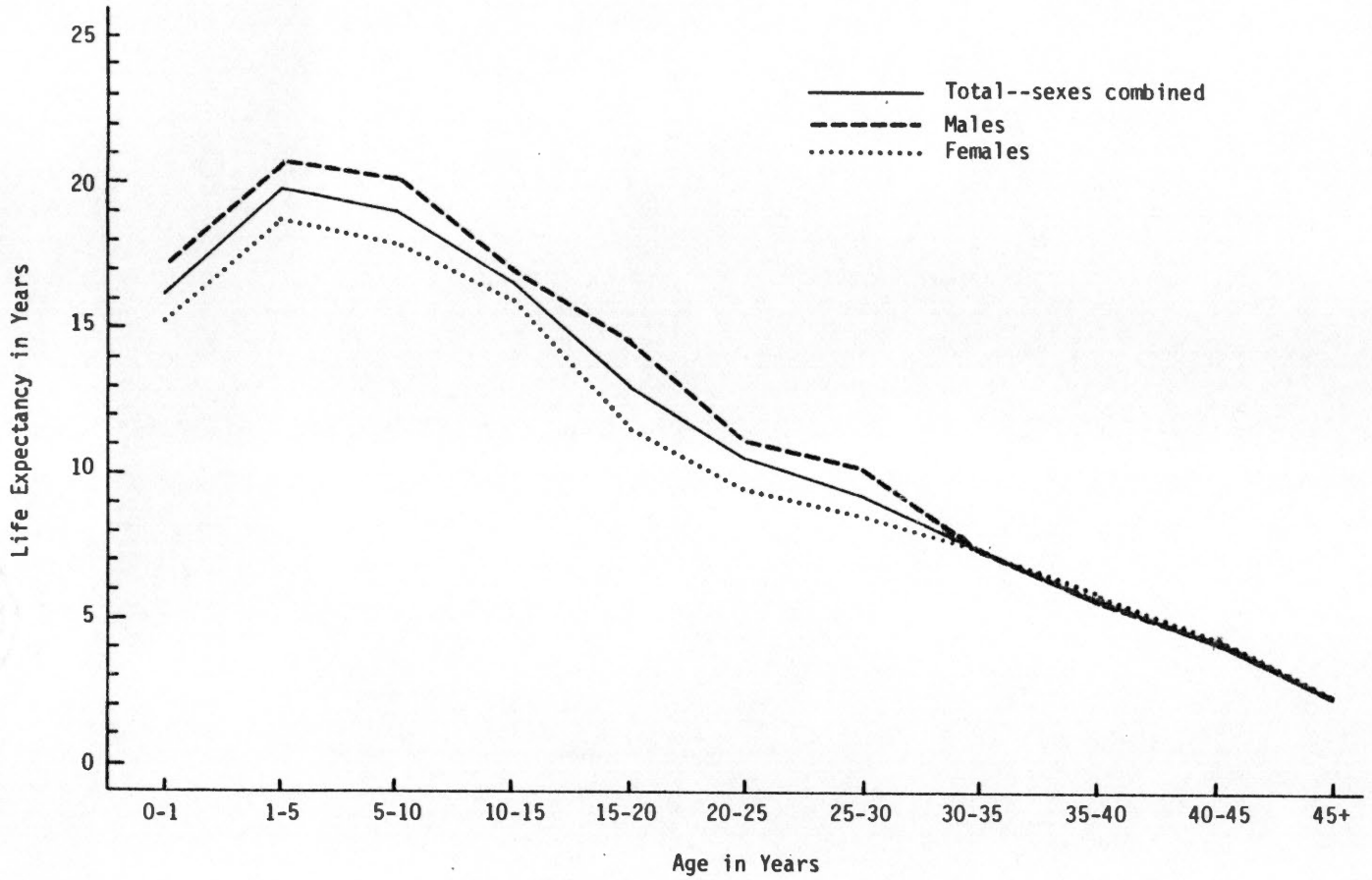

Figure 8. Life expectancy of the Toqua population.

The crude mortality rate represents the number of individuals dying per thousand per year (Ubelaker 1974:65). As shown in Table 6, Toqua's crude mortality rate of 62 is exceeded only by the Leavenworth and Larson sites.

TABLE 6

Life Expectancy at Birth and Crude Mortality Rate in Several Amerindian Skeletal Populations[a]

Populations	Dates	Life Expectancy (Years)	Crude Mortality Rate
Larson, South Dakota	A.D. 1750-1781	13.7	73
Leavenworth, South Dakota	A.D. 1800-1832	15.9	63
Toqua, Tennessee	A.D. 1300-1600	16.1	62
Averbuch, Tennessee	A.D. 1400	16.6	60
Indian Knoll, Kentucky	3000 B.C.	18.6	54
Nanjemoy-Ossuary I, Maryland	A.D. 1500-1600	20.9	48
Nanjemoy-Ossuary II, Maryland	A.D. 1500-1600	22.9	44

[a]Modified from Berryman (1981:68).

Rate of Natural Growth

A population statistic that is interrelated with the crude mortality rate is the rate of natural growth. Calculation of the rate of natural growth requires that a population's crude mortality rate be subtracted from the crude birth rate, the number of live births in one year per one thousand people in the mid-year population (Kammeyer 1971:154). However, there is no way of knowing the exact crude birth rate of

prehistoric populations. In other paleodemographic studies (e.g., Owsley 1975; Berryman 1981) the crude birth rate has been estimated from ethnographic sources or from published demographic information for developing nations.

Earlier it was assumed that Toqua was a stationary population with a zero growth rate. This implies that Toqua had a crude birth rate of 62 which would have resulted in a zero rate of natural growth when subtracted from the crude mortality rate of 62. Although one cannot positively state that Toqua had a zero rate of natural growth, this suggestion is tenable in view of the fact that certain contemporary tribal groups (e.g., the Yanomamo) have a crude birth rate that approaches 62 (Neel and Weiss, 1975).

Estimated Population Size of Toqua

Average population size based on biological data may be calculated according to two formulae. The first by Ubelaker (1974:66) is computed as follows:

$$P = \frac{1000\ N}{mT}$$

P = population size
N = total number of individuals buried
m = crude mortality rate (62)
T = time interval represented by the skeletal series (300)

The second formula by Acsádi and Nemeskéri (1970:65) is calculated accordingly:

$$P = K_{+}\ \frac{D\ e^{o}}{T}$$

P = average population size
D = total number of dead
e^{o} = life expectancy at birth (16.1)
T = time interval (300)
K = a correction factor, approximately 10% of T (30)

When applying these formulae to the Toqua population all but the total number of dead are known variables. Earlier it was reported that only about 10 to 20% of the total dead were recovered from the site. If the previously mentioned multiple burials and those graves for which little or no osseous remains were recovered are included in the sample estimate we arrive at approximately 500 individuals. Increasing this number by 80 and 90% yields a minimum and maximum number of dead of 2,500 and 5,000 individuals. Table 7 provides a comparison of the two formulae using both values. It is obvious that the only difference between the formulae is the addition of the K value (i.e., 10% of 300 years = 30) in the Acsádi and Nemeskéri (1970:65) formula. Regarding the actual population estimates, those calculated with the maximum number of dead (5,000) is seemingly more realistic than those calculated with the minimum (2,500) especially when considering the length of occupation of the site (Richard Polhemus, personal communication).

TABLE 7

Calculation of Toqua Population Size Using Two Formulae and Two Estimates of the Total Number of Burials

Total Number of Burials	$P = \frac{1000\ N}{mT}$ (Ubelaker 1974:66)	$P = K + \frac{D\ e^{o}_{o-1}}{T}$ (Acsádi and Nemeskéri 1970:65)
2500	134	164
5000	269	299

Mortality Comparison between the Toqua Mound and Village Components

Introduction

To reiterate, status differentiation for the Toqua skeletal series is based on the mound/village dichotomy. If mound burials are indeed higher status than village interments, one might hypothesize that the mortality profiles of the respective components would differ. Should this prove valid, then it may be possible to suggest sociocultural implications of the differences.

The ensuing analysis is basically similar to Blakely's (1977) mortality comparison between mound and village components at the Etowah site of northwestern Georgia. His results showed that only 3% of the Mound C interments were under 10 years of age. Furthermore, two modes in the Mound C profile, one consisting of individuals in their twenties and the other in their forties, revealed differential sex compositions as 70% of the burials comprising the mode in the third decade were females and a larger percentage in the fifth decade were males. A last comparison showed that the number of deaths in the village component decreased as age increased, but among Mound C individuals the likelihood of dying increased with advancing age.

Blakely's (1977:57-58) interpretations of these results are summarized as follows:

1. In light of the high social status and probable preferential treatment enjoyed by Mound C individuals, the Mound C "male mode" and "female mode" cannot be explained in terms suggested for their village counterparts: that is, warfare and hunting for males and childbearing for females.

2. Because infants and children were virtually excluded from interment in the mound, and inclusion in Mound C was significantly correlated with the advancing age of males, it seems probable that high status among males was achieved, not ascribed.
3. Females included in Mound C are generally younger than the males, indicating that they achieved high status at an earlier age. One can conclude that they were apparently deriving their status through marriage to high-status males who were, therefore, probably older.
4. Over 50% of the females interred in Mound C were under 30 years of age, indicating that it is at least possible that wives were frequently sacrificed upon the deaths of their husbands, as Sears (1956) has suggested was the case at the Mississippian site of Kolomoki in southwestern Georgia.

Blakely (1977) then tested these conclusions by performing a multivariate distance analysis based on craniometrics of individuals from the two components. Because the results of this test showed that Mound C and village individuals were statistically indistinguishable, he suggested that both groups were derived from the same population. Thus, genetic differences resulting from ascribed status for the Mound C individuals was unsubstantiated.

General conclusions pertaining to the nature of status at Etowah are summarized by Blakely (1977:62) as follows:

> Social organization at Etowah appears to include combined elements of both chiefdoms and egalitarian societies. That Etowah does not fall entirely within one organizational scheme should not be of concern. There are, in fact,

> advantages to be gained by adopting multiple systems. By integrating aspects of more than one social structure, it is possible that the Etowah people made their society more flexible and thereby more adaptive, while at the same time maintaining organizational (hierarchical) efficiency.

Blakely's (1977) study was the only analysis found in the literature that dealt with comparative mortality of societal components for Late Mississippian sites. Although differences such as complexity and size exist between Etowah and Toqua, the two sites are contemporaneous and both exhibit similar attributes such as Southern Cult items. Blakely's (1977) study, therefore, provides relative guidelines for assessing mortality relationships between societal components at Toqua.

Methodology

Mortality frequencies and percentages for mound and village components were computed (Tables 8 and 9). Combined-sex mortality for the components was statistically evaluated for differences by the Kolmogorov-Smirnoff method, a non-parametric test that is applicable to cumulative frequency distributions (Thomas 1976:322-326). This statistical method was also used to test for differences between male and female mortality from the mound component, females from mound and village components, and males from each component (Table 10).

Results and Discussion

Statistical testing of combined-sex mortality between mound and village components at Toqua revealed that the cumulative frequency distributions differ at the 0.01 level (Table 10). The major difference between the two components is the comparatively low infant and childhood mortality of the mound. By the first year mound mortality is only 4.0% as compared to 29.7% for the village component (see Figure 9).

Blakely (1977) assessed mortality for the Etowah components in 10 year increments. Children for the first 10 years from Mound C at

TABLE 8

Mortality Frequencies and Percentages for the Toqua Mound Component

	Males (N=75)				Females (N=49)				Combined Sexes (N=124)			
x	Dx	Cum. Dx	dx	Cum. dx	Dx	Cum. Dx	dx	Cum. dx	Dx	Cum. Dx	dx	Cum. dx
0-1	3	3	4.00	4.00	2	2	4.08	4.08	5	15	4.03	4.03
1-5	3	6	4.00	8.00	2	4	4.08	8.16	5	10	4.03	8.06
5-10	7	13	9.33	17,33	4	8	8.16	16.32	11	21	8.87	16.93
10-15	7	20	9.33	16.66	2	10	4.08	20.40	9	30	7.26	24.19
15-20	6	26	8.00	34.66	12	22	24.99	44.89	18	48	14.52	38.71
20-25	18	44	24.00	58.66	12	34	24.49	69.38	30	78	24.19	62.90
25-30	11	55	14.67	73.33	5	39	10.20	79.58	16	94	12.90	75.80
30-35	11	66	14.67	88.00	4	43	8.16	87.74	15	109	12.10	87.90
35-40	4	70	5.33	93.33	6	49	12.24	99.98	10	119	8.06	95.96
40-45	5	75	6.67	100.00	0	49	0	99.98	5	124	4.03	99.99
45+	0	75	0	100.00	0	49	0	99.98	0	124	0	99.99

Etowah exhibited a cumulative mortality of 3%. This compares with 16.9% for the Toqua mound component. At Etowah, Blakely (1977:58) stated that children were "virtually excluded" from interment in Mound C. Given the manifestly high childhood mortality from the Toqua mound component, is it justifiable to say that children were virtually excluded from interment in the mounds at Toqua? It may also be possible that high-status children at Toqua could have had a greater chance for survival than village children as a result of preferential treatment; however, Toqua village mortality for the first 10 years (54.7%) is also considerably greater than Etowah village mortality for the same age interval (32%). What this

TABLE 9

Mortality Frequencies and Percentages for the Toqua Village Component

	Males (N=147)				Females (N=153)				Combined Sexes (N=300)			
x	Dx	Cum. dx	dx	Cum. dx	Dx	Cum. dx	dx	Cum. dx	dx	Cum. dx	dx	Cum. dx
0-1	45	45	30.61	30.61	44	44	28.76	28.76	89	89	29.67	29.67
1-5	25	70	17.01	47.62	25	69	16.34	45.10	50	139	16.67	46.34
5-10	8	78	5.44	53.06	17	86	11.11	56.21	25	164	8.33	54.67
10-15	11	89	7.48	60.54	3	89	1.96	58.17	14	178	4.67	59.34
15-20	7	96	4.76	65.30	13	102	8.50	66.67	20	198	6.67	66.01
20-25	13	109	8.84	74.14	18	120	11.76	78.43	31	229	10.33	76.34
25-30	6	115	4.08	78.22	13	133	8.50	86.93	19	248	6.33	82.67
30-35	13	128	8.84	87.06	8	141	5.23	92.16	21	269	7.00	89.67
35-40	11	139	7.48	94.54	5	146	3.27	95.43	16	285	5.33	95.00
40-45	4	143	2.72	97.26	4	150	2.61	98.04	8	293	2.67	97.67
45+	4	147	2.72	99.98	3	153	1,96	100.00	7	300	2.33	100.00

TABLE 10

Kolmogorov-Smirnoff Tests of Significance for Differences in Mortality Distributions of Mound and Village Components at Toqua

Test	Computed Statistic	P
Between components--combined-sex	0.383	< 0.01
Mound component--male vs. female	0.107	> 0.05
Between components--females	0.400	< 0.05
Between components--males	0.396	< 0.01

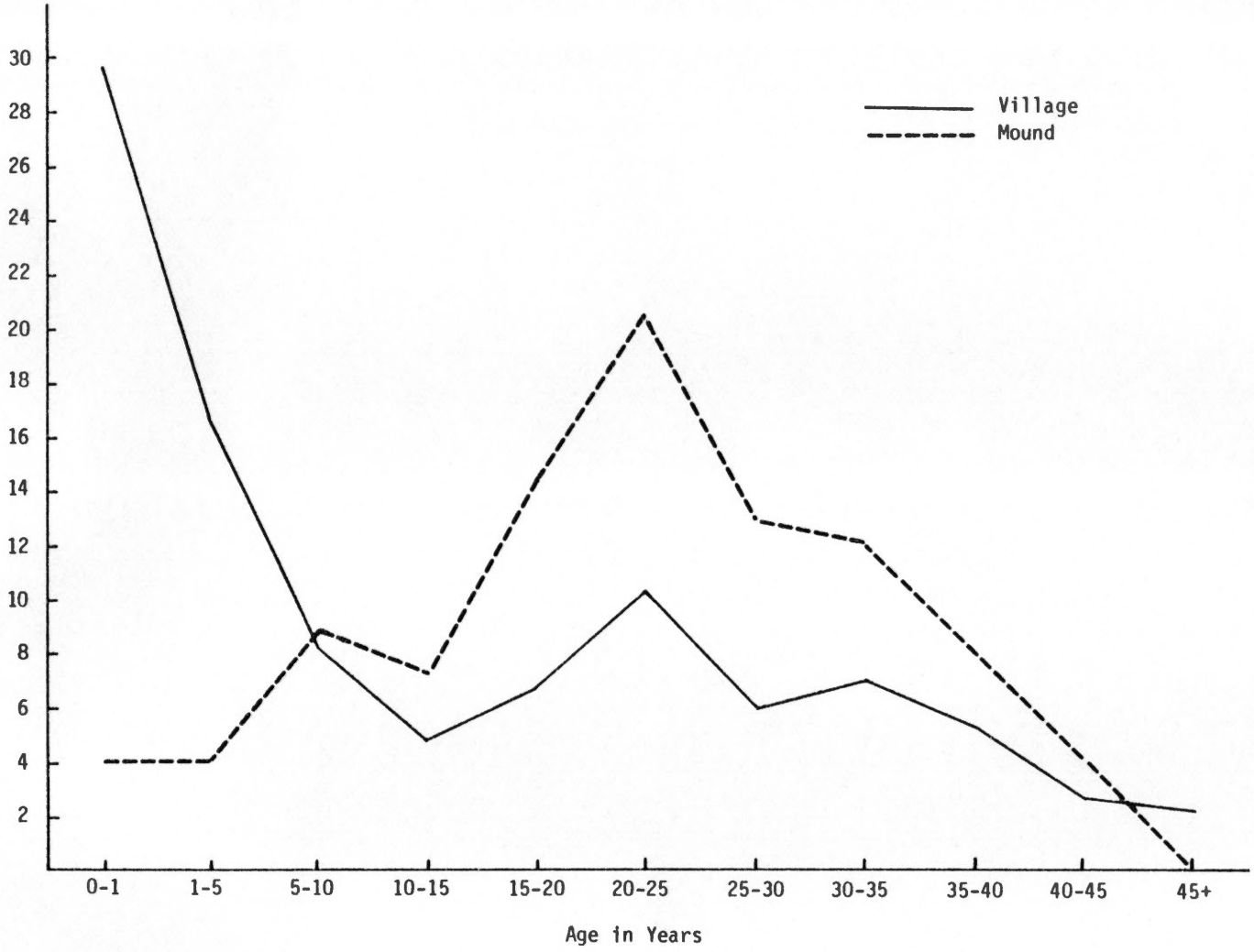

Figure 9. Age distribution of combined-sex mortality for the Toqua mound and village components.

may imply is that each segment of Toqua society experienced greater stress than at Etowah.

The two modes in the Etowah Mound C profile during the third and fifth decade are only partially detectable at Toqua. Whereas Blakely reported 70% of the burials in the third decade to be female, a higher percentage of males (38.7%) than females (34.7%) were revealed in the Toqua mound component for the same age interval. For the fifth decade, Blakely reported that the majority were males, and at Toqua all five burials 40 years and older in the mound component are also males. Despite the apparent congruency between Etowah and Toqua mound mortality during the fifth decade, the Kolmogorov-Smirnoff test indicates that the male and female mortality profiles from the mound component are not significantly different at the 0.05 level (Table 10).

Of major interest is Blakely's (1977:57) statement that the Mound C "female mode" cannot be explained in terms of childbearing. Although the "female mode" is not readily detectable at Toqua, a comparison of mortality rates between mound and village females presents some interesting patterns. To begin with, the Kolmogorov-Smirnoff test indicates that the two female components are significantly different at the 0.01 level (Table 10). Close scrutiny of the mortality curves (Figure 10) reveals that village childhood mortality is, as expected, higher than mound, but then mound mortality exceeds village between 15-40 years. This disparity is marked between 15-25 years and somewhat so at the 35-40 year interval. What is most interesting about this comparison is that mound females peak at 15-20 years (24.5%) and maintain this percentage between 20-25 years. Village females peak five years later at 20-25

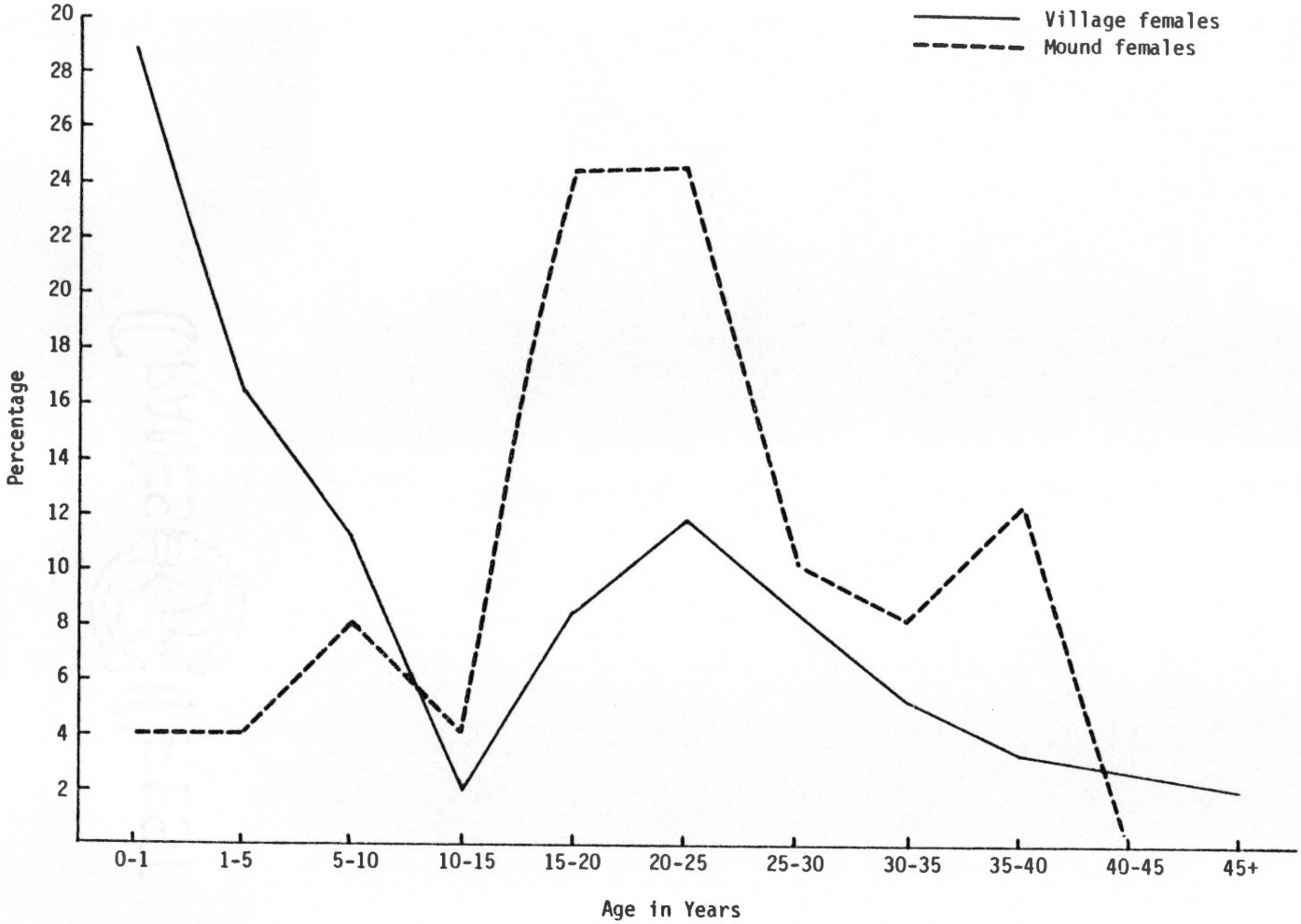

Figure 10. Age distribution of female mortality for the Toqua mound and village components.

years and their mortality is considerably lower (11.8%) than the mound peak. Setting aside the possibility of sacrifice for the moment, if it is assumed that childbearing induces peak mortality for females then it is also possible that high-status females at Toqua were marrying younger than their village counterparts. This implies that mound females may have incurred greater obstetrical problems by virtue of their youth. It has been substantiated for modern populations that teenage pregnancies are associated with higher risk to both mother and infant (Moerman 1981).

