To the Graduate Council:

I am submitting herewith a thesis written by Michaelyn Suzanne Harle entitled "A Bioarchaeological Analysis of Fains Island." I have examined the final paper copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

Lynne P. Sullivan, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Provost and Dean of Graduate Studies

A BIOARCHAEOLOGICAL ANALYSIS OF FAINS ISLAND

A Thesis
Presented for the
Masters of Arts
Degree
The University of Tennessee, Knoxville

Michaelyn S. Harle
August 2003

DEDICATION

This thesis is dedicated to my mother, Vickie Harle, who has always been my biggest cheerleader. Her strength has always been a source of inspiration. I would also like to dedicate this thesis to my Indiana University of Pennsylvania undergraduate Professors who have inspired my love for anthropology. If it were not for these individuals I would not have gotten as far as I have.

ACKNOWLEDGMENTS

I wish to thank those who have helped me during this endeavor. First and foremost, I would like to thank my committee chair, Dr. Lynne Sullivan, who has supported me through every step in this process, from helping me obtain a research grant to helping with the organization of this thesis. Her advice has been invaluable, and her time and patience is greatly appreciated. I could not have completed this thesis without the time and effort made by my committee members. I am indebted to Dr. Konigsberg who lent me his knowledge, time, and assistance as I struggled with the paleodemographic analysis and Dr. Murray Marks for his educational contributions and his insightful advice and suggestions.

Many other individuals shared their time and knowledge. The staff at the Frank H. McClung Museum were very accommodating in allowing access to the collections. A big thanks goes out to Nicole Kuemin-Drews who brought Fains Island to my attention and for sharing her expertise in paleopathology. I cannot express my gratitude enough to Dr. Nicholas Herrmann, who spent countless hours helping me prepare GIS maps and patiently answered many of my questions. Dan Marcel also assisted in preparing maps. Amanda Hall, Bob Garrett, and Rebecca Dietman commented on rough drafts of this thesis. Research for this thesis was made possible by funding from the Tennessee Valley Authority. Although these individuals have helped me with this process, any failings within this thesis are my own.

My deepest gratitude goes to my family and friends for their encouragement. This is especially true for my parents who believed in my abilities, even when I did not and supported me emotionally (and to be honest sometimes financially). Last, but not least, I would like to thank Joshua Elder for his unconditional love and for keeping me grounded during this process.

ABSTRACT

The Fains Island site (40JE1) is a Late Mississippian, Dallas Phase site located in Jefferson County, Tennessee. Fains Island was excavated as a Works Progress Administration project in 1934. A total of 300, mostly mound based, burial features were recovered from the site. The purpose of this study is to present bioarcaheological data from Fains Island. Analysis was conducted for the total skeletal sample (N=338) in order to assess morbidity and mortality. Analytical techniques included aspects of paleodemography (through the use of a hazard model), and paleopathology (i.e., porotic hyperostosis, dental hypoplasia, periostitis, dental caries, trauma, and other descriptive pathological conditions). Comparisons were made between skeletal indicators of stress and age and sex. In addition, correlations were performed between selected stress markers and the presence of funerary objects. The assumption was that differences in funerary treatment in death may lead to insights regarding differences in social conditions in life. Since one of the objectives of this study was to fit Fains Island into a larger regional context, comparisons were made between the findings of this analysis and other Mississippian sites.

All selected biological indicators of stress were present in varying degrees. The results of various analyses indicate some differences in the incidences of stress markers between age, sex, and funerary treatment. These differences were attributed to physiological and social role differences rather than "nutritional buffering" or social inequality. Inter-site comparisons with other Mississippian communities yielded some

noteworthy differences. Incidences of periostitis were low compared to other Mississippian communities. Conversely, enamel hypoplasia rates were slightly higher than some other Mississippian communities. Nonetheless, it appears that the Fains Island's sample, located in a peripheral area away from larger multi-mound sites, was no more stress than many other Mississippian communities.

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Chapter I: Introduction

Until now, little was known of the early inhabitants that occupied what is today Douglas Reservoir. Fains Island (40JE1) is a late Mississippian, Dallas phase site, located in Jefferson County, Tennessee. Fains is one of only two sites excavated by professional archaeologists prior to creation of Douglas Dam. The site consisted of a ceremonial mound, associated structure, and surrounding village. A total of 300 burial features was recovered, mainly from the mound. Fains Island is one of the largest mound-based burial samples of all Dallas sites. Although excavated in the 1930's, the skeletal collection had not been analyzed.

The purpose of this bioarchaeological study is to assess the general health of the Fains Island inhabitants. There has been suggestion that, within Southeastern Mississippian communities, the high dependence on a maize-based diet and increased sedentism led to a highly stressed population (Cohen 1989; Cohen and Armelagos 1984; Larsen 1995; but compare Wood, Milner, Harpending, and Weiss 1992). Nonetheless, the term Mississippian subsumes a great deal of social complexity and variability (Scarry 1996) and, differences in site location, population density, political structure, and social conditions may contribute to differences in a population's ability to mitigate stress (Steckel and Rose 2002). Here, stress is defined as a disruption in an individual's homeostasis or normal metabolic functions (Powell 1988). One goal of this study is to place the by-product of stressors (e.g., pathological markers on bone) faced by the Fains' population within a larger regional context. Not all segments of a population may be stressed equally, due to both physiological and sociocultural variables. Therefore, a

second goal of this study is to compare paleopathological markers across age, sex, and status.

There has been lengthy scholarly discourse about the biological consequences of the transition from a hunter-gather subsistence to an agricultural one (Cohen 1989; Cohen and Armelagos 1984; Larsen 1995). However, some researchers (Wood, Milner, Harpending and Weiss 1992) have questioned the prevailing hypothesis of health decline with the adoption of agriculture and sendentization. Wood and coworkers (1992) suggest that increased skeletal lesions may not be a straightforward association between the decline in health and the transition of subsistence activities. As they point out, an individual needs a relatively good immune response to have bone involvement from infection. They write, "... it is unrealistic to think that the transition from foraging to agriculture must always have had the same demographic and biomedical effects" (Wood, Milner, Harpending, and Weiss 1992:367).

As a reaction to their suggestion, Steckel and Rose's (2002) volume documents the morbidity and mortality of numerous studies using the same "health index" spanning from prehistoric hunter-gathers to historic populations. They conclude that those practicing agriculture were among the "sickest" populations. However, similar to Wood and coworkers, Steckel and Rose underscore the importance of variability across populations.

> Subsistence shifts, climate, population growth, technological change, and political evolution have all been suggested as active ingredients contributing to changes in health...health has played a central role in human history, both as an agent of change and as an outcome measure indicating the quality of life (Steckel and Rose 2002:3-4).

Steckel and Rose (2002) make the distinction between what Wood and coworkers (1992:366) define as health, "something that adversely affects an individual's relative risk of death," and disease that although may have minimal impact on mortality, may have a substantial adverse effect on "quality of life."

Although the association of skeletal lesions and health within a population may be complex, as will be shown, there is a substantial body of data suggesting that quality of life may have been significantly impacted for many populations with the adoption of agriculture. Yet, we must take into consideration micro-environmental and specific cultural conditions to best characterize localized adaptations. For example, the Fains Island population was located in a somewhat peripheral setting. Were Mississippian communities who lived in these peripheral areas away from large multi-mound centers more or less prone to these stressors? To answer this question, four main health indicators: paleodemography, dental health (i.e., caries rates, antemortem tooth loss, and dental hypoplasia), porotic hyperostosis, and nonspecific infectious disease (i.e., periostitis) are examined. Trauma is also considered since it plays a major role in a society's ability to mitigate stress. Finally, certain pathologies exist that are not prevalent enough to be of any statistical significance, but discussion of these conditions may facilitate future research.

An increasing trend towards greater reliance on maize-based agriculture has been well documented from the Woodland to the Mississippian period (Smith 1992). In Mississippian communities in general, and Dallas communities in particular, a major component of subsistence was based on cultivation of corn (Hudson 1976; Lewis and

Kneberg 1946; Smith 1992). Although there were benefits in the transition from a foraging to an agricultural lifestyle, these benefits may have come at a significant cost to the overall health of the community (Cook 1984; Goodman and Armelagos 1989; Larsen 1995). Maize may be sufficient to meet daily caloric requirements, but it is lacking in essential amino acids, vitamin B, niacin, and affects the absorption of iron (Baynes and Brothwell 1990; Larsen 1997; Leonard 2000). Also, certain food processing techniques can remove fiber and important minerals (Powell 1988). Within Dallas communities, a maize-based diet was supplemented by wild food sources such as deer, turkey, fish, waterfowl, mollusks, nuts, berries and seeds (Bogan 1980; Lewis and Kneberg 1946). The mix of these resources varies between different communities (Scarry 1996). Because health status relates to diet, this variation can effect the kinds of nutritional and other stressors on the population.