In turning to the idea of sacrifice, the skeletal evidence at Toqua does not support this contention, although, as Blakely (1977:58) points out, many sacrificial techniques would not leave their marks on the bones. Furthermore, in viewing the male and female mortality curves for the Toqua mound component (Figure 11) a curious feature emerges. At 20-25 years the male curve peaks and then proceeds to drop until the 40-45 year interval where another increase is evident. As stated above, the female curve peaks at 15-20 years, remains the same through 20-25 years, then drops until 35-40 years where a significant increase is detected. The two modes in the male curve appear to be matched by increases in the female curve occurring five years earlier. Especially for the latter mode, for which childbearing would not be a likely factor, sacrifice could be a possibility.

Blakely's final suggestion is that the number of deaths increases with advancing age among Mound C males at Etowah and vice-versa among village males. The Kolmogorov-Smirnoff test shows that the cumulative mortality frequencies of the two male components at Toqua differ significantly at the 0.01 level (Table 10). The difference is initially

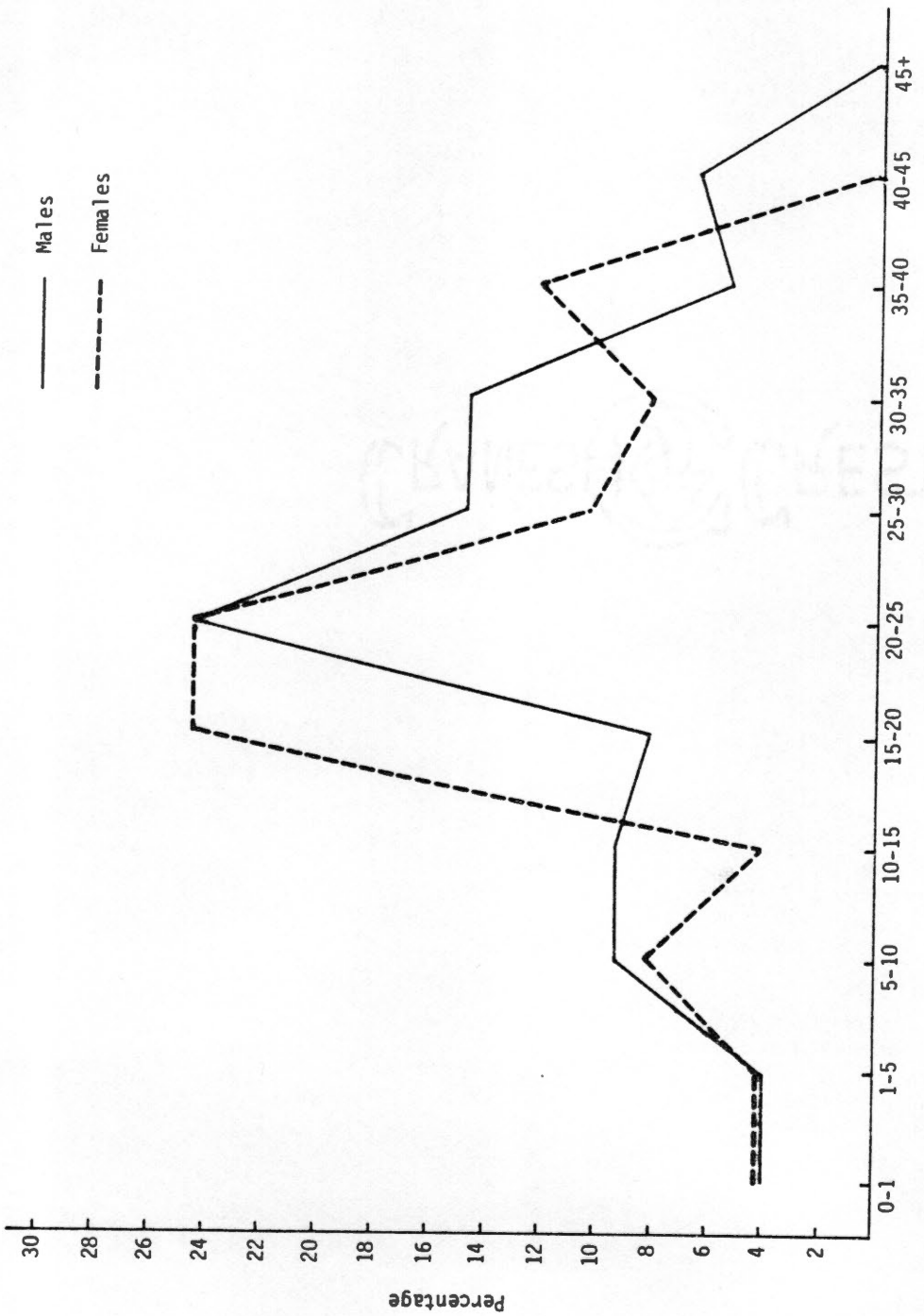

Figure 11. Age distribution of male and female mortality for the Toqua mound component.

explained again by the great disparity in childhood mortality (Figure 12). Between 5-35 years mound component male mortality exceeds village. At the 35-40 year interval the village (7.5%) rises slightly above mound (5.3%) but at 40-45 years mound mortality again exceeds village (6.7% versus 2.7% for mound and village, respectively). Interestingly, there were no mound males older than 44 years. This evidence is contrary to what Blakely found at Etowah.

Though both male curves at Toqua peak at 20-25 years, mound mortality (24.0%) is considerably higher than village (8.8%). Actually, village mortality is also 8.8% at 30-35 years. Surely the idea of increased probability of death with advancing age among mound males cannot be substantiated at Toqua. However, in light of the possibility of preferential treatment for high status males, can it still be inferred that hunting and warfare activities led to the extremely high peak mortality rate for mound component males? In a model of achieved status these skills may have earned one the right to be interred in the mounds.

In conclusion, the aim of Blakely's (1977) study was to test the hypothesis that, based on mortality data between mound and village components at Etowah, status was largely ascribed rather than achieved. The present study sought to either corroborate or repudiate this suggestion for similar societal components at Toqua. In spite of differing mortality structures between the two sites, the possibility of an achieved aspect at Toqua seems reasonable, although for different reasons. The fact that the mortality data at Toqua do not readily conform to Etowah's should not cause a great deal of concern. What is of more importance is that societal variability in demographic parameters between these two

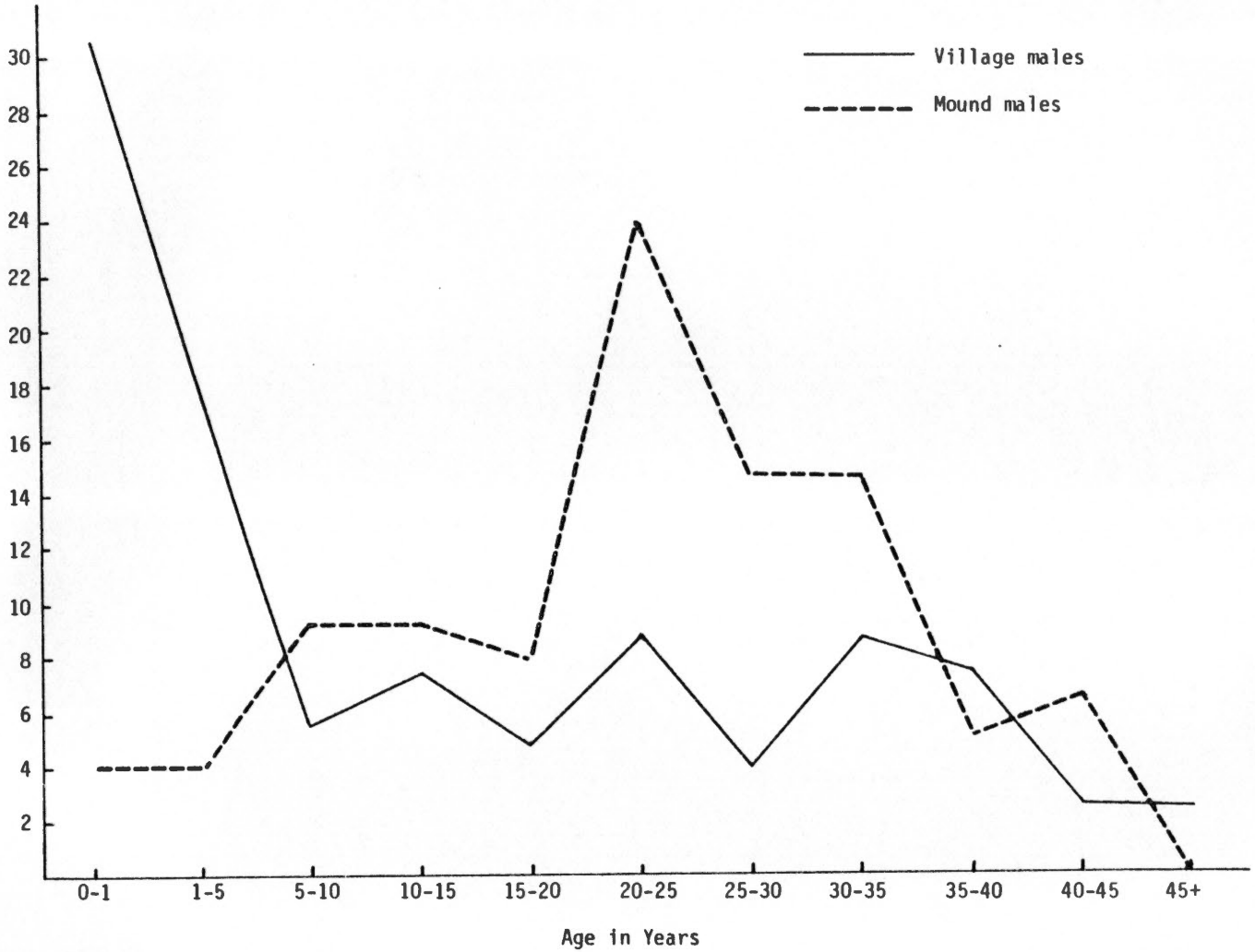

Figure 12. Age distribution of male mortality for the Toqua mound and village components.

Mississippian sites, and probably others, is a distinct realization that should be addressed in future Mississippian studies.

Mortality of the Structure 3 Individuals

The age and sex distribution of the 15 individuals from Structure 3 are presented in Table 11. Because seven of these individuals are under 10 years of age, it is suggested that the infant and childhood mortality of this group conforms more closely to the village component. With the exception of the 20-25 year interval which has two individuals, the remaining age intervals in the table have one individual each. Since peak mortality for both components occurs at the 20-25 year interval, the additional Structure 3 individual in this age range is expected. There are no Structure 3 individuals 40 years and older.

The sex ratio of the diagnostic individuals from Structure 3 is biased in favor of males (six of eight males versus two of eight for females). This feature of mortality is curious, particularly in view of the suggestion that Structure 3 represents a late occurring dwelling with conflicting expressions of high status as manifested by their mortuary patterning.

TABLE 11

Age and Sex Distribution of the Structure 3 Individuals from Toqua

Age Interval	Unsexed	Male	Female	Total
0-1	5	-	-	5
1-5	2	-	-	2
5-10	0	0	1	1
10-15	0	1	0	1
15-20	0	0	1	1
20-25	0	2	0	2
25-30	0	1	0	1
30-35	0	1	0	1
35-40	0	1	0	1

CHAPTER 3

MEASUREMENTS AND MORPHOLOGY

Introduction

This chapter presents descriptive information for the Toqua skeletal series. In addition to the various measurements and indices, stature estimates and the incidence of cranial deformation are included for the total sample as well as for the separate mound and village components. Statistical tests are performed between the two components to examine the possibility of status differences in stature and cranial deformation.

Metric Data

Means and standard deviations of cranial and postcranial measurements for males are provided in Table 12 and Table 13, respectively. Summary statistics for female cranial and postcranial measurement are presented in Tables 14 and 15. For the sake of brevity, descriptions of the measurements are not provided in the text; however, sources are footnoted in the tables. Cranial measurements were taken from individuals 15 years and older. All postcranial measurements are confined to individuals for which epiphyses had attached to the respective bones.

TABLE 12

Cranial Measurements (mm.) of Toqua Males

Measurement	No. of Cases	Mean	S.D.
Maximum lgt.[1]	22	172.91	15.10
Maximum brdth.[1]	17	148.88	11.41
Min. front. brdth.[1]	28	96.29	6.04
Bizygomatic brdth.[1]	3	145.00	5.29
Basion-bregma[1]	3	142.33	8.74
Endobasion-masion[2]	4	100.50	9.26
Endobasion-alv. pt.[2]	3	108.33	23.86
Endoba-gn.[3]	3	107.00	9.17
Biorbital brdth.[4]	4	103.00	10.58
Orbital ht.[1]	7	36.57	2.37
Orbital brdth.[1]	7	41.86	4.38
Nasal ht.[1]	6	53.17	3.13
Nasal brdth.[1]	6	24.67	2.73
Ext. alv. lgt.[1]	7	53.57	6.63
Ext. alv. brdth.[1]	6	68.67	3.27
Nasion-alv. pt.[1]	4	72.00	3.56
Na.-gnathion[1]	2	125.50	3.54
Auricular ht.[1]	4	125.00	4.24
Ba-po ht.[1]	3	12.33	6.11
Porion-nasion[5]	5	88.80	1.92
Porion-subnasale[5]	3	90.00	3.61
Porion-prosthion[5]	3	95.00	2.65
Porion-gnathion[5]	2	108.00	9.90
Symphysis ht.[1]	23	36.52	2.68
Diam. bigonial[1]	24	98.21	11.19
Diam. bicondylar[1]	16	128.50	5.73
Ht. ascen. ramus[1]	32	58.72	5.87
Gonion-gnathion[3]	34	89.24	5.15
Na.-br. chord[6]	26	110.65	5.92
Na.-br. subtense[6]	26	20.62	4.44
Na.-subt. fraction[6]	26	55.04	7.78
Br.-lambda chord[6]	27	109.41	7.90
Br.-lambda subtense[6]	27	24.52	4.26
Br.-subt. fraction[6]	27	54.96	7.01
La.-opisthion chord[6]	10	94.00	7.75
La.-opisthion subtense[6]	10	24.00	4.06
La.-subtense fraction[6]	10	49.60	9.56
Indices			
Cranial index[1]	15	87.66	14.00
Cranial module[1]	3	154.67	5.24
Mean ht. index[1]	3	59.58	6.92
Length ht. index[1]	3	90.83	14.30

TABLE 12 (Continued)

Measurement	No. of Cases	Mean	S.D.
Brdth ht. index[1]	3	87.11	3.48
Fronto-parietal index[1]	15	65.13	4.27
Frontal index[7]	26	18.56	3.48
Parietal index[8]	27	22.35	3.20
Occipital index[9]	10	25.47	3.44
Upper facial index[1]	2	50.73	1.51
Total facial index[1]	2	87.20	1.83
Nasal index[1]	6	46.56	6.27
Orbital index[1]	7	87.81	5.78
Palatal index[1]	5	136.52	18.54
Flatness crabase[1]	2	10.32	3.08

[1]After Bass (1971).

[2]After Hrdlička (1952).

[3]After Wilder (1920).

[4]After Morant (1927).

[5]After Snodgrass (1951).

[6]After Howells (1973).

[7]After Howells (1978).

[8]After Larnach (1974).

[9]Per author.

TABLE 13

Postcranial Measurements (mm.) of Toqua Males

Measurements and Indices	Right N	Right Mean	Right S.D.	Left N	Left Mean	Left S.D.
Humerus						
Max. morph. lt.[1]	18	316.56	13.65	14	321.07	10.71
Max. diam. mdsht.[1]	24	23.13	1.26	24	22.17	1.46
Min. diam. mdsht.[1]	24	16.83	1.83	24	15.79	1.72
Circum. mdsht.[1]	24	66.58	2.76	24	64.29	3.53
Max. diam. head[1]	14	44.57	1.79	12	44.25	1.82
Humero-fem. index[2]	14	72.01	1.67	11	71.29	1.66
Radius						
Max. lgt.[1]	16	245.00	9.76	18	243.11	10.11
Humero-rad. index[1]	7	76.62	3.56	5	76.60	2.86
Ulna						
Max. lgt.[1]	15	265.07	9.15	21	263.95	10.87
Clavicle						
Max. lgt.[1]	11	153.27	9.71	12	153.50	7.56
Clav. hum, index[1]	8	47.02	2.40	6	46.85	2.12
Scapula						
Max. lgt.[1]	2	143.00	12.73	2	144.00	15.56
Max. brdth.[1]	3	104.00	10.15	2	98.00	2.83
Scap. index[1]	2	66.31	9.63	2	68.56	9.37
Femur						
Max. morph. lgt.[1]	33	443.91	15.83	35	439.57	16.65
Phys. lgt.[1]	32	441.38	15.40	34	436.88	16.63
Ant.-post. diam. mid.[1]	40	29.98	2.43	40	30.20	2.36
Transv. diam. mid.[1]	39	26.13	1.73	38	26.37	1.73
Circum. midshaft[1]	41	88.29	4.84	39	88.23	5.14
Max. diam. head[1]	22	45.09	1.93	24	44.75	2.23
Pilastric index[3]	39	115.37	10.72	38	114.73	10.44
Index of robusticity[1]	30	12.73	0.61	28	12.91	0.67
Tibia						
Max. morph. lgt.[4]	22	368.14	14.41	26	362.38	16.70
A-P diam.nut for.[1]	36	36.83	2.87	34	37.35	2.85
Transv. diam. nut for.[1]	36	24.11	2.08	36	24.72	2.48
Circum. midshaft[5]	27	87.11	4.89	27	87.37	4.73
Tibio-fem. index[2]	17	82.89	1.67	21	82.19	1.68
Cnemic index[1]	36	65.71	6.23	34	66.45	7.22

TABLE 13 (Continued)

Measurements and Indices	Right			Left		
	N	Mean	S.D.	N	Mean	S.D.
Fibula						
Max. lgt.[1]	10	357.30	12.39	7	357.43	18.52
Innominate						
Isch. tub-il. cr.[1]	5	208.80	10.13	6	209.67	10.17
ASP-PSP[1]	6	152.33	2.58	7	151.71	10.37
Sacrum						
Max. lgt.[1]	4	110.50	11.45	--	--	--
Max. brdth.[1]	8	114.00	10.03	--	--	--

[1]After Bass (1971).

[2]After Wilder (1920).

[3]After Oliver (1969).

[4]After Trotter and Gleser (1952).

[5]After Hrdlička (1952).

TABLE 14

Cranial Measurements (mm.) of Toqua Females

Measurement	No. of Cases	Mean	S.D.
Maximum lgt.	25	153.44	9.62
Maximum brdth.	19	147.16	13.85
Min. front. brdth.	26	93.65	5.23
Bizygomatic brdth.	3	134.66	7.09
Basion-bregma	6	142.33	6.59
Endobasion-nasion	5	104.40	6.02
Endobasion-alv. pt.	3	100.33	8.14
Endoba-gn.	2	99.50	10.61
Biobital brdth.	10	95.10	3.14
Orbital ht.	13	36.46	1.94
Orbital brdth.	12	40.92	2.02
Nasal ht.	15	50.00	3.14
Nasal brdth.	15	25.87	2.17
Ext. alv. lgt.	16	51.75	4.12
Ext. alv. brdth.	16	62.38	2.85
Nasion-alv. pt.	12	70.50	3.70
Na.-gnathion	3	115.33	1.53
Auricular ht.	8	120.88	4.09
Ba-po ht.	5	13.20	1.92
Porion-nasion	10	90.90	7.23
Porion-subnasale	7	89.86	6.28
Porion-prosthion	7	95.00	7.66
Porion-gnathion	3	106.33	5.03
Symphysis ht.	24	33.54	2.54
Diam. bigonial	26	91.81	6.46
Diam. bicondylar	11	122.64	6.55
Ht. ascen. ramus	31	51.35	5.21
Gonion-gnathion	35	84.91	3.14
Na.-br. chord	32	106.28	5.66
Na.-br. subtense	32	20.28	3.93
Na.-subt. fraction	32	54.19	7.81
Br.-lambda chord	24	103.25	7.48
Br.-lambda subtense	24	22.04	2.49
Br.-subt. fraction	24	53.21	6.30
La.-opisthion chord	20	94.25	5.87
La.-opisthion subtense	20	22.10	3.73
La.-subtense fraction	20	45.20	5.75

TABLE 14 (Continued)

Measurement	No. of Cases	Mean	S.D.
Indices			
Cranial index	16	90.90	13.67
Cranial module	3	147.67	2.52
Mean ht. index	3	59.10	1.51
Length ht. index	6	84.68	2.18
Brdth. ht. index	3	101.19	7.75
Fronto-parietal index	14	63.33	5.91
Frontal index	32	19.03	3.31
Parietal index	24	21.33	1.71
Occipital index	20	23.41	3.40
Upper facial index	3	52.87	4.31
Total facial index	3	85.85	5.75
Nasal index	15	51.82	4.28
Orbital index	12	89.81	6.34
Palatal index	15	121.86	14.21
Flatness crabase	5	9.44	1.60

TABLE 15

Postcranial Measurements (mm.) of Toqua Females

Measurements and Indices	Right			Left		
	N	Mean	S.D.	N	Mean	S.D.
Humerus						
Max. morph. lgt.	23	302.61	11.36	30	296.50	11.94
Max. diam. mdsht.	26	20.81	1.30	36	20.47	1.44
Min. diam. mdsht.	26	14.81	0.98	36	14.31	1.31
Circum. mdsht.	26	59.27	3.61	36	58.36	4.29
Max. diam. head	17	38.53	0.94	17	38.18	1.42
Humero-fem. index	16	72.78	2.39	21	71.97	2.36
Radius						
Max. lgt.	20	227.35	10.17	21	225.90	11.37
Humero-rad. index	14	74.91	1.69	14	76.50	1.40
Ulna						
Max. lgt.	14	246.86	10.80	15	247.53	13.18
Clavicle						
Max. lgt.	10	140.70	6.06	9	139.56	6.50
Clav.-hum. index	6	47.10	1.22	6	47.59	2.68
Scapula						
Max. lgt.	--	--	--	--	--	--
Max. brdth.	--	--	--	--	--	--
Scap. index	--	--	--	--	--	--
Femur						
Max. morph. lgt.	31	413.71	17.91	31	417.32	17.88
Phys. lgt.	30	409.13	17.89	30	414.23	17.68
A-P diam. mdsht.	36	25.89	1.92	37	26.03	1.96
Transv. diam. mdsht.	35	23.94	1.51	36	24.56	1.36
Circum. mdsht.	35	78.14	4.47	36	78.38	4.67
Max. diam. head	20	40.65	1.66	25	41.40	1.29
Pilastric index	35	108.46	8.29	36	106.15	8.03
Index of robusticity	26	12.12	0.75	28	12.32	0.74

TABLE 15 (Continued)

Measurements and Indices	Right			Left		
	N	Mean	S.D.	N	Mean	S.D.
Tibia						
Max. morph. lgt.	19	341.47	19.19	16	343.06	20.56
A-P diam. nut. for.	35	32.31	2.71	35	31.43	2.32
Transv. diam. nut. for.	35	22.57	2.15	35	22.43	2.21
Circum. mdsht.	23	76.04	5.24	23	74.26	3.88
Tibio-fam. index	16	82.07	2.38	13	82.19	2.83
Cnemic index	35	70.05	6.50	35	71.66	8.22
Fibula						
Max. lgt.	8	335.63	21.63	9	325.22	6.42
Innominate						
Isch. tub.	2	192.00	7.07	2	197.50	4.95
APS-PSP	1	144.00	--	3	142.67	4.93
Sacrum						
Max. lgt.	3	103.33	4.04	--	--	--
Max. brdth.	5	120.40	4.77	--	--	--

Stature

Mean Stature for the Toqua Series

Stature estimates based on Amerindian populations, for which individual height is known beforehand, are few in number. Researchers generally turn to the formulae of Genovés (1967) and Trotter and Gleser (1952, 1958) when dealing with prehistoric Amerindian populations. However, Genovés' (1967) formulae have their limitations for North American populations in that they were derived from a series of Mesoamerican Indians which are quite short in stature. Bass et al. (1971:166) note that in a comparison of four different stature studies, Genovés' male estimates were approximately three centimeters below the others which were otherwise fairly comparable to one another. Thus, Trotter and Gleser's (1958) Mongoloid formulae based on a composite of several populations are conventionally used for estimation of stature among North American Amerindian males. They were therefore applied to the Toqua males.