Quantification of dental caries is one method by which bioarchaeologists reconstruct past diet. Research has long documented a trend of increasing caries rate as documented by more affected teeth per individual, and an increase in the frequency of affected anterior teeth and deciduous teeth (Patterson 1982; Smith 1983). The occurrence of dental caries becomes particularly prevalent with the transition to maize agriculture via a high level of sucrose (Larsen 1997). Turner (1979) used a worldwide sample to determine caries increase from foraging (1.7 percent), mixed foraging (4.4 percent), to full-blown agriculturalists (8.6 percent). Today, the presence of two carious lesions per person usually indicates dependency on carbohydrates (Rose et al. 1991). In southeastern archaeological series, this increased caries rate is well documented with the adoption of

agriculture during late Woodland/Mississippian societies (Cook 1984; Larsen et al. 1991; Rose et al. 1991). Stable isotopic analysis has become particularly useful in supporting this assumption (Blakely 1995).

Although carious lesions are not a marker of stress per se, their prevalence is often noted in conjunction with pathological markers of malnutrition among prehistoric populations. Research has demonstrated a decline in health among Middle Woodland foragers and Late Woodland agriculturalists suspected of a greater reliance on maize-based diets (Cook 1984). Thus, the prevalence of dental caries in a population has been important in understanding the stress of a population in transition in its subsistence activities (Cook 1984; Larsen et al. 1991; Larsen 1998).

Another potential nutritional stress has to do with consumption of protein. Although meat was consumed within Mississippian communities, nutritional sufficiency is questionable (Powell 1988). No one suffered more from this lack of protein than the youngest (Goodman and Armelagos 1989). Children could not consume the amount of calories in low protein quality sources to make up for this deficiency (Powell 1988). Skeletal markers of this phenomenon can be seen in increased rates of pathogenic cranial lesions indicating dietary deficiency anemia (i.e., porotic hyperostosis) and developmental defects in enamel (i.e., enamel hypoplasia) among agricultural societies (Goodman and Armelagos 1989, 1985; Stuart-Macadam 1989,1985).

Population increase, increased sedentism, and possibly increased trade networks associated with the Mississippian era also led to an increase in the opportunity for the spread of infectious and parasitic disease (Cohen and Armelagos 1984;

Milner 1982). Furthermore, longer periods of occupation can lead to a decrease in sanitation and poor hygienic conditions (i.e., pathogenic contact), which facilitate the spread of disease. Bioarchaeological comparisons of the prevalence of nonspecific infectious diseases (i.e., periostitis) indicate that agricultural societies were much more prone to these types of infections than earlier groups (Cook 1984; Larsen 1995, 1984). There is also evidence that these social conditions fostered the spread of more specific infectious diseases such as tuberculosis (Buikstra and Williams 1991) and endemic treponematosis (Powell 1988).

There is also a synergistic relationship between malnutrition and infection. Poor diet lowers immunity against infectious disease and some infections can preclude the absorption of necessary dietary needs (Powell 1988). "Differential exposure to pathogens may provide initial opportunities for variations in disease experience, but the strength of resistance permitted by the nutritional status of stressed individuals determines in great part the ultimate outcome of encounters between hosts and invaders" (Powell 1988:33).

An important consideration is that not all segments of a population will be equally impacted by stress. This study examines the distribution of pathologies among high and low rank, age, and sex. Although genetic and physiological factors play a role in these differences, one cannot ignore cultural considerations. The eco-political perspective here highlights how social inequality can be involved in the allocation or control of resources and how such inequality can have a direct implication on health. Unlike standard cultural ecology, which simply looks at human adaptation to the

environment, political ecology adds the nuances of political economic analyses, which place emphasis on historical processes and a focus on historical (in this case prehistoric) conditions of labor as a source of inequality (Dewalt 1998).