Because no female Mongoloid estimates are provided by Trotter and Gleser (1952, 1958), it was necessary to employ their formulae for white females. However, Neumann and Waldman (1968) provide an alternative to using Trotter and Gleser's white female formulae. Neumann and Waldman (1968) estimated stature based on the grave length of Hopewell and Middle Mississippian interments. Since it has been noted that the Neumann and Waldman (1968) estimates are comparable to Trotter and Gleser's (1952) estimates for white females (e.g., Bass et al. 1971:167; Loveland 1980: 135), the latter were retained for use in the present study.

Stature estimates were derived from morphological femur length only. There are inconsistencies in the literature regarding tibia measurements, and the upper limb bones are generally considered to be less reliable than the lower limb bones for estimating stature (Bass et al. 1971:166).

Tables 16 and 17 present individual stature estimates and means for the Toqua males and females, respectively. The male mean is 167.6 cm. (66.0 in.). The male range is 158.9 cm. (62.6 in.) to 176.0 cm. (69.3 in.). The female mean is 156.5 cm. (61.6 in.) and ranges from 148.5 cm. (58.5 in.) to 166.7 cm. (65.6 in.).

Stature and Status at Toqua

The attainment of adult stature results from both genetic and environmental factors which influence growth. With the hypothesis that stature differences exist between archaeologically-defined components at Toqua, it is necessary to determine which of these factors may influence the outcome of tests of this hypothesis.

It is obvious that age influences stature. According to Trotter and Gleser (1951), maximum height is usually reached by about 25 years of age. At a rate of approximately 1.2 centimeters per each 20 years thereafter, stature decreases. These potential biases are, for the most part, controlled in the ensuing analysis. By removing those individuals which possessed incompletely attached femoral epiphyses, subadults were eliminated. Additionally, it is doubtful that the few number of very old individuals, say 45+ years, that were included in the analysis would drastically affect the means.

TABLE 16

Individual and Mean Stature Estimates for the Toqua Males (N=43)

Bu. No.	Location[1]	Femur Length (cm.)	Stature (cm.)[2]	Stature in.)[3]
7	3	45.0	169.3	66.7
13	1	43.1	164.9	64.9
28	2	45.5	170.4	67.1
55	2	40.5	258.9	62.6
91	3	47.5	174.7	68.8
93	3	45.5	170.3	67.0
95	3	46.2	171.6	67.6
103	2	45.2	169.2	66.6
131	3	45.6	170.6	67.2
136	2	43.3	165.1	65.0
137	2	48.1	176.0	69.3
151	2	45.0	169.2	66.6
157	2	43.3	165.7	65.2
158a	2	44.1	167.4	65.9
173	2	41.5	161.2	63.6
174	1	46.1	171.4	67.5
177	1	41.7	161.2	63.5
209	1	43.9	166.2	65.4
229	1	46.6	172.5	67.9
243	1	43.2	164.3	64.7
244	1	44.6	168.2	66.2
250	1	43.2	165.3	65.1
261	1	45.1	169.4	66.7
262	1	47.1	173.8	68.4
279	1	44.0	167.2	65.8
329c	1	45.8	171.0	67.3
332	1	42.5	163.6	64.4
343	1	45.5	170.4	67.1
345	1	44.1	167.1	65.8
350	1	41.3	161.4	63.5
353	1	42.3	163.5	64.4
357	1	44.8	168.9	66.5
363a	1	42.6	163.9	64.5
367	1	43.6	166.2	65.4
369	1	42.6	164.2	64.6

TABLE 16 (Continued)

Bu. No.	Location[1]	Femur Length (cm.)	Stature (cm.)[2]	Stature (in.)[3]
372	1	46.2	171.3	67.4
397	1	44.6	168.5	66.3
400	1	43.4	165.6	65.2
411a	1	44.4	167.3	65.9
417	1	44.4	167.3	65.9
419	1	46.8	172.3	67.8
438	1	43.4	166.0	65.4
458	1	42.3	162.5	64.4
Means		44.3	167.6	66.0
S.D.		1.75	3.85	1.52

[1] 1 = village; 2 = mound; 3 = structure 3.

[2] ± 3.80 cm.

[3] ± 1.50 in.

TABLE 17

Individual and Mean Stature Estimates for the Toqua Females (N=37)

Bu. No.	Location[1]	Femur Length (cm.)	Stature (cm.)[2]	Stature (in.)[3]
9	1	42.2	158.3	62.3
77	1	38.2	148.5	58.5
82	1	39.4	151.4	59.6
94	3	40.7	154.6	60.9
132	2	40.6	154.4	60.8
135	2	42.9	160.1	63.0
150	2	45.6	166.7	65.6
165	1	41.3	156.1	61.5
166	1	42.2	158.3	62.3
167	1	39.7	152.2	59.9
187a	1	40.8	154.9	61.0
187b	1	44.4	163.8	64.5
200	1	42.1	157.9	62.2
202	1	39.6	151.9	59.8
217a	1	40.1	152.4	60.0
230a	1	40.9	154.8	60.9
236	1	43.8	162.3	63.9
277c	1	42.2	158.3	62.3
241	2	43.4	161.3	63.5
242	1	42.0	157.8	62.1
245	1	39.4	151.4	59.6
255	1	38.7	149.5	58.9
263	1	42.2	157.1	61.9
325	1	42.1	158.0	62.2
330	1	40.4	253.9	60.6
356	1	41.9	157.6	62.0
359	1	44.2	163.1	64.2
388	1	42.3	158.6	62.4
413	1	41.6	156.1	61.5
414	1	41.2	155.9	61.4
416	1	41.1	155.3	61.1
425	1	41.2	155.6	61.3
433	1	39.5	151.7	59.7
435	1	43.0	160.3	63.1
440b	1	39.1	150.7	59.3
450	1	40.3	152.7	60.1
453a	1	45.1	165.5	65.2
Mean		41.5	156.5	61.6
S.D.		1.78	4.42	1.74

[1] 1 = village; 2 = mound; 3 = structure 3.

[2] ± 3.72 cm.

[3] ± 1.46 in.

Sexual dimorphism is another obvious factor that gives rise to stature differences (Tobias 1972; Eveleth 1975; Gray and Wolfe 1980). This bias is eliminated by comparing each sex separately.

Because there is documented stature variation between different ethnic groups, it is necessary to consider two possibilities of a genetic nature that could induce differences between the two components at Toqua: (1) that one dominant group, perhaps of greater stature, intruded upon the domain of a more subordinate group thereby establishing residence and exerting control over the population; (2) that intrapopulational variability in stature may be due to assortive mating according to strict hierarchical guidelines (Hatch and Willey 1974). Regarding the first possibility, the archaeological evidence does not substantiate any major social upheavels at Toqua. As for the second possibility, if significant stature differences are demonstrated then this suggestion cannot be entirely rejected. Hatch and Willey (1974:120) note that "either possibility could be tested, however, through the examination of metric and non-metric traits other than stature within the hypothesized ethnic populations." Due to poor preservation at Toqua no non-metric traits were included for analysis and cranial measurements unaffected by deformation were few in number.

Illness is another factor that may potentially affect stature. However, unless illness is chronic during the subadult years it is suggested that some individuals will compensate for temporary growth arrests during childhood via accelerated growth periods and differences in growth potential (Hardy 1938; Prader et al. 1963).

Of primary interest in this thesis is the idea that biological

differences between social components may reflect differential dietary intakes due to differential access to certain foodstuffs. This possibility has been explored for other prehistoric populations of a ranked nature by Haviland (1967) among the Ancient Maya, Miller (1974) among Ancient Hawaiiians, and Buikstra (1976) among Hopewell people from the Gibson site located in the Lower Illinois Valley. In assessing her "dietary hypothesis," Buikstra (1976:39) states:

> High status individuals could have privileged access to food resources and hence be under less dietary stress than others in the same social unit. The effect would be apparent increased stature in persons of high rank, though the true explanation would involve the failure of low ranking individuals to attain their genetic potential. In this situation, high status individuals would not display distinctive epigenetic characters, but instead fewer signs of dietary stress, e.g. Harris Lines, dental hypoplasia.

If stature differences between components at Toqua are demonstrated, then nutrition may well play a role in explaining the differences.

Hatch and Willey (1974) and Hatch (1976) considered the inferences of stature differences between status components for the Dallas Focus as a whole, and for five Dallas sites individually. After first showing that, in general, certain high status artifacts were significantly associated with taller males but not females, they then confined their analysis to locational differences (i.e., mound versus village). Based on location, stature differences were again significant for males but not for females. When comparing male stature by location and burial accompaniments, they found that village individuals showed increasing stature with artifact status, but the mound individuals did not follow this pattern.

The present analysis considers only locational differences (i.e., mound and village). Additionally, morphological femur lengths as a measure

of stature were utilized for the status comparisons. Between status components (by sex) mean femur lengths were tested for differences by use of a t-statistic that is applicable to small, unequal sample sizes (see Sokal and Rohlf 1969:22). Means and standard deviations of femur lengths from the mound and village components at Toqua are presented in Table 18.

TABLE 18

Summary Statistics of Male and Female Femur Lengths from Mound and Village Components at Toqua

	Mound				Village			
Sex	N	Mean	S.D.	Var.	N	Mean	S.D.	Var.
Male	9	44.06	2.26	5.12	29	44.11	1.57	2.48
Female	4	43.13	2.05	4.21	32	41.32	1.69	2.87

The results from Toqua do not entirely agree with the results of Hatch and Willey (1974) or Hatch (1976). Unlike those analyses, differences in male stature at Toqua are not statistically significant ($t = 0.284$, $p > 0.05$). Consistent with the analyses of Hatch and Willey (1976) differences in female stature at Toqua were also non-significant ($t = 1.98$, $p > 0.05$).

Since the males do not exhibit significant differences in stature, it would be erroneous to assume nutritional differences between status components. On a genetic basis, one might conclude that high-status males originated from the same population as the village males. This

conclusion lends support to a hypothesis of achieved status at Toqua. In light of the high peak mound mortality between 20 and 25 years as reported in the previous chapter, one might also suggest that interment in the mounds could have resulted from status positions earned through combative or hunting prowess (see Gibson (1974) for a discussion of this idea). Of course, this does not necessarily preclude the possibility that some of the males buried in the mounds belonged to a high ranking kinship group with pre-eminent status.

Because neither males nor females were significant, it cannot be contended that females, by virtue of their sex, were more equally disadvantaged than males (see Hatch and Willey 1974:125). However, again it appears possible that females may have achieved status through marriage to high-status males. Hatch and Willey (1974:126) also note that if stature was influential for attaining status then tallness in females was not as important as other attributes. At Toqua, the same case could be made for males as well.

Stature Comparisons with the Structure 3 Individuals

In using raw femur length as a measure of stature, the mean of 45.96 cm. for the five Structure 3 adult males is larger than both the village and mound means (see Table 18). A statistical comparison with each component shows that the Structure 3 male stature differs significantly at the 0.05 level ($t = 2.53$) from village male stature but does not differ from the mound.

If status was achieved for the Structure 3 males, then tallness may have played a role in attaining a high ranking late in the Dallas occupation at Toqua.

Since there was only one adult female from Structure 3, no statistical comparisons were conducted with the mound and village females.

Cranial Deformation

A classification system of cranial deformation that is commonly utilized for North American Indians is that of Neumann (1942). Neumann (1942) considers 10 different types of deformation of both an intentional and unintentional nature.

For the Toqua series, Neumann's (1948) system was largely followed; however, only three types of deformation were evident. These were natural lambdoid, occipital, and fronto-vertico-occipital (hereafter designated F-O) (Figures 13-18). According to Neumann (1942:308), occipital deformation "is probably unintentional, often markedly asymmetrical, and generally does not involve the frontal bone." Because lambdoid deformation also appears to be unintentional at Toqua, F-O deformation stands as the only intentional type found at the site.

Clues pertaining to exactly how deformation was accomplished among prehistoric groups of the Southeast can be found in Swanton's (1946) and Adair's (1775) ethnographic accounts of early historic Southeastern groups. For example, Adair (1775:9-10) notes:

> . . . to effect this, fix the tender infant on a kind of cradle, where his feet are tilted, about a foot higher than a horizontal position . . . his head bends back into a hole, made on purpose to receive it, where he bears the chief part of his weight on the crown of the head, upon a small bag of sand, without being in the least able to move himself. The skull resembling a fine cartilaginous substance, in its infant state, is capable of taking any impression. By this pressure, and their thus flattening the crown of the head, they consequently make their heads thick and their faces broad . . .

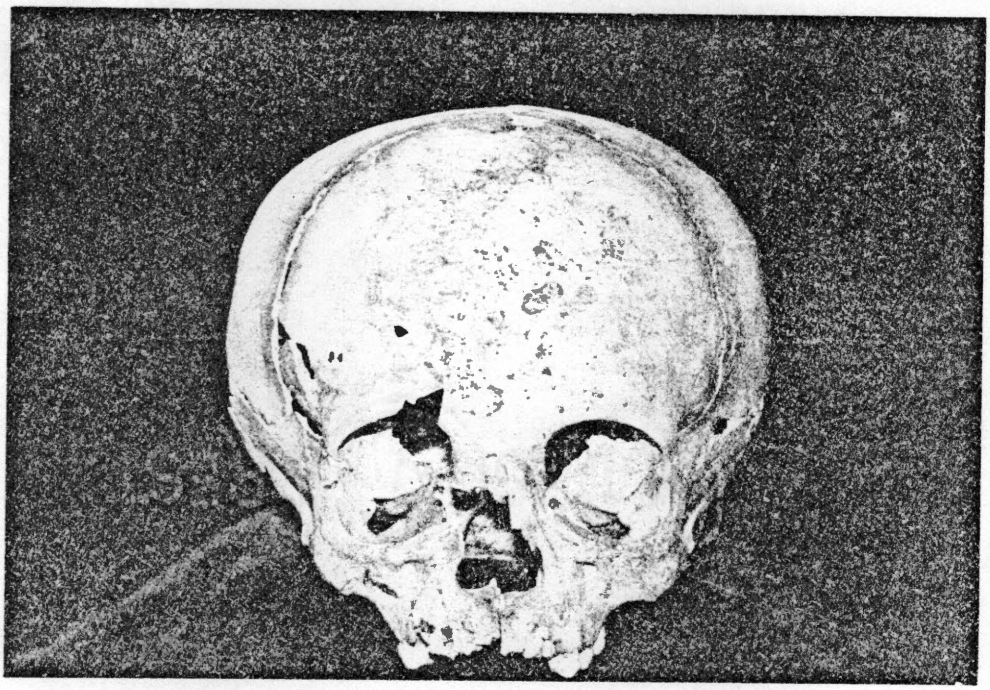

Figure 13. Frontal view of cranium of Bu. 446A (5-7 years) showing F-O deformation. (Note the "coronal saddle" anterior to the coronal suture.)

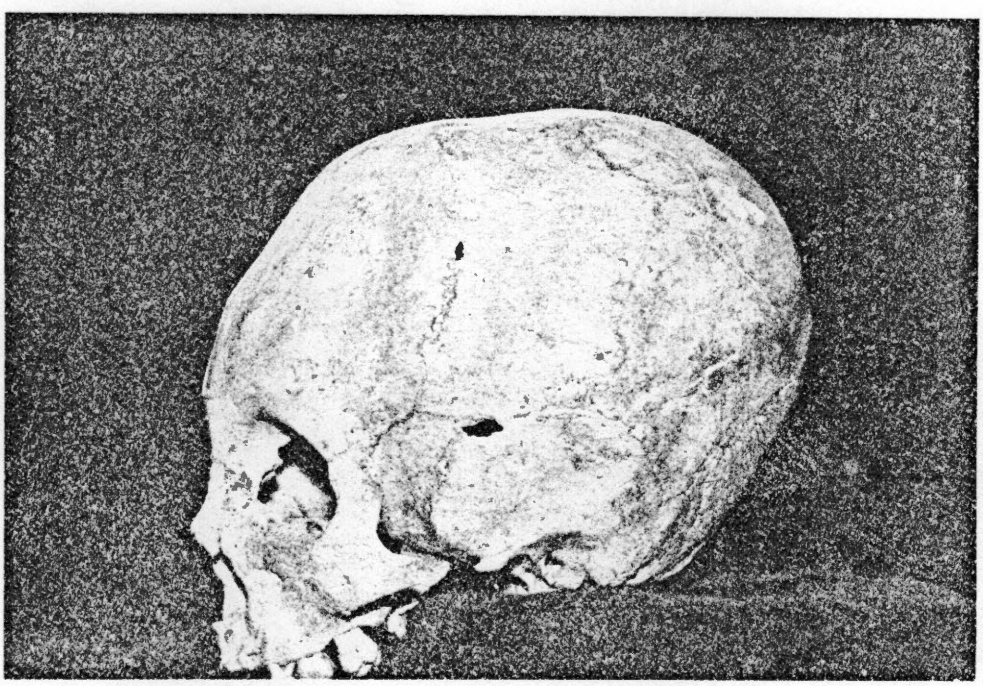

Figure 14. Lateral view of cranium of Bu. 446A showing F-O deformation.

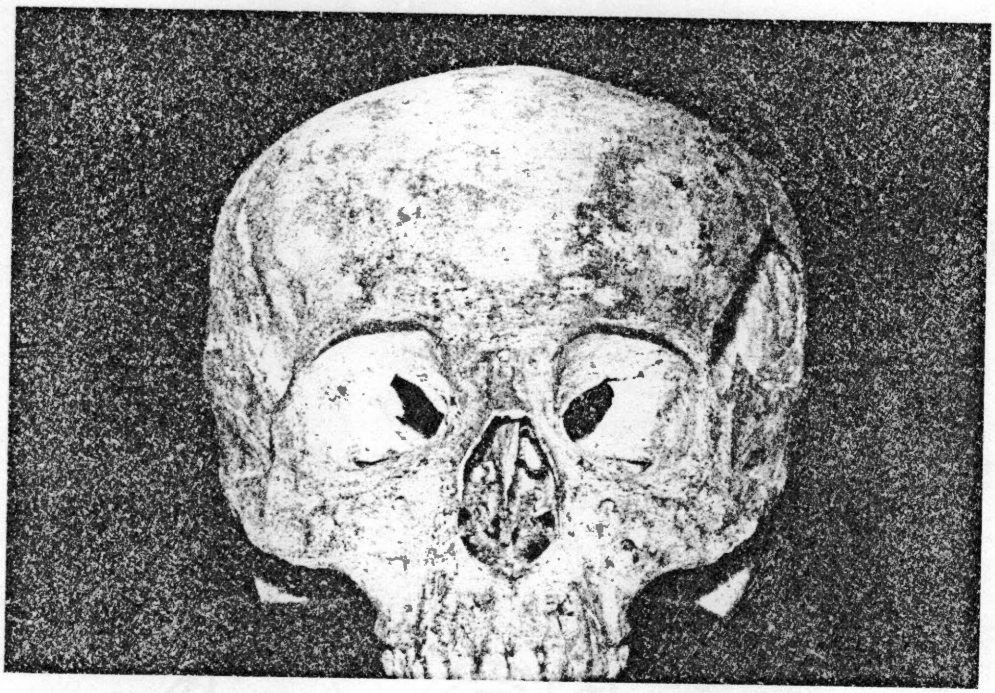

Figure 15. Frontal view of occipitally deformed cranium of Bu. 093 (adult male).

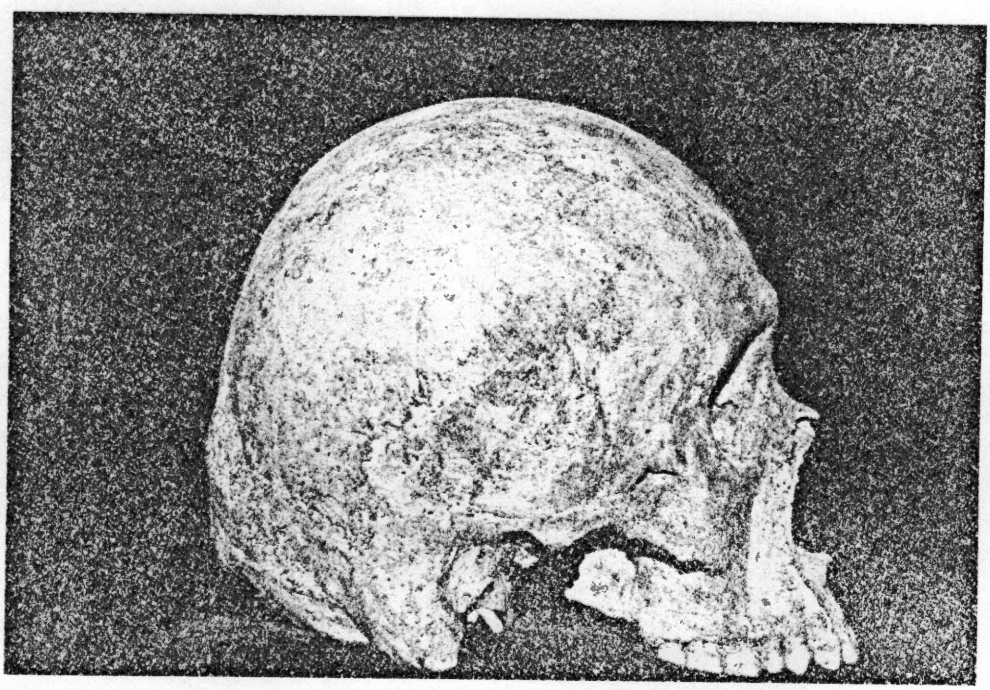

Figure 16. Lateral view of cranium of Bu. 093 showing occipital deformation.

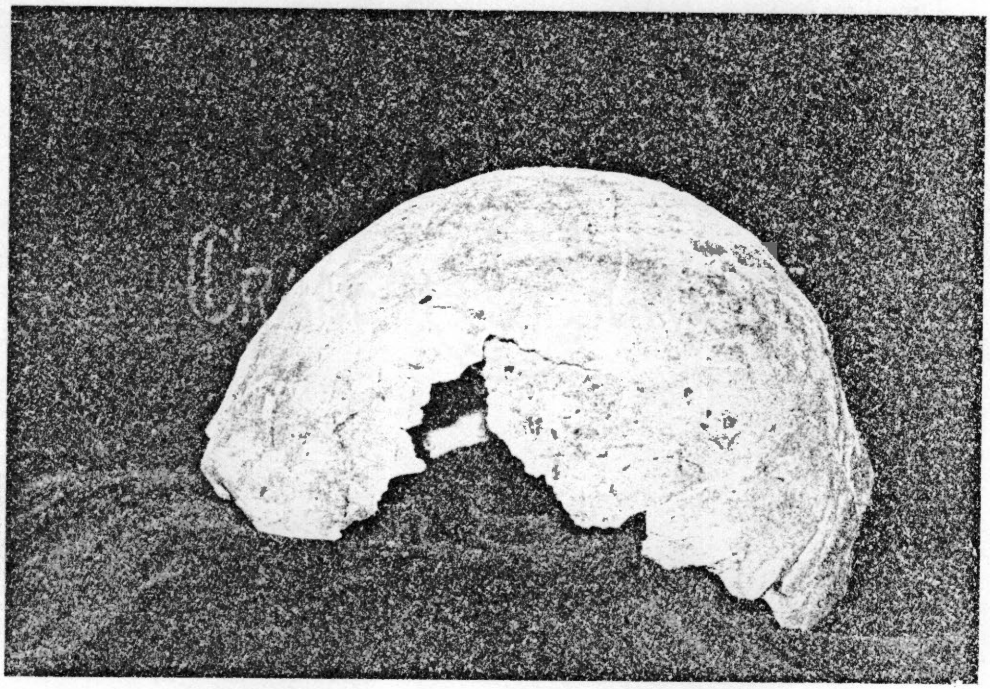

Figure 17. Lateral view of calotte of Bu. 411A (adult male) showing lambdoid flattening.

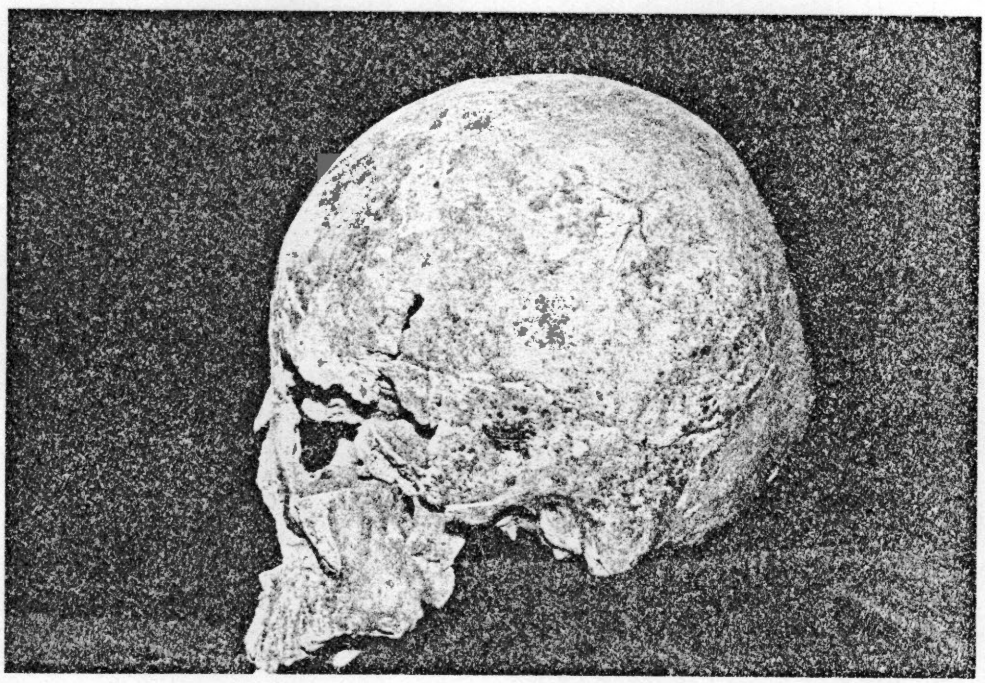

Figure 18. Lateral view of cranium of Bu. 008A (adult female) showing lambdoid flattening.

This passage and others described in Swanton (1946) are undoubtedly referring to what Neumann (1942) called fronto-parieto-occipital deformation. Although intentional deformation at Toqua did not include parietal flattening, the methodology was probably similar. Interestingly, several of the Toqua infant burials contained rectangular clay "pallets" and at least one burial included two, one being about twice the size of the other. This evidence suggests that at least some of the individuals were deformed by a "free board" technique (Richard Polhemus, personal communication). Otherwise, occipital flattening was probably achieved by resting on a cradleboard, and frontal flattening was completed by placing a board transversely across the forehead, then affixing it to the cradleboard with rope or leather thongs.

Loveland (1980:118) notes a variant of this configuration in which a "saddle" or ridge is formed just anterior to the coronal suture. Swanton (1946) makes reference to inducing more pronounced frontal flattening by placing bags of sand or clay beneath the board. This additional pressure interacting with growth along the coronal suture likely gave rise to this curious configuration found predominantly among children at Toqua.

In addition to how deformation was accomplished, one might also wonder about the timing and duration that the deforming devices were applied. Most sources (e.g., Adair 1775; Swanton 1946) simply state that the devices were applied during infancy and then left in place until a permanent configuration was achieved. In a translated version of Relacion de las Cosas de Yucatan (1941:125), Bishop Landa, the great chronicler of the Yucatan Maya, provides more definitive clues as follows:

> . . . since four or five days after the infant was born, they placed it stretched out upon a little bed, made of osier and reeds; and there with its face upwards, and they put its head between two small boards one on the back of the head and the other on the forehead, between which they compressed it tightly, and here they kept it suffering until at the end of several days, the head remained flat and molded as was the custom of all of them.

Table 19 provides frequencies and percentages of the types of deformation observed at Toqua. For both sexes F-O deformation is by far the most abundant category. A X^2 test of significance shows that there is no difference between males and females at the 0.05 level ($X^2 = 2.31$).

TABLE 19

Frequencies and Percentages of Cranial Deformation for Males, Females, and Unsexed Individuals at Toqua (Total Sample)

Deformation Type	Males		Females		Unsexed		Combined Sexes	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Undeformed	10	17.9	13	22.8	5	13.2	28	18.5
Occipital	13	23.2	8	14.0	6	15.8	27	17.9
Lambdoid	8	14.3	6	10.5	1	2.6	15	9.9
F-O	25	44.6	30	52.6	26	68.4	81	53.6
Totals	56	37.1	57	37.7	38	25.2	151	--
% Deformed		82.14		77.19			81.46	

Lewis and Kneberg (1946:163) presented the following comparative information for intentional cranial deformation among the Dallas component at Hiwassee Island:

> Moderate asymmetrical deformation, mainly of the posterior portion of the cranium, is frequent. This does not seem to be

> intentional and we feel justified in concluding that the Dallas people rarely if ever practiced intentional deformation as did the Waxhaws, Chickasaws, Choctaws and Natchez. The few cases of extreme deformation may be attributed to incorporation of individuals from other ethnic groups.

In view of the evidence from Toqua, this conclusion is conspicuous, to say the least. One might expect to find intentional deformation to be an ubiquitous cultural practice among all Dallas sites. Future analyses should determine whether this hypothesis is supported or rejected.

Cranial Deformation and Status at Toqua

Studies attempting to compare cranial deformation and status are sparse in the literature. Hooton (1930:34) entertained this possibility in Indians of the Pecos Pueblo but never followed up on the idea with testing (Cassells 1972:90). More recently, Cassells (1972) tested this hypothesis at the Grasshopper site, a 14th century "Late Mongollon" ruin in east-central Arizona. His results showed that there were no differences between status groups. Guagliardo (n.d.) observed frequencies of deformed crania in a sample consisting of three Dallas sites (Hiwassee Island, DeArmond, Hixon) and found that lower status adults were more frequently deformed than high status adults when burial location was considered.

Table 20 presents mound and village frequencies and percentages for the respective deformation categories at Toqua. No differences between sexes were observed so they were combined in testing the two components. The results indicate that 41.2% of the mound burials were undeformed versus 17.1% for the village. If we consider the occipital

TABLE 20

Frequencies and Percentages of Cranial Deformation for Combined Sexes in Mound and Village Components at Toqua

Deformation Type	Mound		Village		Totals	
	Freq.	%	Freq.	%	Freq.	%
Undeformed	7	41.2	21	17.1	28	20.0
Occipital	6	35.3	20	16.3	26	18.6
Lambdoid	2	11.8	13	10.6	15	10.7
F-0	2	11.8	69	56.1	71	50.7
Totals	17	12.1	123	87.9	140	--

and lambdoid types to be unintentionally deformed, the combined percentage of 47.1% for the mound component compares with 26.8% for the village. The greatest disparity is evident in the F-0 category where 11.8% of the mound burials compares with 56.1% for the village. A X^2 test between components reveals that these differences are significant at the 0.05 level ($X^2 = 13.05$).

It is difficult to find references in the literature regarding a motive behind the intentional deformation of skulls. However, those that mention this presume that it was practiced for cosmetic purposes (e.g., see Morley 1956:163; Loveland 1980:120). At Toqua it could be inferred that high-status individuals did not view this cultural practice in the same manner as low-status individuals. Although not completely absent from mound individuals, the extremely low frequency could possibly be construed as indicative of ascribed status. If F-0 deformation was a

mark of lower status then one might expect higher frequencies in the mound component resulting from achieved status.

Cranial Deformation Among the Structure 3 Individuals

Of the 15 individuals from Structure 3, it was possible to determine cranial deformation on 10 of the skulls. All 10 were characterized by F-O deformation. On this basis they conform more closely to the pattern of deformation for the village component. If the Structure 3 individuals are considered to be a high-status group from the end of Dallas occupation at Toqua, then it is likely that status was achieved for these individuals rather than ascribed.

CHAPTER 4

PALEOPATHOLOGY AT TOQUA

Introduction

In a recent article Mensforth et al. (1978:2) state:

> The study of human paleopathology is concerned with disease process as a selective agent in the evolutionary history of our species. As an evolutionary biologist, the paleopathologist attempts to describe, to classify, and to interpret the epidemiological parameters of disease in human populations. The objectives of such studies should be twofold: first, to employ disease patterns to evaluate the relative fitness of a human population under stress; and second, to analyze the interactions among cultural, biological and environmental components of disease process as they contribute to the nature and scope of human variation.

Because many diseases are not manifested on bones, and because those that are often produce lesions similar in appearance (Brothwell 1972; Morse 1969), the approach to paleopathological analysis offered above is essential and necessary for the proper assessment of disease patterns among large prehistoric skeletal populations. Despite archeological problems such as differential preservation or unbalanced sampling within a site, this epidemiological approach with disease viewed as the interaction between biological, cultural, and environmental factors leads to the generation of important statements regarding general and specific health/disease states of prehistoric peoples (Kunitz and Euler 1972; Mensforth et al. 1978). As Rathbun et al. (1980:52) note, "It is increasingly important to attempt to evaluate the general

health/disease patterns of past populations rather than emphasizing single traits."

In the same vein as Mensforth et al. (1978:3) who examined "the synergistic interaction between nutritional deficiency and infectious disease," nutritional stress is a primary topic of consideration for the Toqua population, especially in relation to status. Although different variables are examined, this is essentially an extension of Buikstra's (1976:39) "dietary hypothesis" whereby differential access to foodstuffs may be reflected in the incidence of disease patterns among different societal components.

In his analysis of the Toqua faunal remains, Bogan (1980) extended one of Peebles and Kus' (1977) archaeological correlates of mortuary patterning to include the availability of animal protein and the distribution of certain animals in specific areas of the site. Although Bogan's (1980) high-status locations included sections of the village area as well as Mound A, there appeared to be a preference for the front leg and haunch of deer in these areas. Other mammals such as bear, raccoon, and beaver followed a similar pattern in terms of distribution. Turkey, waterfowl, and preferences for certain types of fishes (e.g., suckers) and turtles (e.g., box turtles) were also noted in greater numbers in high-status areas. Sources of animal protein in the low-status areas included "less desirable pieces (body sections with less meat)" of deer in addition to fewer percentages of the other mammals, and differeent preferences of fish, turtles, etc. (Bogan 1980:136).

On the basis of the mound/village dichotomy for status as established earlier in this report, it is difficult to categorically

state that high-status individuals at all times had access to protein-rich food sources. However, since it is generally accepted that Toqua was heavily dependent upon maize as its major food staple, one might speculate that high-status individuals could have had more consistent access to protein-rich foods, rather than an occasional supplementation in a maize-rich diet as suggested for low-status inhabitants. On the other hand, Chapple (1977:134), in response to similar assumptions among other prehistoric American populations, states:

> This approach is perfectly natural as a point of departure. Necessarily, however, it requires us to assume that . . . postulated cultures represented some kind of continuity to the ethnographic present--more complex perhaps, as evidenced in their mound construction, but relatively homologous just the same. Generalizations in regard to hierarchical differentiation provide no rebuttal to the criticisms that a Hindu anthropologist might make as he or she referred, for example, to the towering structures of taboos affecting diet and nutrition which are incorporated within what is superficially called the caste system. Whereas the present authors argue that dietary sufficiency would occur maximally in the highest rank of the postulated hierarchical order, our Hindu opponent would maintain the contrary argument by pointing out that the best diets, and by far the greatest physical development, are to be found in some, but by no means all, outcaste groups.

Insofar as this "dietary hypothesis" has potential limitations, statistical testing of certain paleopathological variables, if significant, may nonetheless support this contention. If insignificant associations are demonstrated then the hypothesis may be rejected either on the grounds that differential access to food sources did not play a major role in the incidence of certain diseases between societal components, or that the assumptions upon which the hypothesis is predicated are indeed faulty.

With this hypothesis in mind, paleopathological analyses for the Toqua skeletal series are based on the perspective established by Mensforth et al. (1978), particularly with respect to porotic hyperostosis and periosteal reactions. Additionally, other skeletal pathologies are considered; however, they are approached largely from a descriptive viewpoint. It must also be noted that, with the exception of porotic hyperostosis, primary causes of pathologies and incidences of specific diseases will not be discussed. The rationale for these omissions is aptly voiced by Ubelaker (1978:77):

> We should reserve such judgments to the relatively few persons qualified to make them because of their thorough knowledge of the disease process and its effect on bone. These individuals do not include all pathologists, and certainly not all physical anthropologists.

Porotic Hyperostosis

Description

According to Angel (1966, 1967), porotic hyperostosis is a descriptive term that refers to lesions occurring on the cranial vault, the eye orbit and, to a lesser degree, the sphenoid and temporals. El-Najjar et al. (1976:477) note that the lesions are manifested as a "widening of the diploe, thinning of the outer table, and the presence of small apertures, giving a coral or sieve-like appearance to the bone." By radiographic examination, Moseley (1965, 1966) has described the diploe as having a "hair-on-end" appearance. More severe manifestations of the lesions have been described by Mensforth et al. (1978:4) as displaying "a symmetrical 'spongy bone' appearance which is due to excessive tissue hypertrophy and obliteration of the outer table." (Figures 19-22.)

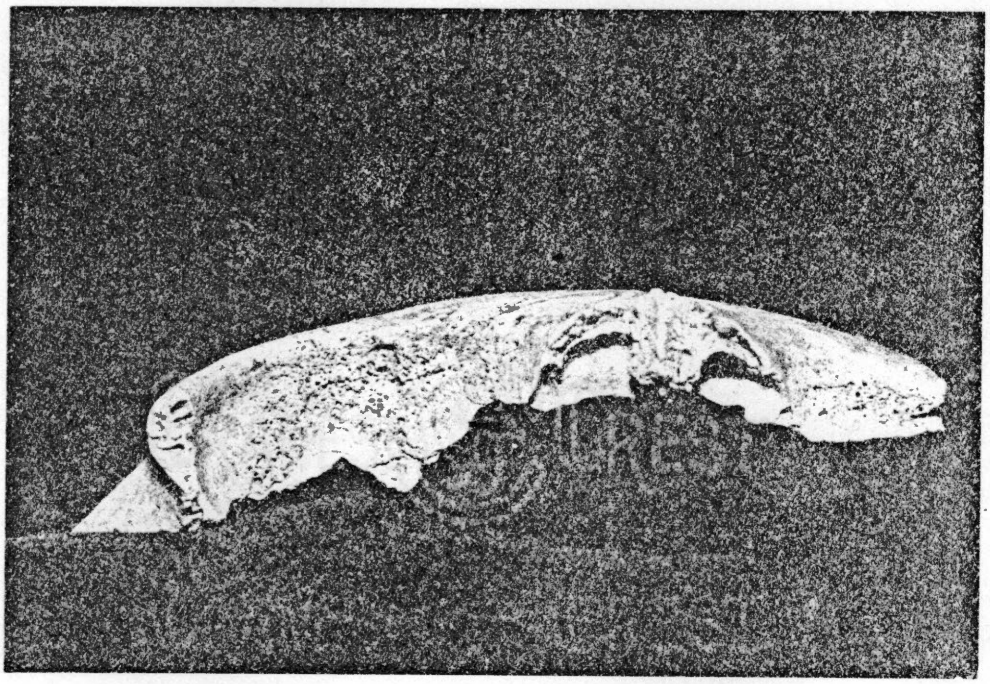

Figure 19. Right orbit of Bu. 106 (juvenile female) showing cribra orbitalia.

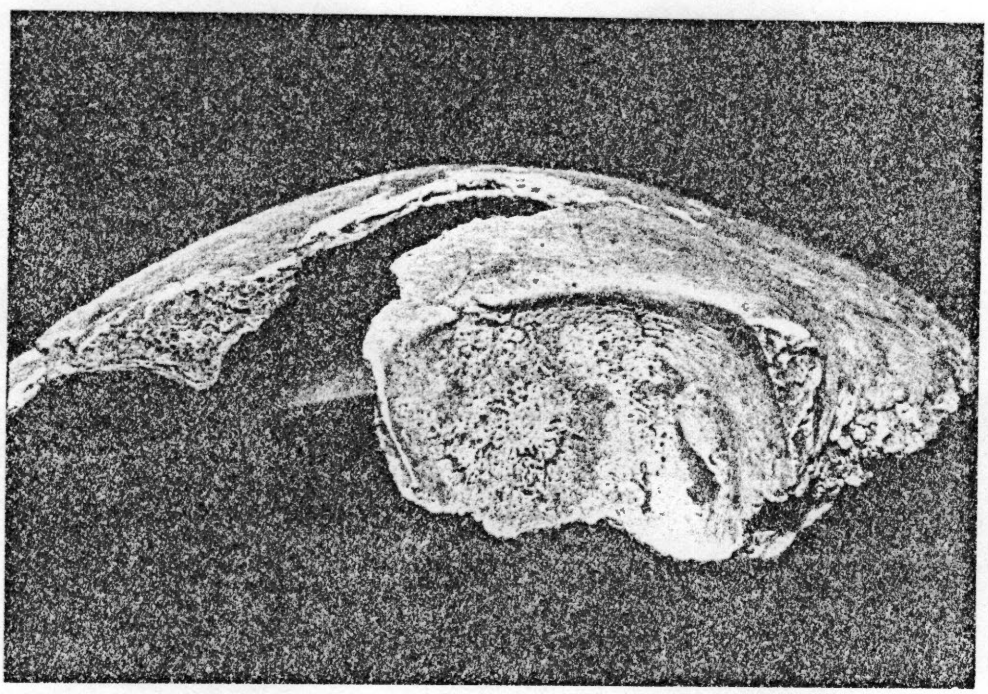

Figure 20. Left orbit of Bu. 127 (3-5 years) exhibiting advanced cribra orbitalia.

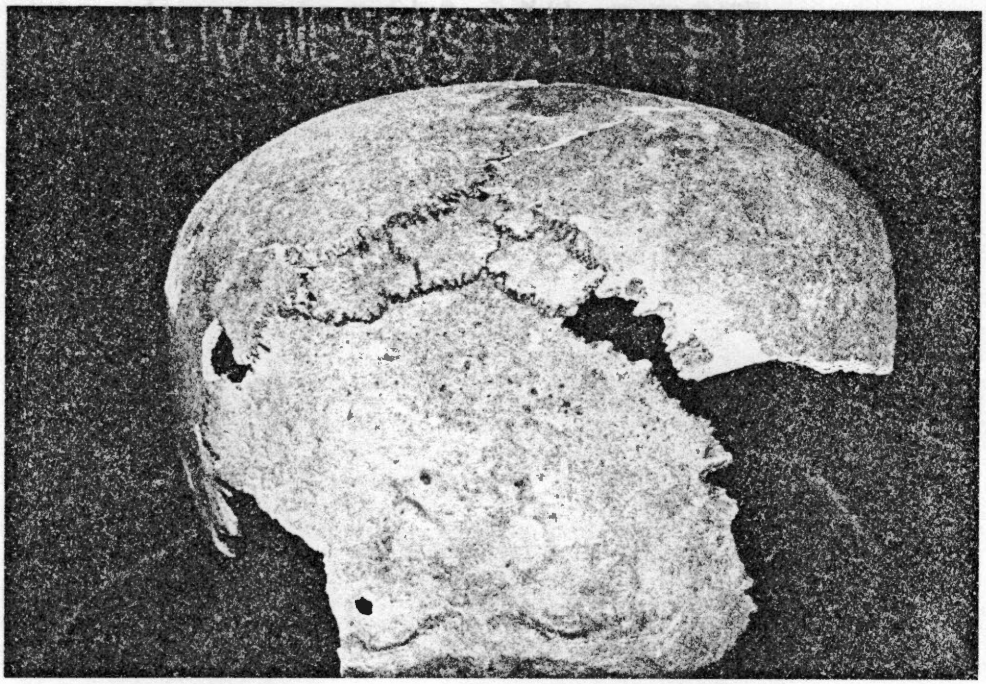

Figure 21. Posterior view of cranium of Bu. 012 (6-8 years) showing pitting indicative of calvarial porotic hyperostosis.

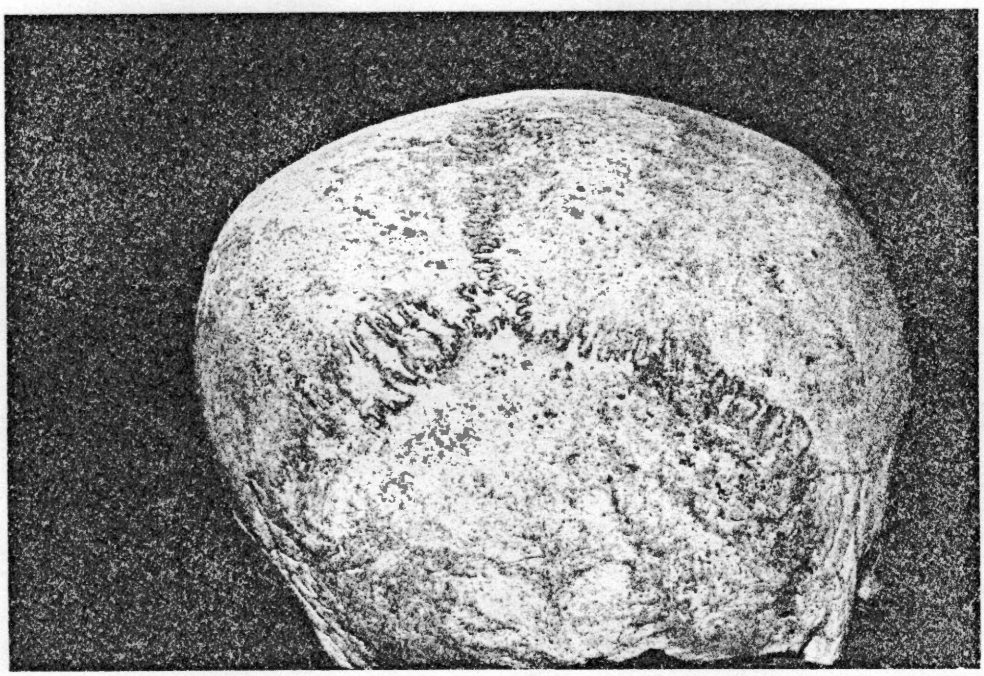

Figure 22. Posterior view of cranium of Bu. 094 (female adult) showing osteoporotic pitting.

Since 1885, when Welker first used the term cribra orbitalia to describe lesions occurring on the superior walls of the eye orbits (Angel 1967; El-Najjar 1976; Lallo et al. 1977), the nomenclature of this pathology has received numerous designations in the literature. In addition to cribra orbitalia, the lesions have been called cribra cranii (Henschen 1961), hyperostosis spongiosa or spongy hyperostosis (Hamperl and Weiss 1955), osteoporosis symmetrica or symmetrical osteoporosis (Hrdlicka 1914), and, of course, porotic hyperostosis (Angel 1966, 1967). More recently Carlson et al. (1974) took the general term porotic hyperostosis and broke it down into osteoporotic pitting, spongy hyperostosis, and cribra orbitalia.

The idea of observing different lesions independently has merit, particularly with respect to their location on the cranium. Ortner and Putschar (1981:258) note that "the relationship between the calvarial and orbital lesions has never been clear." One may often find both types of lesions occurring on the same skull; however, it is not that unusual to find them occurring independent of one another (Ortner and Putschar 1981:259).

For the Toqua population a test of association was performed between cribra orbitalia and calvarial porotic hyperostosis. Table 21 presents a two-by-two contingency table of these frequencies. Although the phi coefficient (0.458) is positive and significant, it it not strong enough to warrant lumping the two for further testing between other demographic parameters. Despite their apparent independence as far as occurrence is concerned, it will be seen below that the two result via the same process.

TABLE 21

Mutual Occurrence of Cribra Orbitalia and Calvarial Porotic Hyperostosis for the Toqua Skeletal Series

Category	Frequency with Calvarial Porotic Hyperostosis	Frequency without Calvarial Porotic Hyperostosis	Totals
Frequency with cribra orbitalia	63	12	75
Frequency without cribra orbitalia	27	41	68
Totals	90	53	143*

*Phi coefficient = 0.458 (see Thomas 1976:419-423).