Differences in health by sex, status, and rank provide perspective on food allocation across these groups. Historically, the realm of political economy has played an integral role in shaping human biology (Goodman and Leatherman 2001). For instance, access to resources, to enhance quality of diet and healthcare, and differences in labor allocation, all have biological consequences (i.e., Dewalt 2001; Crooks 1996; Morfin 2001). There is no reason to assume this situation was not present in complex prehistoric society. Evidence for differential redistribution of food in Mississippian societies, however, has been rather conflicting. Populations in the Black Warrior Valley in west central Alabama (Powell 1988, 1991) and the western Illinois American Bottom (Milner 1991) appear to have enjoyed a rather healthy life with no marked health quality differences between socioeconomic strata. Yet, in other Mississippian societies such as Dickson Mounds (11FO34) in western Illinois (Goodman and Armelagos 1989) and Averbuch (40DV60) in central Tennessee (Eisenberg 1991), the distribution of pathologies suggests populations carrying a high pathogen load. The difference in these studies may not reflect the relative robustness of research techniques between investigators insomuch as they reflect the heterogeneity and complexity of the Mississippian period cultural and micro-environmental landscape. Goodman and Armelagos (1985; Goodman 2001), and to a lesser extent Eisenberg (1991:86), suggest that high pathogen loads at Dickson and Averbuch may be indicative of unequal

exchange of resources as a tribute to larger political centers, namely Cahokia. However, Milner (1990) challenges this suggestion of long-distance tributary exploitation on both empirical and logistical grounds.

Within Dallas communities, researchers have compared trace element concentration (Hatch and Greidel 1983), cortical thickness (Hatch et al. 1983), and paleopathological rates (Betsinger 2002; Langdon 1989; Parham 1982; Parham and Scott 1980) between mound and village interments. These studies have produced conflicting results regarding differential health between high and low rank individuals.

Zooarchaeological research also demonstrated that better cuts of meat (e.g., front legs of deer) may have been distributed to the highest ranks within Dallas communities (Bogan 1980). In contrast, VanDerwarker (1999) relates differences in meat distribution to feasting activities on and near Dallas mounds rather than differential allocation.

Studying health status by sex can be even more complex. First, it is important to note the distinction between sex and gender. Sex refers to the biological differences between males and females. Conversely, gender is culturally constructed expectations of social roles. Many times, but not necessarily, gender roles are based on biological sex. This distinction is important since "the behavioral practices that reflect gender expectation may have biological outcomes" (Armelagos 1998:22).

Research suggests hormonal differences between males and females that affect immunological activity (Ortner 1998). Study of a modern population demonstrates that girls have higher levels of IgM (immunoglobulin M) than boys (Purtilo and Sullivan

1979). Ortner (1998) suggests this difference may be related to differential selection due to the female's role as child bearer. Since there are sex differences in buffering among hormonal systems, when subjected to nutritional duress, men should be more vulnerable to disease. If resource exchange is equal and the population is subjected to stress, males should exhibit more stunted growth (Stini 1985). Yet, with unequal resource distribution by sex, females are subjected to added nutritional stress, and females may have a greater growth reduction than males. Larsen (1998; Larsen et al. 1991) utilizes this approach in his long-term study of prehistoric populations in coastal Georgia and North Florida. He found that females had a higher prevalence of dental caries, which he argues relates to maize access. Hence, differences in health status by sex may not represent differences in sex per se but the cultural manifestation of these differences (i.e., gender).

Evidence for significant differences in health between sexes among Dallas communities is also conflicting. While Hatch and coworkers (1983) found some differences between males and females in cortical bone thickness at the Hixon (40HA3) and Dallas (40HA1) sites in the Chickamauga Basin, Betsinger (2002) found no statistically significant difference in periostitis or porotic hyperostosis frequency by sex in other Dallas phase sites in the Tellico reservoir (Betsinger 2002). Here, I will attempt to broaden the understanding of this interaction between diet, sex, and gender within Dallas communities by considering paledemographic comparisons and a broader range of disease classes.

In summary, this research evaluates the health status of the inhabitants of Fains Island, a Dallas Phase site. This investigation is through a population perspective and through comparison of segments of the population. Chapter II situates this study within the broader archaeological context. Chapter III provides an in-depth discussion of the variables, while chapter IV presents materials and methods employed in this study. Chapters V and VI focus on the results and interpretation with some concluding remarks.