Etiology

Although several disease states have been suggested as causes for porotic hyperostosis in general (see Steinbock 1976:219) and cribra orbitalia specifically (see Steinbock 1976:243-248), two hypotheses regarding the origin of these pathological manifestations have received the most attention in the literature. The first states that the causal factor is some form of hemolytic anemia such as sicklemia or any of the thalassemias (e.g., Zaino 1964, 1967). This hypothesis seems to hold true for the Old World. However, at this time there is no reason to suggest that the hemolytic anemias are responsible for the pathology in the New World. Angel (1966) notes that malaria and associated genetic polymorphisms such as sicklemia, the thalassemias, and G6PD were confined to an Old World distribution during pre-Columbian times. Furthermore, Livingstone's (1967) work among several modern Amerindian populations showed few cases of abnormal hemoglobins, especially thalassemia, and

deduced that the few that were present resulted from recent admixture of immigrant populations (Steinbock 1976).

The second hypothesis proposes that the cause of this pathology is nutritional deficiency (Henschen 1961; Nathan and Haas 1966). This view is supported by a number of workers who are convinced that the deficient nutrient is iron (e.g., Moseley 1966; Hengen 1971; Carlson et al. 1974; El-Najjar et al. 1975, 1976; El-Najjar and Robertson 1976). Among modern populations the world over, iron-deficiency anemia is the most common nutritional deficiency (Davidson and Passmore 1969).

For prehistoric Amerindian populations it has been demonstrated that chronic iron-deficiency anemia is a result of intense maize consumption. For example, El-Najjar et al. (1975, 1976) showed an incidence of porotic hyperostosis as high as 82% among prehistoric Anasazi Indian children of the American Southwest. In addition, they revealed regional differences in the Southwest in which a higher frequency of the pathology occurred among canyon dwelling inhabitants who relied on maize more intensely for consumption than the sage plain inhabitants who exploited a more variable environment for subsistence. El-Najjar (1976) expanded his study to include seven distinct geographical areas of the Americas and demonstrated a remarkably significant difference between maize-dependent localities and other areas where less or no maize was consumed by the inhabitants. Recently Lallo et al. (1977) observed frequencies of porotic hyperostosis through time in the Dickson Mound populations. They proposed that an increase in maize agriculture would be reflected by a concomitant increase in the pathology. Beginning with Late Woodland, and progressing to Mississippian Acculturated Late Woodland to Middle

Mississippian, the frequencies increased, thus supporting their hypothesis. In Mexico and Guatemala where it is known that the Maya depended heavily on maize for subsistence, Saul (1972) showed a relatively high incidence of the pathology (36% of 90 individuals including adults) at Altár de Sacrificios. Earlier, Hooten (1930) noted that 66% of the children from the Sacred Cenote at Chichén Itzá exhibited some degree of porotic hyperostosis. These studies overwhelmingly support the contention that maize consumption in the New World produces iron-deficiency anemia as manifested by high frequencies of porotic hyperostosis.

The manner in which iron-deficiency anemia physiologically affects an organism must be understood in terms of the absorbability and bioavailability of iron. Anatomically, iron absorption occurs primarily in the duodenum and the upper small intestine. A neonate is born with an excess of red blood cells which store iron. These stores are exhausted by about the fourth month of life, after which iron requirements must be met entirely by diet. Iron requirements amount to approximately 0.5mg per day early in life and then decrease to around 0.2mg per day in later childhood. A subsequent increase of 0.5mg to 1.0mg per day occurs during adolescence (Finch 1976).

For infants and children a particular syndrome called hypochromic microcytic iron-deficiency anemia is primarily affected by the rate of growth and other constitutional factors such as iron stores at birth and birthweight (Mensforth et al. 1978). It is no surprise that premature and low birthweight infants contract anemia at earlier ages (Schulman 1959). Also, during the weaning process "a prolonged dependence on foods low in bioavailable iron such as milk, unfortified cereals and

carbohydrates" in conjunction with respiratory and gastrointestinal infections (i.e., parasitic) can greatly affect the bioavailability of iron (Mensforth et al. 1978:16). In this way chronic diarrhea limits the time that bioavailable iron remains in the gastrointestinal tract (Conrad 1970).

For adolescent females the onset of menstruation and subsequent pregnancies may induce inordinate blood loss. Not only does this affect the bioavailability of iron but it also reduces the overall fitness of the host thereby making her more susceptible to other infectious diseases (Mensforth et al. 1978).

Regarding dietary deficiency specifically, the bioavailability of iron in maize is influenced by several factors. One of these is phytic acid which binds iron at the molecular level thus rendering it nutritionally useless. This operates due to the deficiency of phytase in maize, an enzyme that reduces the effect of phytic acid (Finch 1976). Two other factors that influence the bioavailability of iron in maize are excess calcium and phosphates (Cravioto et al. 1945; Wintrobe 1967; Conrad 1970). Cravioto et al. (1945) examined a common method of preparing tortillas in which they are treated with lime. These researchers found an extraordinary increase in calcium as well as phosphorous in the tortillas. El-Najjar and Robertson (1976) also note that maize is deficient in the essential amino acids lysine and tryptophan, both of which enhance iron absorbability. Several studies (Layrisse et al. 1968; Martinez-Torres and Layrisse 1971) have shown that meat is much more conducive to iron absorption than are other vegetable food items. One study by Layrisse et al. (1968) demonstrated that a diet of corn

combined with veal produced a decreased level of iron absorption than did a diet consisting of only veal. This suggests that a population that is able to obtain some meat yet still relies heavily on maize for subsistence would be affected by iron-deficiency anemia and ultimately produce relatively high frequencies of porotic hyperostosis. By the same token, one might extend this idea for its implications to different segments of the same population.

Methodology

All crania were macroscopically examined for cribra orbitalia and calvarial porotic hyperostosis. Determination of presence or absence of the lesions was based on the aforementioned descriptions; however, degrees of severity were not coded. Additionally, there was no distinction made between healed and unhealed lesions. Osteoporosis of the skeleton may also occur in a senescent state but Jaffe (1972:367) notes that "even when the involvement of the skeleton is extensive, the calvarium usually shows little if any evidence of osteoporosis."

The rapid rate of growth coupled with anemic stress due to acute and chronic diarrhea among infants and children induces heavy demands for bioavailable iron (Conrad 1970; Mensforth et al. 1978), and higher frequencies of porotic hyperostosis are expected for young individuals (El-Najjar et al. 1975, 1976; Lallo et al. 1977; Mensforth et al. 1978). For this reason, age-related analyses for the Toqua series were approached in two ways. First, the sample was divided into an under-10 age group and a 10-plus age group. These two categories were then compared for incidences of cribra orbitalia and calvarial porotic hyperostosis by use of a X^2 statistic (Thomas 1976:264-279). Second, in order to obtain a

better idea of the incidence of the pathologies among the younger individuals, three age classes were compared. These age classes are 0-1 year, 1-5 years, and 5-10 years. The age classes were then statistically tested for differences by a X^2 statistic using Yate's Correction for Continuity (Thomas 1976:279-282). The correction is applicable when the total sample size is greater than 40, but also when the smallest cell size is less than 10 (Thomas 1976:298).

In order to remove the potential age bias, distinctions according to sex excluded any sexed individuals under 10 years of age. The total site analysis for each pathology according to sex was tested by the X^2 statistic. Comparisons between sexes in the mound component utilized a statistic known as Fisher's Exact (Thomas 1976:291-297). This test is necessary when the total sample size is less than 20, or when the sample size is between 20 and 40 and the smallest cell size is less than five (Thomas 1976:298).

Comparisons according to status were based on the mound village dichotomy. The two components were analyzed by sex for the individual lesions. Again, individuals under 10 years of age were omitted. For the same reasons stated above, X^2 using Yate's Correction for Continuity was employed for testing differences between the two components.

Total Series Incidence of Porotic Hyperostosis

Out of 168 diagnostic individuals, 50.0% exhibited some degree of cribra orbitalia (Table 22). In contrast, 64.6% of 192 diagnostic individuals exhibited calvarial porotic hyperostosis (Table 23). On a population basis both of these relatively high frequencies attest to probable endemic proportions of iron-deficiency anemia at the site. One

TABLE 22

Frequencies, Percentages and X^2 Values of Cribra Orbitalia for Demographic and Social Categories at Toqua

Category	N	Frequency Without	Percentage Without	Frequency With	Percentage With	X^2
Total site	168	84	50.0	84	50.0	--
Age (Total site)						
<10 years (0-1	31	3	9.7	28	90.3	
(1-5	26	8	30.8	18	69.2	
(5-10	14	5	35.7	9	64.3	37.10*
10+	97	68	70.1	29	29.9	
Sex (Total sample)[1]						
Male	52	30	57.3	22	42.3	8.23*
Female	45	38	84.4	7	15.6	
Sex (Village)[1]						
Male	37	19	51.4	18	48.6	7.31*
Female	37	30	81.1	7	18.9	
Sex (Mound)[1,2]						
Male	10	6	60.0	4	40.0	0.09[3]
Female	7	7	100.0	0	0.0	
Status (Males)[1,2]						
Mound	10	6	60.0	4	40.0	0.02[4]
Village	37	19	51.4	18	48.6	
Status (Females)[1,2]						
Mound	7	7	100.0	0	0.0	0.48[4]
Village	37	30	81.1	7	18.9	

[1]Does not include sexed individuals under 10 years of age.

[2]Does not include Structure 3 individuals.

[3]Not significant at $p < 0.25$ per Fisher's Exact.

[4]Not significant at $p < 0.05$ per Yate's Correction for Continuity.

*Significant at $p < 0.01$ where $X^2 = 6.64$.

TABLE 23

Frequencies, Percentages and X^2 Values of Calvarial Porotic Hyperostosis for Demographic and Social Categories at Toqua

Category	N	Frequency Without	Percentage Without	Frequency With	Percentage With	X^2
Total site	192	68	35.4	124	64.6	--
Age (Total site)						
<10 years (0-1	43	1	2.3	42	97.7	
<10 years (1-5	28	8	28.6	20	71.4	31.38*
<10 years (5-10	15	3	20.0	12	80.0	
10+	106	56	52.8	50	47.7	
Sex (Total sample)[1]						
Male	53	21	39.6	32	60.4	7.63*
Female	51	29	56.9	14	27.5	
Sex (Village)[1]						
Male	38	15	39.5	23	60.5	6.35**
Female	43	29	67.4	14	32.6	
Sex (Mound)[1,2]						
Male	9	5	55.6	4	44.4	0.88[3]
Female	7	5	71.4	2	28.6	
Status (Males)[1,2]						
Mound	9	5	55.6	4	44.4	0.03[4]
Village	38	15	39.5	23	60.5	
Status (Females)[1,2]						
Mound	7	5	71.4	2	28.6	0.05[4]
Village	43	29	67.4	14	32.6	

[1]Does not include sexed individuals under 10 years of age.

[2]Does not include Structure 3 individuals.

[3]Not significant at $p < 0.25$ per Fisher's Exact.

[4]Not significant at $p < 0.05$ per Yate's Correction for Continuity.

*Significant at $p < 0.01$ where $X^2 = 6.64$.

**Significant at $p < 0.025$ where $X^2 = 5.02$.

might expect a heavy reliance on maize for subsistence at Toqua, and the paleoethnobotanical findings certainly bear this out (Andrea Shea, personal communication). This is also supported by botanical evidence at other Dallas sites. For instance, Lewis and Kneberg (1946) reported an abundance of charred and uncharred corn cobs in the Dallas component at Hiwassee Island.

Porotic Hyperostosis and Age

The frequency of cribra orbitalia for the under-10 age group is 77.5% as compared with 29.9% for the 10-plus age group (Table 22). Calvarial porotic hyperostosis shows a frequency of 86.0% for the under-10 group and 47.2% for the 10-plus group (Table 23). Between age groups both types of lesions are highly significant ($p < 0.01$). Higher frequencies among the younger individuals are expected due to their increased susceptibility to iron-deficiency anemia.

Age-specific distributions for cribra orbitalia among infants and children (Table 22) show that 90.3% in the 0-1 age category exhibited this pathology. The rate decreases to 69.2% and 64.3% in the 1-5 and 5-10 categories, respectively. Calvarial porotic hyperostosis (Table 23) is noted in virtually all of the infants (97.7%), then decreases to 71.4% in the 1-5 age category. Unlike cribra orbitalia, calvarial porotic hyperostosis increases to 80.0% in the 5-10 year category. Despite this variation, both lesions show the same pattern when age categories are statistically tested for differences (Table 24). The 0-1 age category differs significantly from both the 1-5 and 5-10 categories. There are no statistical differences betwen the 1-5 and 5-10 age groups.

TABLE 24

X^2 Values Using Yate's Correction for Continuity for the Age-Specific Distribution of Cribra Orbitalia (Above the Diagonal) and Calvarial Porotic Hyperostosis (Below the Diagonal)

Age	0-1	1-5	5-10
0-1	--	5.51*	6.43**
1-5	13.06**	--	0.45
5-10	8.51**	0.06	--

*Significant at $p < 0.25$ where $X^2 = 5.02$.

**Significant at $p < 0.01$ where $X^2 = 6.64$.

These findings are somewhat similar to the results of Lallo et al. (1977) for the Dickson Mound population and Mensforth et al. (1978) for the Libben population, although in both of those studies the age groups were set up differently. The Toqua results, nevertheless, provide further evidence of the impact of iron-deficiency anemia on morbidity and mortality among infants and children in sedentary prehistoric Amerindian populations.

Porotic Hyperostosis and Sex

The total sample incidence of cribra orbitalia for males and females is 42.3% and 15.6%, respectively. For the village component the male rate of 48.6% compares with 15.6% for females (Table 22). Interestingly, these differences are statistically significant at the 0.01 level. Although 40.0% of the males in the mound component overshadows the total absence of cribra among females, this difference cannot

be statistically demonstrated (Table 22). The same pattern of occurrence for calvarial porotic hyperostosis is seen for the total sample (60.4% for males; 27.5% for females) and for the village component (60.5% for males; 32.6% for females), Table 23.

Why females show lower frequencies of these pathologies than do males is extremely problematical, especially when menstrual and obstetrical blood loss is considered. The only plausible solution is the evidence presented by several studies which suggest that females resist nutritional stress better than males (Greulich 1951; Greulich et al. 1953; Stini 1972).

Porotic Hyperostosis and Status

The incidence of cribra orbitalia for mound males is 40.0% as compared with 48.6% for village males (Table 22). Mound females show a frequency of 0.0% versus 18.9% for village females (Table 22). Calvarial porotic hyperostosis shows a rate of 44.4% for mound males as compared with 60.5% for village males (Table 23). The incidence for mound females is 28.6% versus 32.6% for village females (Table 23).

Not one of the four comparisons is statistically significant even at the 0.05 level using X^2 with Yate's Correction for Continuity. In terms of the proposed "dietary hypothesis" for the societal components at Toqua, the higher frequencies of these pathologies in the village component only reveal a tendency in support of more frequent access to mineral and protein-rich foodstuffs among high-status individuals. On the basis of the statistical findings, however, a definitive statement as such cannot be proffered.

Porotic Hyperostosis Among the Structure 3 Individuals

Frequencies of cribra orbitalia and calvarial porotic hyperostosis for the Structure 3 individuals are presented in Table 25. The under-10 age group exhibits proportionately higher frequencies for both types of lesions than the 10-plus group; however, these differences are not significant when Fisher's Exact statistic is applied.

There is only one female in the 10-plus age group. She showed no evidence of cribra orbitalia but did exhibit calvarial porotic hyperostosis.

Of the six males in the 10-plus age category, one was too poorly preserved to determine whether or not cribra orbitalia was present. None of the remaining five exhibited cribrotic lesions. By use of Fisher's Exact statistic the Structure 3 male frequencies were tested against the male frequencies of cribra orbitalia for the mound and village components and in both cases the differences were not significant ($p < 0.05$).

TABLE 25

Frequencies of Cribra Orbitalia and Calvarial Porotic Hyperostosis Among the Structure 3 Individuals

	Cribra Orbitalia		Calvarial Porotic Hyperostosis	
Age Group	Frequency Without	Frequency With	Frequency Without	Frequency With
<10	1	3	1	4
10+	6	0	1	6
Totals	7	3	2	10

Five of the six Structure 3 males exhibited calvarial porotic hyperostosis, and one did not. These frequencies were not significantly ($p < 0.05$) different from either mound or village male frequencies of calvarial porotic hyperostosis upon applying Fisher's Exact.

It was not expected for the Structure 3 frequencies of either type of lesion to statistically differ from the mound and village frequencies. The results again suggest that differential access to more nutritionally sound foodstuffs by high-status individuals was not the case at Toqua.

Periosteal Reactions

Description

Periostitis is a nonspecific inflammatory response to insults occurring along the surface (i.e., periosteum) of bone. The long bones of the body are the most commonly affected; however, the endocranial surface of the skull and, less frequently, the ectocranial surface and eye orbits may also exhibit periosteal lesions (Mensforth et al. 1978). In this report only infections of the long bones are considered.

Periosteal lesions are manifested in several ways depending upon the nature and severity of the insult. The lesions may appear as tracks of hypervascularity, osteoporotic pitting with pores of variable size, and the formation of plaque-like "woven" bone which may ultimately cover an entire shaft (Ortner and Putschar 1981). The lesions result when the periosteum is lifted from the underlying cortex and a subperiosteal hemorrhage forms, thus reducing the blood supply to the bone (Mensforth et al. 1978). Should stimulation of the reaction cease before necrosis

occurs, the periosteal depositions may "be completely incorporated into the cortex in form of remodelled lamellar bone" (Ortner and Putschar 1981:130-131).

Periostosis, in a strict sense, should not be confused with osteitis (inflammation of cortical bone) or osteomyelitis (inflammation of bone including the marrow). Nevertheless, in both of these cases inflammation of the periosteum usually occurs (Morse 1969; Steinbock 1976).

In modern clinical cases periostitis is generally considered to be a response to a number of specific disease processes (Ortner and Putschar 1981). However, in an archaeological context the paleopathologist only has osseous material to work with, and specific systemic diseases are infrequently identified. For this reason, periostitis found among archaeological skeletal specimens is often treated as a specific disease entity (Ortner and Putschar 1981).

While it is noted that certain systemic diseases may cause periostitis, other factors are also responsible. For example, localized infections on overlying soft tissue may give rise to periosteal reactions on the underlying bones (Morse 1969; Ortner and Putschar 1981). Traumatic insults to bone, invariably when fractured but also when injured in other ways, will produce periosteal lesions (Brothwell 1972; Ortner and Putschar 1981). Often it is extremely difficult to determine whether localized lesions resulted from trauma or localized infections of overlying soft tissue (Ortner and Putschar 1981).

Methodology

If one consults the relevant literature dealing with studies that examined incidences of periostitis among skeletal populations, a variety of ways to score the lesions are noted. For example, Stothers and Metress (1975) subdivided periosteal reactions into two major categories: those with plaque-like formations as manifested in four stages; and osteoporotic pitting. Mensforth et al. (1978) viewed the lesions as being remodeled or unremodeled. Lallo et al. (1978) examined periosteal infections of the tibia according to three stages of involvement: slight, moderate, and severe, each depending upon the extent of involvement and amount of tissue destruction.

For the Toqua series the primary concern was the degree of periosteal involvement and simply whether or not a long bone exhibited periosteal infection. This approach obviously combines lesions of a localized, systemic, or traumatic origin. However, since the aim in this report is to obtain a general health picture on a population basis, this approach is deemed justified. Thus, all long bones in the Toqua skeletal series were examined for periosteal reactions according to the following stages:

Stage 1: Tracks of hypervascularity or osteoporotic pitting and striations with virtually no subperiosteal deposition of bone (Figures 23 and 24).

Stage 2: Subperiosteal deposition of woven bone of moderate thickness and expansion of the shaft (Figures 25 and 26).

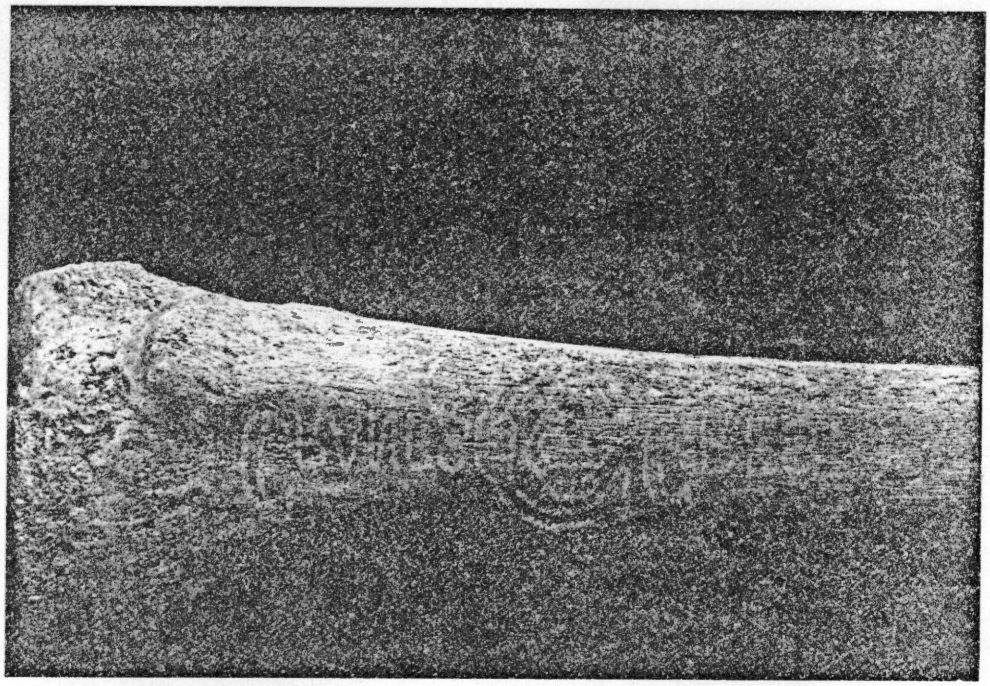

Figure 23. Proximal end of left tibia of Bu. 007 (adult male) showing stage 1 periosteal pitting.

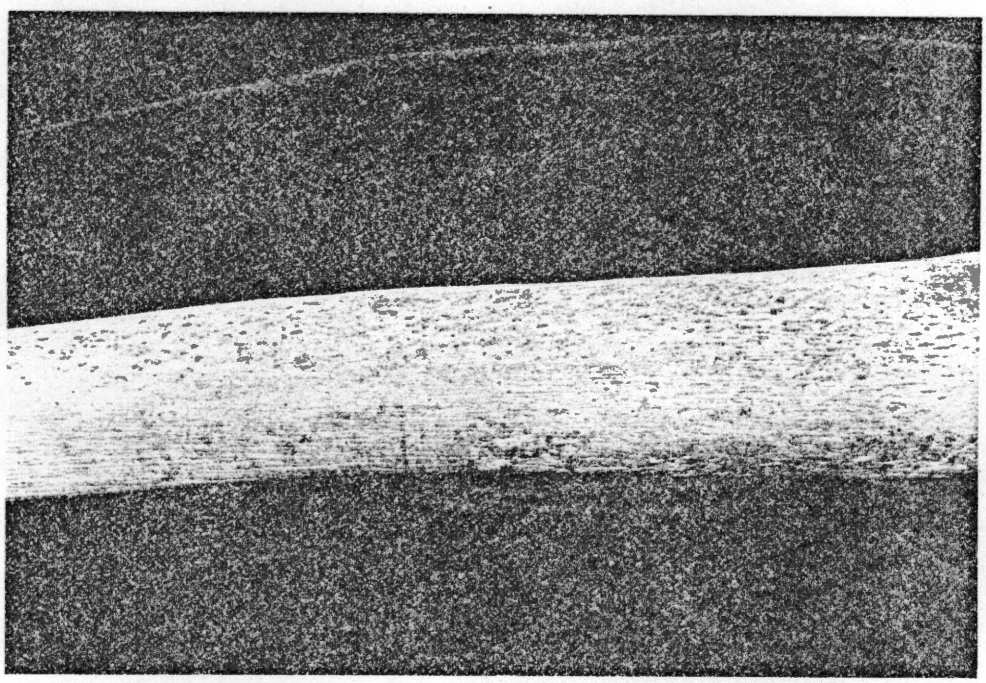

Figure 24. Another example of stage 1 periosteal pitting on right tibia of Bu. 007.

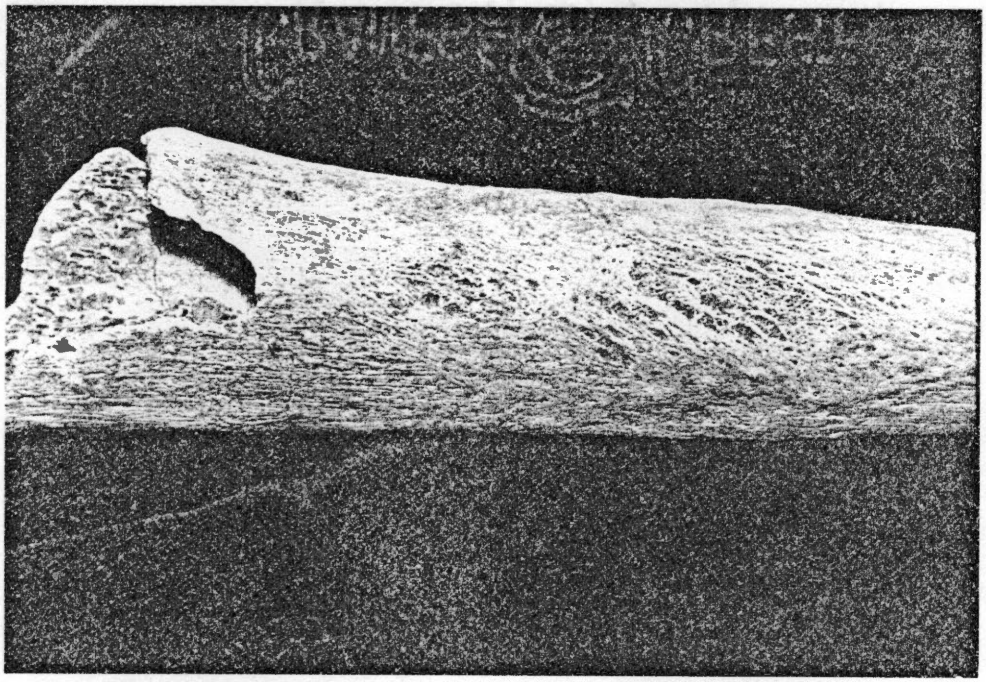

Figure 25. Right femur of Bu. 129 (adult female) showing stage 2 periosteal deposition.

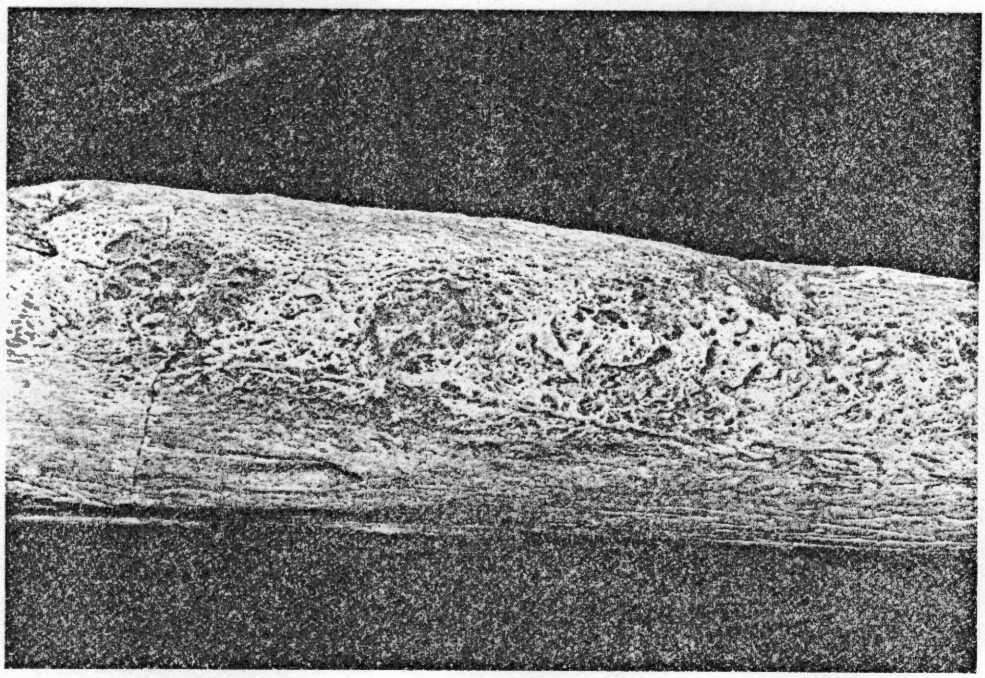

Figure 26. Right tibia of Bu. 129 showing stage 2 periosteal reaction.

Stage 3: Subperiosteal deposition of woven bone of pronounced thickness with notable expansion of the shaft (Figures 27-32).

Analytical examination of periosteal reactions were first considered for the total sample on a bone-by-bone basis. These frequencies and percentages are presented in table form and also graphically by a histogram.

All subsequent statistical analyses along age, sex and status lines utilized variations of the G-statistic, a log likelihood ratio test that, in certain cases, has distinct advantages over conventional X^2 tests (see Sokal and Rohlf 1969:559-560, 591-607). The derived values for the G-statistic are ultimately compared to the X^2 distribution to determine significance between frequencies. It must also be noted that age, sex and status relationships were based on comparisons between unaffected and affected bones, rather than considering each of the bones individually or the separate stages of involvement.

The relationship of periosteal reactions and age was tested in two ways. First, differences according to the previously established demographic age categories were analyzed. Second, in order to get a clearer picture between infants and young children versus older individuals, the sample was divided into an under-10 age group and a 10-plus group. Testing was then conducted between these two groups.

Differences between the sexes were examined by first considering the overall incidence between males and females, and then by considering the interaction of age and sex.

Status considerations based on the mound/village dichotomy were

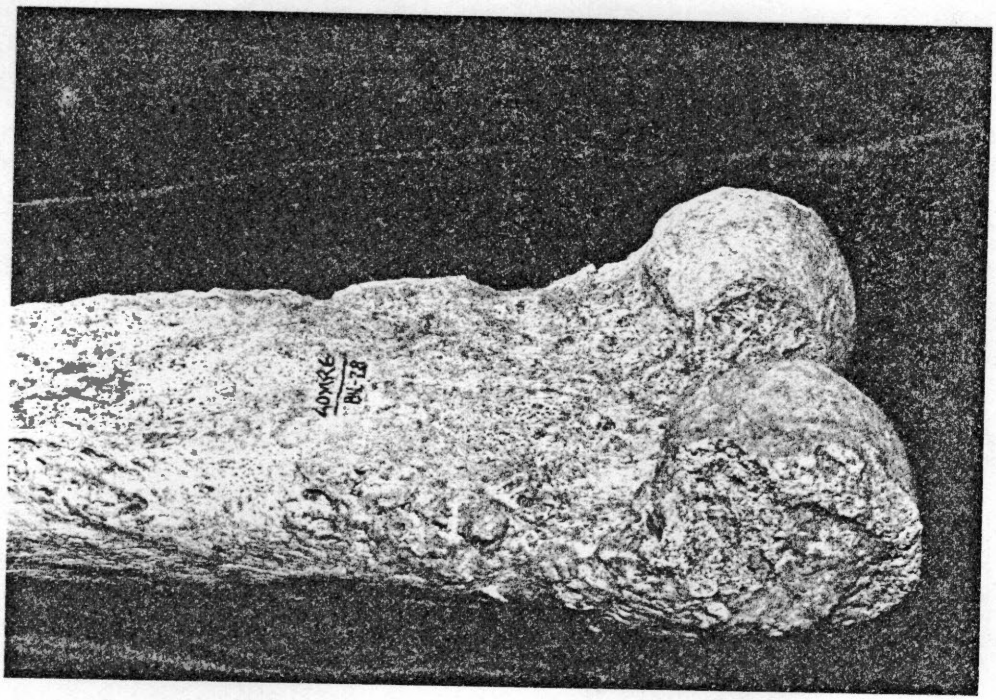

Figure 27. Right femur of Bu. 28 (adult male) exhibiting stage 3 periosteal reaction.

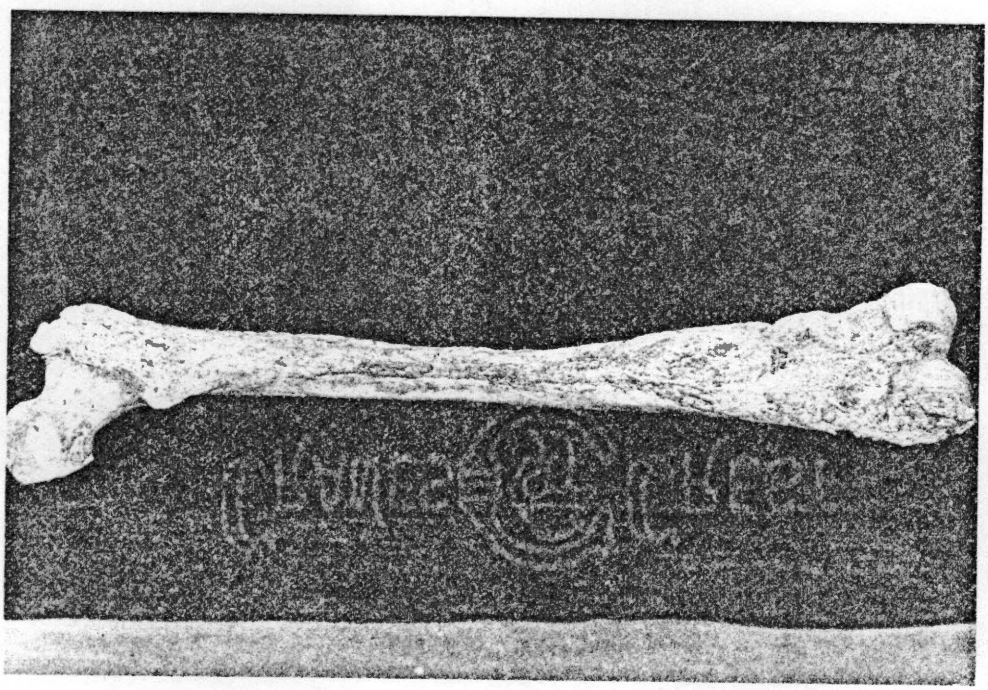

Figure 28. Complete view of right femur of Bu. 28. (Note marked swelling of distal shaft.)

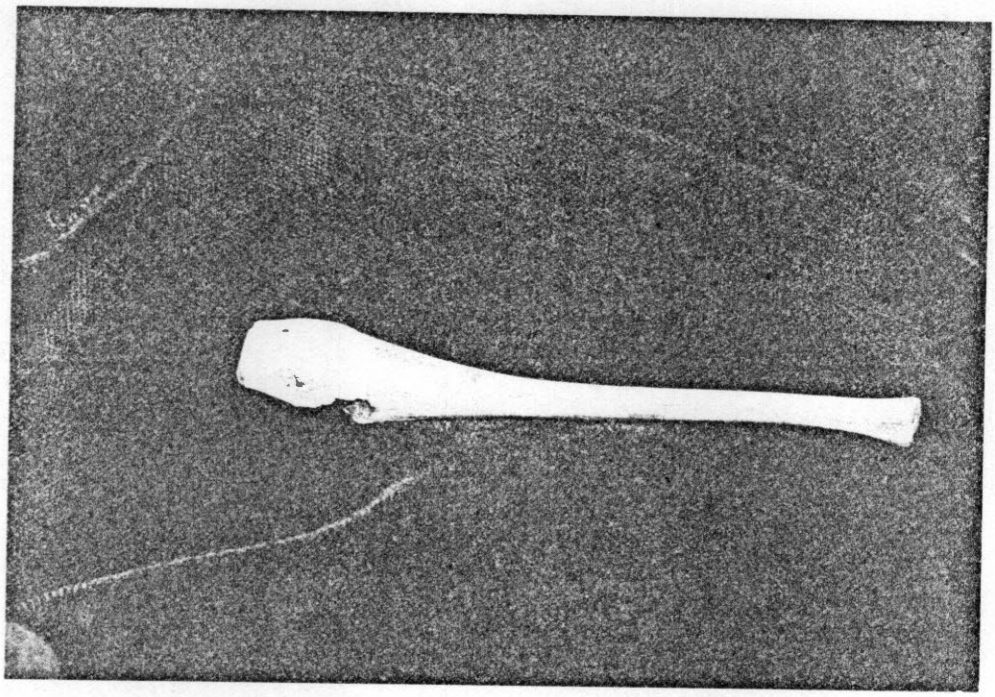

Figure 29. Left ulna of Bu. 107 (child) showing swollen head indicative of osteomyelitis (stage 3).

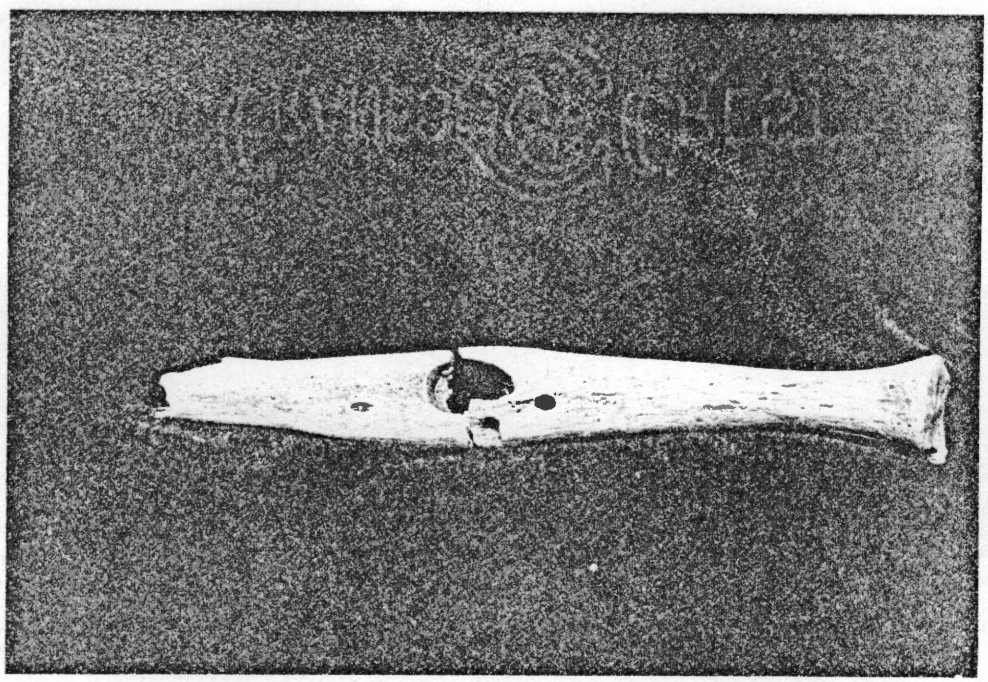

Figure 30. Radius of Bu. 107 showing swollen shaft with large cloaca.

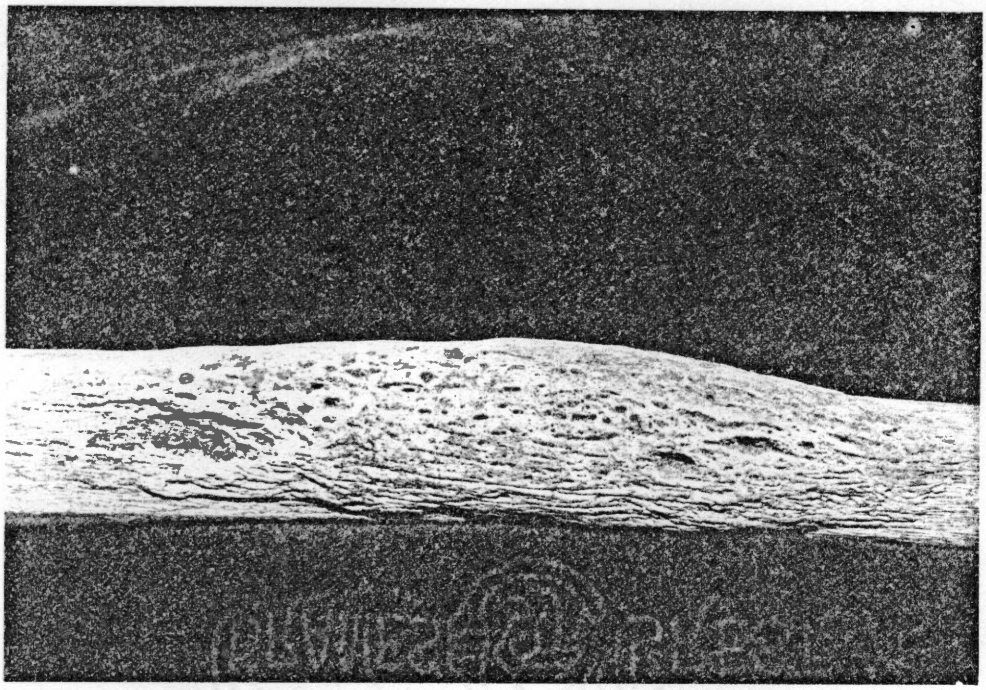

Figure 31. Lateral view of right tibia of Bu. 167 (adult female) showing ossified hematoma.

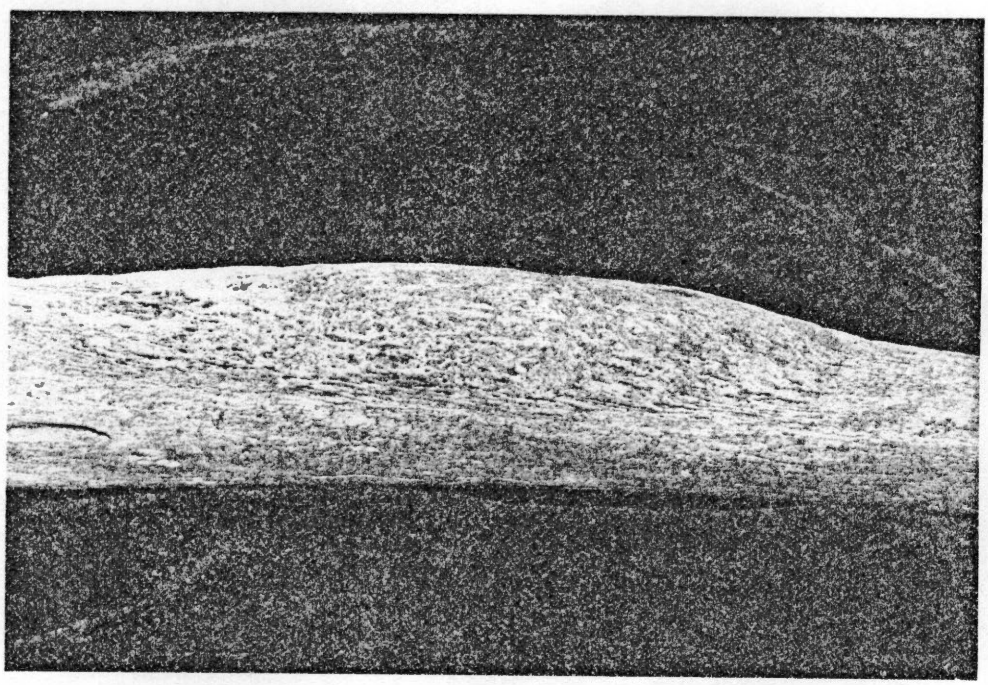

Figure 32. Medial view of right tibia of Bu. 167 showing ossified hematoma.

tested; however, in this analysis only individuals 10 years and older were utilized.

General Incidence of Periostitis Per Bone

Frequencies and percentages of periosteal reactions on the long bones from Toqua are presented in Table 26. The histogram in Figure 33 presents the percentages for each stage of involvement and for all affected bones per type. Regarding stage 1 involvement, 71.1% of the affected radii exhibited this degree of severity. The radius is followed in descending order by the clavicle, femur, tibia, ulna, humerus, and fibula. The highest percentage in the stage 2 level is seen for the humerus followed by the fibula, ulna, femur, tibia, clavicle and radius. Stage 3 involvement is highest for the tibia (16.5%), followed by the fibula, femur, clavicle, radius, ulna, and humerus. Overall, 61.0% of the affected bones are in stage 1, 27.7% in stage 2, and 11.3% in stage 3.

The dark shaded area of the histogram shows the percent of all bones of a particular type that are affected. The tibia at 44.2% by far exceeds the other bones. If the percent of affected bones of a particular type relative to all affected bones is considered (Table 26), the tibia again vastly exceeds the others. This probably occurs because the tibia is nearer to the skin surface, making it more susceptible to direct trauma or to localized infections of the overlying soft tissue (Ortner and Putschar 1981).

Periosteal Reactions and Age

Age-specific frequencies and percentages of periosteal reactions are presented in Table 27. Differences between age categories for the

TABLE 26

Frequencies and Percentages of Long Bone Periosteal Reactions for the Toqua Skeletal Series

Involvement	Bone														Totals Per Involvement	
	Clavicle		Humerus		Radius		Ulna		Femur		Tibia		Fibula			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Unaffected	181	78.7	271	78.6	248	84.6	246	82.6	305	77.4	207	55.8	166	76.9	1624	75.6
Stage 1*	33	67.3	42	56.8	32	71.1	31	59.6	57	64.0	99	60.4	25	50.0	319	61.0
Stage 2	11	22.4	28	37.8	10	22.2	18	34.6	22	24.7	38	23.2	18	36.0	145	27.7
Stage 3	5	10.2	4	5.4	3	6.7	3	5.8	10	11.2	27	16.5	7	14.0	59	11.3
Total affected	49	21.3	74	21.4	45	15.4	52	17.4	89	22.6	164	44.2	50	23.1	523	24.4
Totals per bone	230	10.7	345	16.1	293	13.6	298	13.9	394	18.4	371	17.3	216	10.1	2147	--
Percent affected, all bones affected	--	9.4	--	14.1	--	8.6	--	9.9	--	17.0	--	31.4	--	9.6	--	--

*Percentages for stages computed as the number affected per stage divided by the number affected per bone.

TABLE 27

Frequencies and Percentages of Long Bone Periosteal Reactions Per Age Category for the Toqua Skeletal Series (Combined Sexes)

	Age Cateogory																					
	0-1		1-5		5-10		10-15		15-20		20-25		25-30		30-35		35-40		40-45		45+		Totals	
Involvement	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Unaffected	185	46.1	158	73.8	189	77.5	92	82.1	165	82.9	266	86.9	131	70.4	232	91.3	128	91.4	65	86.7	67	95.7	1678	76.2
Stage 1*	168	77.8	40	71.4	43	78.2	9	45.0	21	61.8	11	27.5	11	20.0	7	31.8	5	41.7	3	30.0	1	33.3	319	61.0
Stage 2	46	21.3	13	23.2	9	16.4	7	35.0	11	32.4	18	45.0	26	47.3	6	27.3	5	41.7	4	40.0	0	0.0	145	27.7
Stage 3	2	0.9	3	5.4	3	5.5	4	20.0	2	5.9	11	27.5	18	32.7	9	40.9	2	16.7	3	30.0	2	66.7	59	11.3
Total affected	216	53.9	56	26.2	55	22.5	20	17.9	34	17.1	40	13.1	55	29.6	22	8.7	12	8.6	10	13.3	3	4.3	523	23.8
Totals per age category	401	18.2	214	9.7	244	11.1	112	5.1	199	9.0	306	13.9	186	8.5	254	11.5	140	6.4	75	3.4	70	3.2	2201	--

*Percentages for stages computed as the nunber affected percentage divided by the total affected per age category.

total frequency of affected bones in each category are highly significant at the 0.005 level (see Table 28). The age distribution of these frequencies is graphically presented in Figure 34. The curve clearly shows the extremely high frequency of affected bones in the 0-1 age category (53.9%). The curve declines thereafter until the 25-30 year interval, although the frequencies are relatively high at the 1-5 interval (26.2%) and the 5-10 year interval (22.5%). The high frequency of affected bones among infants and children aged 0-10 years were tested against individuals 10 years and older and, not surprisingly, the differences were significant at the 0.005 level (Table 28).