Chapter II: Archaeological Investigations

History of Dallas Phase Excavations

The Dallas phase is a late Mississippian occupation usually confined to the Valley and Ridge physiographic province of East Tennessee and North Georgia. Radiocarbon dating suggests a time span of A.D. 1300-1600 (Schroedl et al. 1990). The Dallas phase is preceded by the emergent Mississippian Martin Farm phase (A.D. 900-1000), the early Mississippian Hiwassee Island phase (A.D. 1000-1300), and followed by historically documented American Indian groups such as the Cherokee (Schroedl 1998). A map of major Dallas phase sites and contemporaneous Mouse Creek (A.D. 1400-1600) sites is shown in Figure 1.

The first site recognized with a Dallas component was Citico Mound (40HA65) near Chattanooga, Tennessee, excavated in 1867 by Read (1872). This work marked the beginning of extensive excavations in the Tennessee Valley. For the most part, these excavations were artifact based with little or no regard to contextual discussion (Hatch 1974). Agencies such as the Works Progress Administration (WPA), the Civil Works Administration (CWA) and the Tennessee Valley Authority (TVA) were created in order to generate jobs and help the country rebound from the Great Depression (Lyon 1996). The burgeoning New Deal archaeology in the 1930s and 1940s, with projects conducted by these agencies and the Smithsonian Institution, played a substantial role in the development of southeastern United States archaeology as a whole. Specifically, W.S. Webb at the University of Kentucky, who directed the Norris Basin project, and Madeline Kneberg and T.M.N. Lewis, at the University of Tennessee, were