These frequencies during the early years of life, and particularly during the first year of life, closely conform to the findings of Mensforth et al. (1978) at the Libben site who suggested several conditions and disease states that may induce periosteal reactions among infants. For example, infantile cortical hyperostosis, hypervitaminosis A, prematurity, rickets, scurvy and trauma were discussed as possible causes, but they were summarily dismissed due to lack of evidence on the bones. Mensforth et al. (1978:37) ultimately suggest that acute infectious diseases such as pneumonia, septicemia, staph infections, and gastroenteritis "play a primary role in the etiology of these bony lesions." Considering the high infant mortality rate at Toqua and the fact that approximately 77% of the affected bones in the 0-1 age category were in stage 1 involvement, acute infectious diseases appear to be the likely cause of periosteal lesions among infants at this site as well.

A bit more problematical is the mode at the 25-30 year interval. This will be discussed in the following section.

TABLE 28

Tests of Independence Between Periostitis and Demographic Categories at Toqua

Test	Computed G-statistic	Degrees of Freedom	P
Overall--age and sex	141.19	25	<0.005
Age (by category)	288.24	11	<0.005
Age-- <10 and 10+	156.27	1	<0.005
Sex	2.06	1	<0.05
Interaction--age and sex	49.98	8	<0.005
Mound and village	0.14	1	<0.05

Periosteal Reactions and Sex

Frequencies and percentages for periosteal reactions among males and females are presented according to age intervals in Tables 29 and 30, respectively. The percentages for each are plotted in Figure 34.

Overall differences between males and females are not statistically significant at the 0.05 level (Table 28). However, the interaction between age, sex and the incidence of periostitis is highly significant at the 0.005 level (Table 28). This suggests that the degree of association between one pair of factors, say sex and periostitis, differs over the several levels of a third factor, that is, age (Sokal and Rohlf 1969:607). By referring to Figure 34, it is seen that males and females differ most strikingly at 10-15 years, 15-20 years, and 25-30 years. At 10-15 years the female percentage of affected bones is 39.3% as compared with 10.8% for males. The male rate (34.5%) then rises above the female

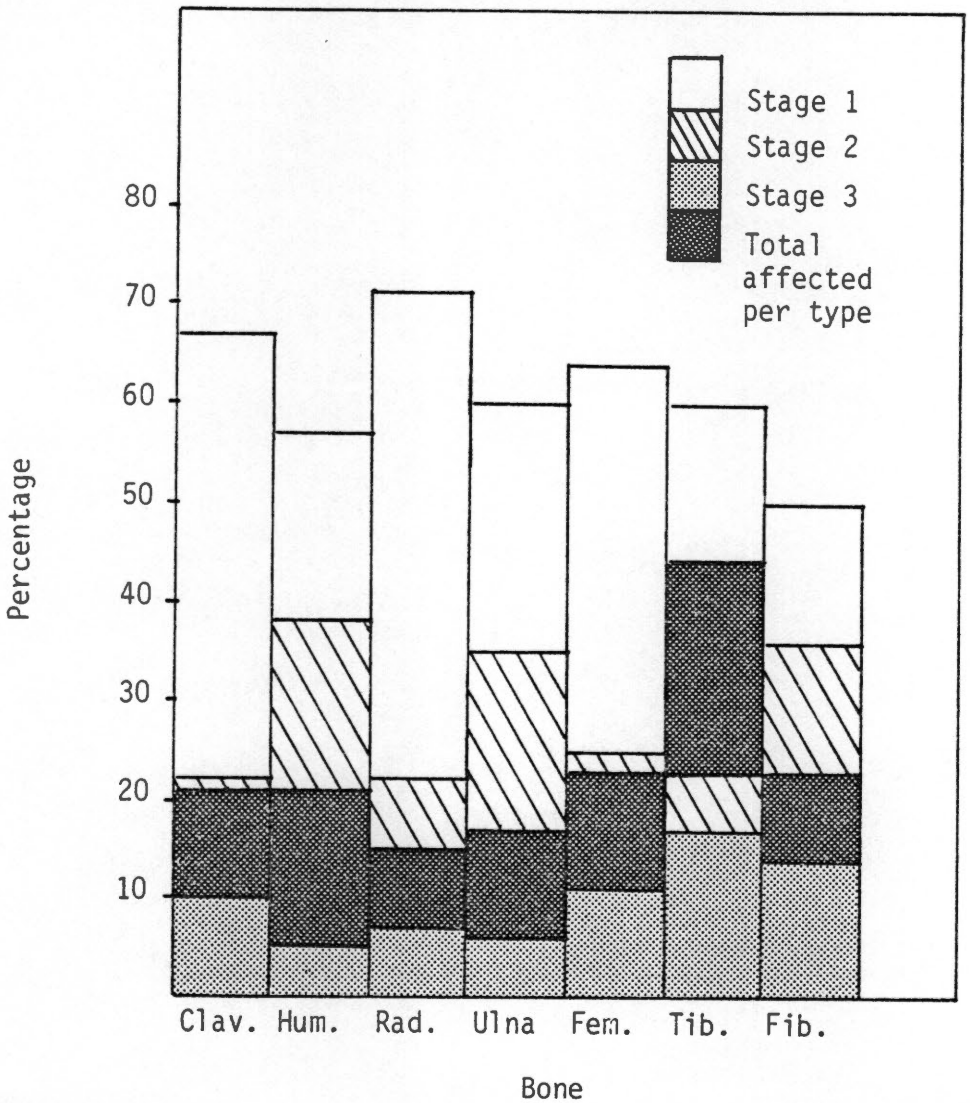

Figure 33. Histogram of periosteal reaction frequencies for the Toqua long bones (total sample).

TABLE 29

Frequencies and Percentages of Long Bone Periosteal Reactions Per Age Category for the Toqua Males

Involvement	Age Category																Totals Per Involvement	
	5-10		10-15		15-20		20-25		25-30		30-35		35-40		40-45		45+			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Unaffected	98	81.7	66	89.2	36	65.5	116	80.6	58	82.9	154	89.5	101	91.0	26	86.7	48	98.0	703	85.2
Stage 1*	21	95.5	7	87.5	12	63.2	9	32.1	2	16.7	5	27.8	5	50.0	0	0.0	1	100.0	62	50.8
Stage 2	1	45.0	0	0.0	5	26.3	15	53.6	2	16.7	5	27.8	4	40.0	2	50.0	0	0.0	34	27.9
Stage 3	0	0.0	1	12.5	2	10.5	4	14.3	8	66.7	8	44.4	1	10.0	2	50.0	0	0.0	26	21.3
Total affected	22	18.3	8	10.8	19	34.5	28	19.4	12	17.1	18	10.5	10	9.0	4	13.3	1	2.0	122	14.8
Totals per age category	120	14.5	74	9.0	55	6.7	144	17.5	70	8.5	172	20.8	111	13.5	30	3.6	49	5.9	825	--

*Percentages for stages computed as the number affected per stage divided by the total affected per age category.

TABLE 30

Frequencies and Percentages of Long Bone Periosteal Reactions Per Age Category for the Toqua Females

Involvement	Age Category																Totals Per Involvement	
	5-10		10-15		15-20		20-25		25-30		30-35		35-40		40-45		45+			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Unaffected	68	68.7	17	60.7	129	89.6	145	92.4	73	62.9	78	95.1	27	93.1	39	86.7	19	90.5	595	82.5
Stage 1*	20	64.5	2	18.2	9	60.0	2	16.7	9	20.9	2	50.0	0	0.0	3	50.0	0	0.0	47	37.3
Stage 2	8	25.8	6	54.5	6	40.0	3	25.0	24	55.8	1	25.0	1	50.0	2	33.3	0	0.0	51	40.5
Stage 3	3	9.7	3	27.3	0	0.0	7	58.3	10	23.3	1	25.0	1	50.0	1	16.7	2	100.0	28	22.2
Total affected	31	31.3	11	39.3	15	10.4	12	7.6	43	37.1	4	4.9	2	6.9	6	13.3	2	9.5	126	17.5
Totals per age category	99	13.7	28	3.9	144	20.0	157	21.8	116	16.1	82	11.4	29	4.0	45	6.2	21	2.9	721	--

*Percentages for stages computed as the number affected per stage divided by the total affected per age category.

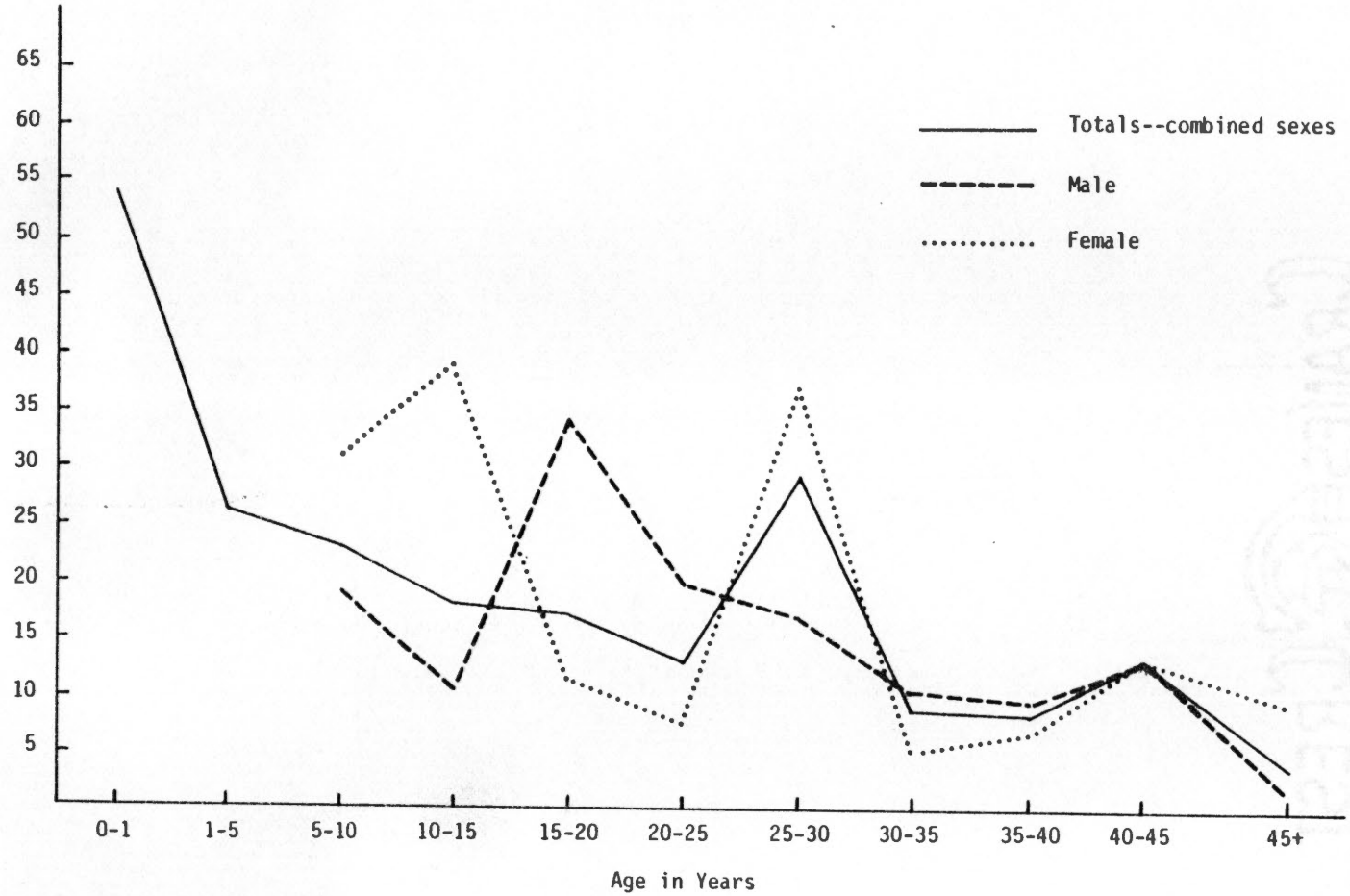

Figure 34. Age distribution of long bone periosteal reactions for combined sexes, males, and females at Toqua.

(10.4%) at the 25-20 year interval. The male percentage remains somewhat higher than the female at 20-25 years, but at 25-30 years the female rate of 37.1% is considerably higher than the male at 17.1%. These relatively high percentages for both sexes, but especially females, at the 25-30 year interval explains the high mode at this age interval for the combined sex curve.

In terms of morbidity and mortality, it is difficult to suggest exactly what these variations between the sexes actually mean. However, if the periosteal curves are compared to the mortality curves, (Figure 5, page 42), an interesting feature is noticeable. At age intervals 10-15, 15-20, 20-25, and 45+ the higher frequency for whichever sex on the periosteal curves is the lower frequency on the mortality curves. Interestingly, the combined-sex periosteal curve drops at 20-25 years and then peaks at 25-30 years. It will be remembered that the combined-sex mortality curve peaks at 20-25 years but drops at 25-30 years. If the suggestions that obstetrical problems for females and warfare/hunting activities for males induce peak mortality are valid, it may be possible that more individuals in the peak mortality periods were dying before periosteal lesions could be manifested in their bones. This may also mean that the more fit individuals who were able to withstand stressful events such as infectious diseases and trauma during these critical periods ultimately met their demise approximately five years later.

Periosteal Reactions and Status

The underlying assumption in comparing mound and village components for incidences of periosteal reactions is that high-status individuals would have been generally healthier than their low-status counterparts due

to preferential treatment in the form of better nutrition and health care. From a nutritional standpoint, tests conducted for porotic hyperostosis are contrary to this hypothesis.

Table 31 presents frequencies and percentages of periosteal reactions for the two components. In this analysis sexes were combined for each component and individuals under 10 years of age were excluded. Testing between the components for the frequency of all affected bones showed that there are no significant differences at the 0.05 level (Table 28, page 125).

Blakely (1980) performed a similar study between the Etowah Mound C and village area skeletal specimens and yielded insignificant X^2 values for periostitis as well as other pathologies, including porotic hyperostosis. On this basis he determined that status was primarily achieved rather than ascribed. In terms of preferential treatment for high-status individuals, the results at Toqua may suggest the same for this Late Mississippian site.

Periosteal Reactions Among the Structure 3 Individuals

Table 32 presents frequencies and percentages of periosteal reactions for the Structure 3 individuals. For individuals under 10 years of age, 37.5% (18 of 48) of their bones were affected by periostitis. For individuals 10 years and older, 12.8% (10 of 78) of their bones were affected. A X^2 test between these two age groups revealed that the frequencies differed at the 0.005 level of significance ($X^2 = 10.47$).

The frequencies of the Structure 3 10-plus age group are compared to the mound and village frequencies for the same age group in Table 31. Differences between Structure 3 periosteal frequencies and the mound and

TABLE 31

Frequencies and Percentages of Long Bone Periosteal Reactions for the Toqua Mound and Village Components, and Structure 3

Component	Involvement									
	Unaffected		Stage 1*		Stage 2		Stage 3		Total Affected	
	N	%	N	%	N	%	N	%	N	%
Mound (N=174)	150	86.2	7	29.2	8	33.3	9	37.5	24	13.8
Village (N=1089)	927	85.1	53	32.7	68	42.0	41	25.3	162	14.9
Structure 3 (N=78)	68	87.2	8	80.0	1	10.0	1	10.0	10	12.8
Total per Involvement (N=1341)	1145	85.4	68	34.7	77	39.3	51	26.0	196	14.6

*Percentages for stages computed as the number affected per stage divided by the total affected per component.

village frequencies were tested by the G-statistic and in both cases the results were nonsignificant at the 0.05 level. These results are consistent with the previous mound and village comparison, and further attest that no one segment of Toqua society was more healthy than another.

Osteomyelitis

Osteomyelitis is an infectious disease of bone involving the marrow cavity. In most cases it is caused by microorganisms capable of producing pus. For this reason it is often referred to as pyogenic osteomyelitis or suppurative osteomyelitis (Morse 1969; Steinbock 1976; Ortner and Putschar 1981).

TABLE 32

Frequencies and Percentages of Long Bone Periosteal Reactions Per Age Categories for the Structure 3 Individuals

	Age Category																		Totals Per Involvement	
	0-1		1-5		5-10		10-15		15-20		20-25		25-30		30-35		35-40			
Involvement	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Unaffected	20	69.0	4	57.1	6	50.0	0	0.0	13	100.0	16	66.7	13	92.9	13	92.9	13	100.0	98	77.8
Stage 1*	0	0.0	3	100.0	6	100.0	0	0.0	0	0.0	8	100.0	0	0.0	0	0.0	0	0.0	17	60.7
Stage 2	9	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	10	35.7
Stage 3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	1	3.6
Total affected	9	31.0	3	42.9	6	50.0	0	0.0	0	0.0	8	33.3	1	7.1	1	7.1	0	0.0	28	22.2
Total per age category	29	23.0	7	5.6	12	9.5	0	0.0	13	10.3	24	19.0	14	11.1	14	11.1	13	10.3	126	--

In approximately 90% of all cases of osteomyelitis the causative microorganism is Stephylococcus aureus. The remaining 10% are attributed to streptococci, pneumococci and other infectious cocci and bacilli (Morse 1969, Steinbock 1976; Ortner and Putschar 1981).

These microorganisms induce osteomyelitis through direct extension from trauma or adjacent soft tissue infections, or indirectly through the bloodstream (hematogenously). The direct or primary foci of infection may in fact lead to the establishment of secondary foci in other bones via the bloodstream (Steinbock 1976; Ortner and Putschar 1981). Depending upon the condition of the host, the hematogenous spread of the microorganism involved may lead to acute osteomyelitis which can be fatal. If the virulence of the microorganism is low and the resistance of the host is high, the infection may become chronic and persist for years with intermittent periods of remission and flare-up (Morse 1969; Steinbock 1976; Ortner and Putschar 1981).

In approximately 80% of all cases acute hematonenous ostemyelitis affects individuals between three and 15 years of age (Steinbock 1976; Ortner and Putschar 1981). Within this age range there is an apparent sex bias of 3:1 in favor of males (Ortner and Putschar 1981). The major areas of infection are metaphyseal areas of the long bones with the distal ends more often affected than the proximal ends. Lower extremities are more often affected than the upper limbs (Steinbock 1976; Ortner and Putschar 1981). The gross morphology and roentgenographic appearance of the affected bones show variable bone destruction, subperiosteal aposition of new bone, and the sequestration of necrotic bone. A cortical bone aposition called the involucrum will envelop the sequestered bone and may

cover the entire shaft. Through the involucrum several perforations or cloaca will form thus allowing drainage of pus and bits of the sequestered bone (Steinbock 1976; Ortner and Putschar 1981).

From either a population approach or on an individual basis the only reasonable way to accurately assess frequencies and individual incidences of osteomyelitis is to X-ray all the available affected bones. Due to cost and time restrictions it was not possible to perform this function on the Toqua skeletal series. Only some of the more seriously infected bones were X-rayed to determine whether or not osteomyelitis was present. Several cases of osteomyelitis are presented in Figures 27-32, pages 118-120.

Trauma

In all of the major references dealing with paleopathology (e.g., Brothwell and Sandison 1967; Morse 1969; Steinbock 1976; Ortner and Putschar 1981), an important point that is stressed is the influence of culture on trauma. Incidences of traumatic lesions found among skeletal specimens result from a number of exogenous sources including fracturing, blows to the body, piercing, physical exertion, primative surgery, scalping, and others.

Probable and possible traumatic lesions for the Toqua skeletal series are presented in Table 33. This listing does not purport to include every incidence of trauma incurred by the Toqua inhabitants for which at least some skeletal material is available. In addition to the possibility of oversight, poor preservation undoubtedly obscured many incidences. Also, as stated previously, it is often difficult to

TABLE 33

Incidences of Trauma in the Toqua Skeletal Series

Burial	Sex	Age Cat.	Affected Bone (Side)	Description
004	---	0-1	Humerus (L)	Possible healed fracture proximal end
013	M	30-35	Fibula (L)	Possible healed fracture at midshaft
			Thoracic Verts. a, 3	Compressed
033	---	0-1	Rib #1 (R)	Healed fracture at midshaft
055	M	40-45	Fibula (L)	Possible healed fracture at midshaft
			Innominate (L)	Periosteal reaction and remodeling superior margin of sacroiliac articular facet
			Occipital	Possible healed depressed fracture (approx. 20 mm. diam.) upper left Squamous portion
077	F	25-30	Sacrum and Innom. (L)	Pronounced pits on anterior superior margin of articular facets (parturitional ?)
093	M	30-35	Clavicle (R)	Possible healed fracture lateral end
104	---	1-5	Frontal	Possible healed depressed fracture (approx. 10 mm. diam.) superior to right brow ridge
113	M	35-40	Tibia (R)	Possible healed fracture anterior midshaft
151	M	30-35	Talus (L)	Eburnation and lipping of superior articular surface; lipping also evident on distal left tibia
157	M	25-30	Radius (R)	Healed fracture distal end
163	M	15-20	Tibia (L)	Possible healed fracture anterolateral midshaft
167	F	20-25	Tibia (R)	Ossified hematoma anterior midshaft
187A	F	15-20	Thoracic Verts. 8, 9	Osteophytes lower right anterolateral body of #8 and upper right anterolateral body of #9
207	F	25-30	Thoracic verts. ?	Two centra exhibit compression
209	M	45+	Radius (R)	Possible healed fracture at midshaft
			Parietal (L)	Healed depressed fracture vicinity of bregma
217A	F	40-45	Femur (R)	Bony nodule medial distal end in area of insertion of vastus medialis muscle

TABLE 33 (Continued)

Burial	Sex	Age Cat.	Affected Bone (Side)	Description
223A	M	10-15	Humerus (R)	Possible healed fracture anterior distal end
229	M	35-40	Innominate (L)	Healed fracture superior acetabulum; pitting also evident on left femur head
230A	F	35-40	Tibia (R)	Possible ossified hematoma anterior midshaft
237C	F	20-25	Fibula (L)	Small bone spur anterior midshaft in area of origin of extensor hallucis longus muscle
239	F	20-25	Calcaneus (R)	Severe suppurative lesion in area of insertion of gastrocnemius muscle; possible secondary infection initiated by trauma
			Humerus (L)	Similar condition to calcaneus; distal end
			Ulna (L)	Similar condition to calcaneus; proximal end
242	F	25-30	Fibula (R)	Possible healed fracture lateral distal shaft
243	M	45+	Tibia (L)	Large protruding bone spurs posterior proximal shaft in area of origin of flexor digitorum muscle
			Tibia (R)	Possible healed fracture anterior proximal shaft
244	M	35-40	Lumbar vert. 3	Compressed centrum
			Ulna (R)	Ossified tendon of triceps brachii muscle on posterior head
246	F	25-30	Innominate (L)	Pronounced pitting superior area of sacroiliac articular facet (parturitional ?)
			Tibia (R)	Bone spur anterior proximal shaft in area of insertion of sartorius muscle
254	M	20-25	Femur (R)	Bony nodule posterolateral side just below midshaft in area of origin of biceps femoris muscle (shorthead)
263	F	45+	Tibia (L)	Possible ossified hematoma anterior midshaft

TABLE 33 (Continued)

Burial	Sex	Age Cat.	Affected Bone (Side)	Description
325	F	30-35	Tibia (R)	Possible healed fracture anterior proximal shaft
332	M	30-35	Tibia (L)	Bone spur posteromedial proximal shaft in area of origin of soleus muscle
356	F	20-25	Fibula (L)	Small ossified hematoma midshaft
365A	M	15-20	Innominate (L)	Bony deposition ventral surface of pubis
367	M	35-40	Radius (L)	Bone spur anteromedial proximal shaft in area of origin of flexor pollicis longus muscle
369	M	25-30	Thoracic verts. 7, 8, 9	Compressed and fused centra
414	F	15-20	Ulna (L)	Possible healed fracture medial distal shaft
425	F	35-40	Hand phalanges	Proximal and medial phalanges fused at joint
438	M	30-35	Femora (both)	Symmetrical bony nodules posteromedial distal end in area of insertion of adductor magnus muscle
458	M	20-25	Tibia (R)	Ossified hematoma anterior midshaft
			Femur (L)	Depression and periosteal reaction posteromedial distal end in area of insertion of adductor magnus muscle
			Femur (R)	Depression and bone reaction inferior surface distal lateral condyle (probable infectious arthritis)

determine whether certain periosteal lesions are trauma-related or are due to infections of overlying soft tissue. Thus, the cases presented in Table 31 are those that were more likely to be trauma-related. The descriptions are essentially self-explanatory and any conclusions as to external causes are left to the discretion of the reader.

Congenital and Developmental Defects

Congenital defects refers to skeletal deviations from a normal configuration that an individual is born with. However, often it is difficult to discern what role heredity, environment, or both play in producing an animalous skeletal condition, hence the term developmental defects (Morse 1969).

Congenital and developmental defects for the Toqua skeletal series are presented in Table 34. A brief scan of the table shows that the more prevalent defects are those involving the vertebral column, particularly the cervical and lumbar vertebrae. Two cases of atlas-occipital fusion are noted in addition to one example of fifth lumbar sacralization, one case of a sixth sacral element, five incidences of separate or absent neural arches, and three cases where intermediate cervical vertebrae are fused together. There were probably many more incidences of congenital vertebral defects among the Toqua inhabitants. However, vertebrae, due to their naturally porous bodies, were destroyed by the acidic soil conditions at Toqua, perhaps more consistently than any other part of the skeleton.

An interesting congenital/developmental feature of the skull that was observed on six individuals is referred to as an "external occipital

TABLE 34

Incidences of Congenital and Developmental Defects in the Toqua Skeletal Series

Burial	Sex	Age Cat.	Affected Bone	Description
028	M	30-35	Cervical vertebra 1	Fused to posterior margin of foramen magnum
079	M	15-20	Cervical vertebra 1	Fused to occipital bone at condyles
			Cervical vertebra 2, 3	Fused
095	M	35-40	Lumbar vertebra 5	Separate neural arch left side
120	M	20-25	Cervical vertebrae	Two vertebrae are fused on right side of centra and at the transverse processes
193	F	15-20	Occipital	Non-pathological external occipital depression
249	M	5-10	Parietals	Scaphocephaly (premature fusion of sagittal sutures)
262	M	20-25	Lumbar vertebra 5	Fused to sacrum; absent neural arch
263	F	45+	Occipital	Non-pathological external occipital depression
325	F	30-35	Sacrum	Sixth sacral element; incompletely fused neural arch
336	M	10-15	Sacrum-segment 1	Separate neural arch
359	F	30-35	Pubes	Symmetrical bony nodules superior pubic ramus (approx. 3 cm. from symphisis)
365A	M	15-20	Occipital	Non-pathological external occipital depression
367	M	35-40	Occipital	Non-pathological external occipital depression
372	M	40-45	Occipital	Non-pathological external occipital depression
374	F	5-10	Certical verts, 2, 3	Fused
431	---	10-15	Occipital	Non-pathological external occipital depression

depression." This term was coined by Phenice (1969) for its occurrence among prehistoric peoples of north central Kansas, and he notes that no other references to this anomaly could be found in the literature.

The depressions vary in size but are usually between five and 10 millimeters in diameter. In most cases they occur slightly superior to the external occipital protuberance and exhibit slight periosteal pitting; however, they do not appear to be trauma-related and the endocranium is not involved. Although there are no apparent biases along sexual lines, four of the Toqua individuals with depressions have intentionally deformed skulls (i.e., F-O deformation) and the other two have unintentional deformation of the occipital region; however, if the great number of deformed individuals with no depressions are considered, to suggest such a relationship would be remiss.

Another congenital/developmental defect in Table 34 concerns an individual that exhibited premature closure of the sagittal suture. This synostotic deformity is called scaphocephaly because the skull takes on an abnormally long boat- or keel-shape (Morse 1969; Brothwell 1972). What is interesting about this case is that the individual's skull, based on the degree of frontal flattening, was probably intentionally deformed. The elongated growth normally associated with scaphocephaly may have been somewhat restricted although it is difficult to tell because much of the posterior parietals and the occiput were poorly preserved.

The final undiscussed congenital/developmental defect in Table 34 concerns a 30-35 year old female that exhibits symmetrical bony nodules on the superior margin of the pubic ramus. There does not appear to be any periosteal reaction involving the projections; however, it could be

speculated that excessive strain on the inguinal ligament during parturition earlier in her life may have induced the deposition of new bone.

Tumors and Tumor-like Processes

A tumor is a swelling or new growth of tissue resulting from the uncontrolled proliferation of osteogenic cells. When the growth remains localized and is composed of well-differentiated cells it is considered benign. A rapidly growing tumor consisting of poorly-differentiated cells may metastacise and spread to other tissues of the body where secondary tumors may become established. This type of tumor is considered malignant (Steinbock 1976; Ortner and Putschar 1981). Among the Toqua skeletons only benign tumors and tumor-like processes were observed (Table 35).

Two individuals (Burials 180 and 359) possessed tumors referred to as button osteomas. These pea-size growths are frequently found on the cranial vault and have a smooth, ivory-like texture (Steinbock 1976).

The left fibula of Burial 255 exhibited a tumorous growth known as an osteochondroma. This common benign tumor usually occurs in the metaphyseal areas of the long bones and is almost always a solitary lesion. Although often present at birth, osteochondromas are not detectable until later in life. Clinically, they appear as an ossified exostosis that is capped with a cartilaginous layer. Among archaeological specimens the cartilage is not evident (Morse 1969; Steinbock 1976).

A rare type of solitary, benign tumor called an osteoid-osteoma is a strong possibility for the distal femur of Burial 200 (per Dr. John Gregg, personal communication). Radiographically, this tumor appears as

TABLE 35

Incidences of Tumors and Tumor-like Processes in the Toqua Skeletal Series

Burial	Sex	Age Cat.	Affected Bone (Side)	Description)
013	M	30-35	Temporal (R)	Monostotic fibrous dysplasia mastoid area and petrous
180	F	40-45	Parietal (R)	Three small benign button osteomas near parietal foramen
200	F	30-35	Femur (L)	Possible benign osteoid-osteoma posterior distal shaft
255	F	30-35	Fibula (L)	Probable osteochondroma posterior proximal end
359	F	30-35	Frontal	Benign button osteoma superior to left brow ridge
365A	M	15-20	Femur (L)	Possible non-ossifying fibroma lateral distal end

a small nidus of osteoid and bone trabeculae surrounded by thickened, remodeled bone. In archaeological specimens the osteoid portion of the nidus may sometimes deteriorate, and the tumor will be recognizable as a transluscent core within the thickened bone (Steinbock 1976).

The two remaining cases presented in Table 35 pertain to tumor-like processes that are actually nonneoplastic conditions. In fact, both are developmental in origin; however, in the major paleopathological references they are commonly placed in the chapters dealing with tumors.

The first of these concerns monostotic fibrous dysplasia found in the mastoid area and petrous portion of the right temporal bone of Burial 013. This particular case has been discussed in a recent article by Gregg and Reed (1980). The affected portion of the bone appears swollen and smooth on the outer surface. The inner matrix appears as a mass of coarse trabeculae of woven bone interspersed with cyst-like areas where fibrous tissue or islands of cartilage once existed (Steinbock 1976).

The final case in Table 35 pertains to a possible non-ossifying fibroma in the distal end of the left femur of Burial 365A (Dr. John Gregg, personal communication). These lesions are commonly found in the metaphyseal areas of the lower long bones. The non-ossifying fibroma may be considered a progressed state of an unhealed fibrous cortical defect (Steinbock 1976). The fibroma appears as a somewhat circular lesion that is separated from the medullary cavity by a "distinct, frequently scalloped, bony shell . . ." (Ortner and Putschar 1981:375).

Arthritis

Arthritis is a disease involving the joints of the body for which a large number of classifications are found in the medical literature. When dealing with dried bone specimens the list is considerably diminished to six or seven basic categories (Morse 1969; Steinbock 1981).

Among the Toqua skeletal specimens three basic types of arthritis were observed. The most prevalent type is an age-related arthritis of the vertebral column known as vertebral osteophytosis. This synarthrotic (i.e., lacking a joint cavity) disease occurs when the cartilaginous discs between the vertebrae degenerate. If the process continues the discs are eventually destroyed (Morse 1969). The ongoing compression and protrusion of the vertebral bodies on the anterior longitudinal ligament results in periosteal reaction which produces anterolateral osteophytes or lipping (Steinbock 1976). It is possible for the osteophytes on contiguous vertebrae to become fused together (Morse 1969; Steinbock 1976). Vertebral osteophytosis is more commonly found on lumbar vertebrae but the cervical vertebrae are also frequently affected (Morse 1969).

The second degenerative joint disease observed at Toqua is referred to as osteoarthritis. This type of arthritis essentially includes arthritic lipping of the long bone joints (diarthroses) due to "deterioration and abrasion of articular cartilage and the formation of new bone . . ." (Steinbock 1976). It must be noted that some researchers do not consider vertebral osteophytosis to be distinct from osteoarthritis (Steinbock 1976); however, the distinction prevails in the major paleopathological references.

As suggested in the descriptions above, both types of arthritis are found on older adults and may be considered indicative of the normal aging process. However, during the course of an individual's lifetime the extent of physical activity may also determine how quickly and how severely these arthritic conditions are manifested.

At Toqua vertebral osteophytosis was recognized on approximately 50 adults. Roughly half this number exhibited osteoarthritis, and a good many had both. No specific frequencies for the incidence of these pathologic conditions were recorded because of poor preservation.

The third type of arthritic condition recognized among the Toqua skeletons is referred to as traumatic arthritis. As the name indicates, this is a secondary form of osteoarthritis or vertebral osteophytosis resulting from trauma-induced alterations of bony joints (Morse 1969; Steinbock 1976). Specific incidences of what appear to be traumatic arthritis are listed in Table 33, page 136.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The purpose of this thesis was to present osteological information for the Toqua skeletal series and to assess these data within a biocultural framework. This was accomplished by the examination of paleodemographic aspects, metric and morphological data (i.e., stature and cranial deformation), and paleopathological variables. For each of these categories, the analyses were presented by: (1) considering age and sex relationships for the total skeletal series; (2) considering status relationships based on the mound/village dichotomy; and (3) comparing Structure 3 information to the mound and village components. Summaries and conclusions of the results are advanced below.

The Total Skeletal Series

Paleodemography

Vital statistics for the Toqua skeletal series were ascertained through life table analysis (Acsádi and Nemeskéri 1970). Mortality, survivorship, probability of death, and life expectancy results demonstrated extremely high infant and childhood mortality at Toqua. The healthiest age interval was between 10 and 15 years. Mortality for females increased markedly at 15-20 years and peaked at 20-25 years. Increased female mortality was probably due to the stresses of childbirth. Male mortality also peaked at 20-25 years. It was suggested that hunting and combative activities contributed to the demise of many males during this age span.

With life expectancy at birth viewed as a measure of health and longevity, Toqua's value of 16.1 years is one of the lowest in a comparison with other aboriginal Amerindian populations. Only the protohistoric Larson site of South Dakota has a life expectancy (13.7) that is considerably lower than Toqua's. A stressful existence is also reflected by Toqua's crude mortality rate (62) which is only greatly exceeded again by the protohistoric Larson site (73).

Average population size was calculated for Toqua by the formulae of Ubelaker (1974:66) and Acsádi and Nemeskéri (1970:65). The more reasonable estimates based on the osteological data suggest an average population of 269 to 299 individuals at Toqua.

Stature

Stature estimates for the Toqua adults were derived by the formulae of Trotter and Gleser (1952, 1958). Average stature for the Toqua males and females was 167.6 cm. (66.0 in.) and 156.5 cm. (61.6 in.), respectively.

Cranial Deformation

Three types of cranial deformation were recognized at Toqua. Two of these, occipital and lambdoid, appeared to be unintentional. The third, fronto-vertico-occipital (designated F-O) was the only intentional type of deformation recognized at Toqua. Tests conducted between the sexes showed that there were no differences in the incidence of cranial deformation.

Paleopathology

The pathological conditions of porotic hyperostosis and periosteal reactions were analyzed from a paleopidemiological perspective. This approach views disease in terms of population fitness and the interaction between biological, cultural, and environmental factors (Mensforth et al. 1978:2).

Considering the total skeletal series, 50.0% of 168 diagnostic individuals exhibited some degree of cribra orbitalia. Out of 192 diagnostic individuals, 64.6% exhibited valvarial porotic hyperostosis. It was suggested that these relatively high frequencies attested to probable endemic proportions of iron-deficiency anemia at Toqua resulting from intense maize consumption.

Since it has been suggested that infants and young children are more susceptible to iron-deficiency anemia than are older individuals, the skeletal sample was divided into an under-10 age group and a 10-plus age group. Statistical tests between the groups for both types of lesions showed that significant differences exist, the younger group having considerably higher frequencies than the older group. This lends credence to the idea that the rapid rate of growth coupled with anemic stress due to acute and chronic diarrhea induces behavior demands for bioavailable iron among infants and children.

To obtain a clearer picture of the incidence of the pathologies among the younger group, three age categories, 0-1 years, 1-5 years, and 5-10 years, were tested against one another. For both types of lesions significant differences were found between the 0-1 age category and the other two. There were no statistical differences between the 1-5 and

5-10 age categories. These findings demonstrate the profound impact of iron-deficiency anemia on the extremely high infant mortality at Toqua.

Of interest are the differences in porotic hyperostosis between males and females. For both types of lesions males had significantly higher frequencies than females when the total sample and the village component were considered. Though male frequencies were higher than females in the mound component, these differences were not statistically significant. Based on the evidence from other studies it was suggested that perhaps females at Toqua resisted nutritional stress better than males.

From a population perspective the pathological condition of periostitis was observed on the long bones of the Toqua skeletons. Each bone was coded according to three stages depending upon the nature of involvement and the degree of severity. On a bone-by-bone basis it was seen that the tibia is the most frequently and most severely affected. This probably relates to the close proximity of the tibia to the skin surface, making it more susceptible to direct trauma or to localized infections of the overlying soft tissue.

Age-specific frequencies of periosteal reaction were organized according to the pre-established demographic age categories. In using the total frequency of affected bones, significant differences between age categories were revealed. Again, an under-10 age group was tested against a 10-plus group and the higher frequency of affected bones for the younger group was significantly different from the older group. Particularly for infants, it was suggested that the high incidence of periosteal reactions among younger individuals relates to acute infectious

diseases such as pneumonia, septicemia, staph infections, and gastro-enteritis.

Overall differences between males and females were not statistically significant. However, the interaction between age, sex, and the incidence of periostitis was significant. It was shown that the greatest differences between the sexes occurred at the 10-15, 15-20, and 25-30 year intervals. A comparison of the periosteal curves with the mortality curves showed that for the 10-15, 15-20, 20-25, and 45+ age intervals the higher frequency on the periosteal curve for whichever sex was the lower frequency on the mortality curve. It was also shown that on the combined-sex periosteal curve the frequency drops at 20-25 years then peaks at 25-30 years. However, peak mortality for combined sexes occurred at 20-25 years with a subsequent decrease at 25-30 years. These features of the two curves may possibly suggest that individuals dying during the peak mortality periods were expiring before periosteal lesions could be manifested on their bones, and that the more fit individuals who withstood stressful events such as disease and trauma during the critical mortality periods ultimately met their demise approximately five years later.

Status Relationships

The Status Hypothesis

It is generally conceded that Mississippian societies were organized at a chiefdom level of sociocultural integration (e.g., Hatch 1976). In a chiefdom model societies are stratified according to hierarchical guidelines with a high-ranking kinship group at the top. Proximity to the high-ranking kinship group usually determines one's

status within the society. This implies that status among chiefdom societies is largely ascribed rather than achieved (Service 1962).

Applications of the chiefdom model to Dallas societies (Hatch 1974, 1976; Sabol 1977) have basically shown that the differential distribution of exotic Southern Cult items corresponds to the range of social stratification within the sites. In a general sense, it was shown that burials within mounds at Dallas sites contained more of these exotic items than did the village burials; therefore, mound interments were higher status than village interments (Hatch 1974, 1976; Sabol 1977).

Status comparisons based on this mound/village dichotomy sought to test the general hypothesis that status was largely ascribed rather than achieved at Toqua. Similar to Buikstra's (1976:39) "dietary hypothesis," if status was ascribed then high ranking individuals, because of preferential treatment, may have been generally healthier and taller.

Mortality and Status

Statistical testing between the combined-sex mound and village mortality profiles at Toqua indicated that significant differences exist. Infant and childhood mortality is extremely high for the village component and quite low for the mound component. Between 10 and 40 years mound mortality exceeds village. This was particularly evident at 20-25 years, the peak mortality interval for both components.

In order to gain perspective on this type of comparison, a similar study by Blakely (1977) at the Etowah site was utilized as a comparative model. His first comparison showed that in the Mound C component at Etowah childhood mortality during the first 10 years of life was only 3%.

For the same age interval in the mound component at Toqua mortality was 16.9%. Toqua village mortality for this age interval (54.7%) is also higher than Etowah village mortality (32%). This seemingly implies that stresses during childhood at Toqua had a more profound effect on mortality than at Etowah.

In turning to comparisons between the sexes, Blakely (1977) detected two modes in the Etowah Mound C profile, one during the third decade and the other during the fifth decade. During the third decade, 70% of the burials were female. At Toqua a slightly higher percentage of males was revealed. In the fifth decade at Etowah the majority of burials were males as was the case at Toqua.

Blakely (1977:58) explained these features of the Mound C mortality curves accordingly: females, who were generally younger than males, achieved status at earlier ages through marriage to high-status males and may have been sacrificed upon the deaths of their husbands.

At Toqua, when female mound and village mortality were compared, it was shown that mound female mortality peaked at 15-20 years, which is five years earlier than village female peak mortality. In addition, mound female peak mortality (24.5%) was considerably higher than village female peak mortality (11.8%). Although Blakely rejected the idea of childbearing as an explanation for his "female mode," the Toqua findings suggested that high-status females may have been marrying younger than their village counterparts, but also may have incurred greater obstetrical problems by virtue of their youth, a suggestion that is not without documentation for modern teenage pregnancies (Moerman 1981).

A comparison of male and female curves for the Toqua mound

component showed that sacrifice of females could not be entirely ruled out. The male curve peaks at 20-25 years, then drops until 40-45 years where a second mode is detected. The female curve rises five years earlier than these two male modes, and it is suggested that sacrifice upon their husbands' death could have occurred for these females, especially during the latter mode.

Blakely's suggestion that the number of deaths increased with advancing age among Etowah Mound C males and vice-versa among village males was not substantiated at Toqua. He also noted that the "male mode" in the Mound C component could not be attributed to warfare and hunting activities. When the male curves for both components at Toqua were compared, it was shown that both peak at 20-25 years; however, mound peak mortality (24.0%) was considerably higher than village (8.8%), and remains somewhat higher until 35-40 years. If peak mortality for males is attributable to hunting and warfare activities, in a model of achieved status personal merit may have determined a man the right to be interred in the mounds.

The general implication of the comparative mortality profiles at Toqua was that achieved status may have been the more common means of upward social mobility. Blakely arrived at similar conclusions from his results at Etowah despite the fact that his mortality profiles differed in some ways from those at Toqua.

Stature and Status

The underlying hypothesis for comparing stature differences between mound and village components at Toqua was that high-status individuals may have had preferential access to food sources in terms of

both quantity and nutritional value. This "dietary hypothesis" suggests that high ranking individuals would achieve greater stature than their low-status counterparts (Buikstra 1976:39).

The results of statistical testing using femur lengths of adults from the Toqua components did not support this hypothesis, and they were not entirely agreeable with the results of similar testing by Hatch and Willey (1974) who compared stature differences between social components for the Dallas Focus as a whole and for five Dallas sites individually. Based on the mound/village dichotomy, Hatch and Willey (1974) found significant differences for males but not for females. For the Toqua components neither males nor females significantly differed. On a genetic basis it might be suggested that high-status males originated from the same population as the village males, thus lending credence to a model of achieved status. Because neither sex was significant, females, by virtue of their sex, could not be considered more equally disadvantaged than males as suggested by Hatch and Willey (1974) from their findings. If status was achieved, being tall was not necessarily a prerequisite for upward mobility. Other factors such as combative and hunting prowess for males probably played a much greater role in attaining status.

Cranial Deformation and Status

As a purely cultural practice, intentional cranial deformation is generally considered to have been performed for cosmetic reasons. At Toqua, the incidences of cranial deformation between mound and village components were found to be significantly different. This may imply that high-status individuals did not view this cultural practice in the

same manner as the low-status individuals. These findings seemingly lend support to a model of ascribed status at Toqua, a suggestion that is contradictory to the other biological assessments.

Paleopathology and Status

The examination of porotic hyperostosis between status components at Toqua was predicated on the previously mentioned "dietary hypothesis." It was suggested that high-status individuals would have had more consistent access to more nutritionally sound foodstuffs than an occasional supplementation in a maize-rich diet, as suggested for low-status individuals. If this holds true then higher frequencies of porotic hyperostosis would be expected for the village inhabitants.

Once again the results did not support this hypothesis. Differences between components for both cribra orbitalia and calvarial porotic hyperostosis were not statistically significant.

In comparing frequencies of periosteal reactions between status components, it was hypothesized that high-status individuals would have been generally healthier due to preferential treatment than their low-status counterparts; therefore, lower frequencies of periosteal reactions would be expected among individuals from the mound component. Statistical testing between components showed that differences in the frequency of periosteal reactions were insignificant.

The Structure 3 Individuals

Structure 3 probably represents a late occurring structure in the Dallas occupation at Toqua. Features such as shaft-and-chamber burial pits apparently indicated high status for certain individuals.

However, high-status artifacts were curiously absent from these graves (Richard Polhemus, personal communication). For these reasons the Structure 3 individuals were analyzed as a separate entity, but were then compared to the results of skeletal analyses for the mound and village components.

Mortality

Seven of 15 individuals from Structure 3 were under 10 years of age. This high childhood mortality rate conforms more closely to the village pattern of mortality.

Stature

Stature of the Structure 3 males differed significantly from the village males but not from the mound males. It was suggested that if status of the Structure 3 males was achieved, then tallness may have played a role in attaining a high ranking position.

Cranial Deformation

All 10 diagnostic individuals from Structure 3 possessed F-O deformation. These findings again conform more closely to the frequency of deformation among village individuals.

Paleopathology

The frequency of cribra orbitalia and calvarial porotic hyperostosis among Structure 3 males aged 10-plus years did not differ significantly from either the mound or village components. This supports the suggestion that differential access to more nutritionally sound foodstuffs was not a factor at Toqua.

Frequencies of periosteal reactions between the under-10 and 10-plus years age groups for Structure 3 were tested for differences. As was the case for the total sample, the results were significant.

The frequencies of the Structure 3 10-plus age group were compared to the mound and village frequencies and in each case the results were nonsignificant. These findings again suggest that no one segment of Toqua society was any more healthy than another.

Evaluation of Structure 3 Relative to Status

If it is hypothetically assumed that Structure 3 was a high-status unit late in the Dallas occupation at Toqua, then based on the biological evidence one must conclude that status for the Structure 3 individuals was achieved rather than ascribed.

General Conclusions

Toqua appears to have been a rather highly stressed Late Mississippian population. The high infant and childhood mortality and paleopathological indicators such as porotic hyperostosis and periosteal reactions bear testimony to the prevalence of nutritional deficiencies and infectious diseases experienced by the Dallas people from Toqua.

With the exception of intentional cranial deformation, the biological data suggest that status at Toqua was achieved to a greater extent than is commonly expected for Mississippian societies at a chiefdom level of sociocultural integration. This does not necessarily preclude the possibility of a high ranking kinship group existing at Toqua for which status was ascribed. The data simply do not greatly support this contention.

Because so few reports dealing with the physical and biocultural attributes of Dallas peoples exist, the findings in this thesis should provide a comparative body of information for future Dallas studies. In closing, it is strongly urged that researchers dealing with Mississippian skeletal populations do not stop at basic descriptive data, but, rather, make some attempt to link biological information with culture and the physical environment.

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