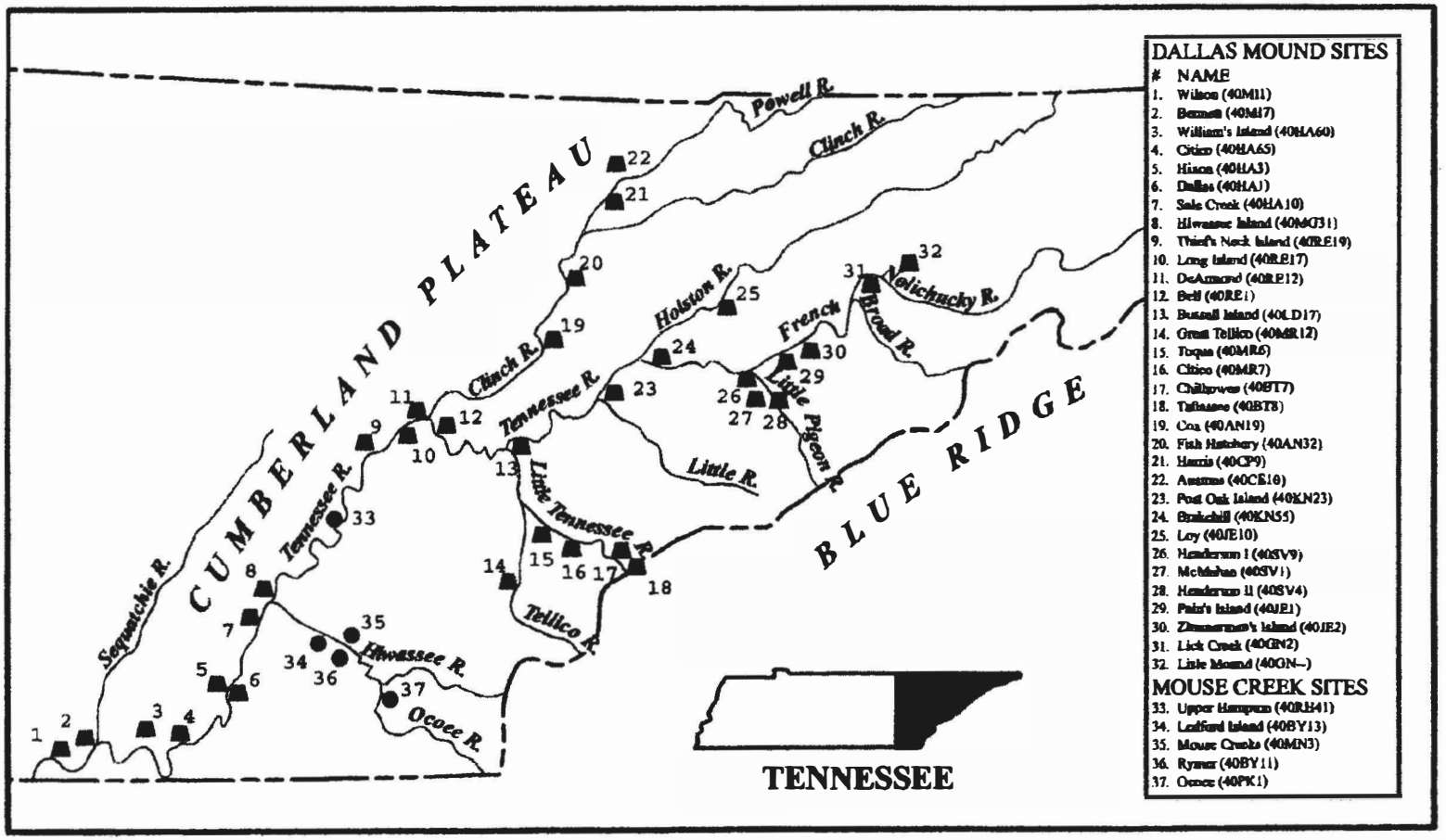


Figure 1: Location of Major Dallas and Mouse Creek Sites (Courtesy of Lynne P. Sullivan)

instrumental in the advancement of eastern Tennessee archaeology (Lyon 1996; Sullivan 1999).

Many early interpretations focused on trait lists to use the direct historic approach to correlate prehistoric sites with historic populations. According to Hatch (1974), many of the Mississippian sites of eastern Tennessee and northern Georgia were initially considered ancestral Cherokee since continuity existed between many historic Cherokee villages and these sites. Webb, however, rejected the hypothesis of historic Cherokee affiliation and instead suggested that Dallas sites represent the ancestral population of the historic Creek (Hatch 1974). This line of reasoning was largely influenced by a cross-regional explanatory framework in which researchers attempted to link Mississippian expansion in the Southeast through the migration of Muskogean peoples into these regions (Smith 1984). Webb (1938: quoted in Hatch 1974) writes:

> **Recent excavations in Madison County, Ala., in connection with the archaeological survey of the Wheeler Basin conducted by the author seem to indicate occupancy on the Tennessee River by some branch of the Muskhogean people closely associated with the builders of the Etowah mounds. It is possible that these were some of the Upper Creek tribes. The burial sites at Sites Nos. 10 and 19 of bodies in a sitting posture have been discussed in reports from these sites. In addition, the use of bark and strips of wood for covering graves has been found at Site No. 19. This trait was also very prominently shown at *Dandridge* (emphasis placed by author). Attention was called to the close resemblance of these customs with burial customs of the Creeks, as reported by several white observers around 1790.**

Although Webb never mentions it explicitly, it can be assummed that the site near Dandridge is that of Fains Island since it was the only site near Dandridge dug at this time.

Lewis and Kneberg first proposed "Dallas Culture" as a term largely based on their work in the 1930s in the Chickamauga Basin and specifically on Hiwassee Island (Lewis and Kneberg 1946; Lewis et al. 1995). Lewis and Kneberg extended Webb's research in attempting to link historic Creek populations with prehistoric Dallas populations. A condensed definition of the Dallas culture given by Lewis and Kneberg (1946:10) is as follows:

> The Dallas Focus represents a Middle Mississippi culture that followed the Hiwassee Island Focus as the dominant culture of the eastern Tennessee Valley... There seems to be little doubt that the Dallas Focus represents the culture of the Creek Indians... The Dallas Focus Culture includes substructure mounds; community buildings and dwellings constructed of large logs; burials (predominately partly flexed) interred in the village areas and substructure mounds; small triangular projectile points; large and small stone disks; shell gorgets; shell vessels and shall ear pins; repousse copper work; elbow pipes; and strap handled pottery with incised, punctuate, filleted and effigy-modeled decoration.

There are thirty-three known Dallas phase village sites with accompanying mounds (Schroedl 1998). Dallas towns usually consist of one or more ceremonial mounds, a plaza, and residential community structures enclosed by a stockade (Sullivan 1995). They usually occupy between two to five hectares of land and include thirty or more houses. The typical population is estimated as two hundred or more (Schroedl 1998).

A marked increase in both size and complexity of villages in the transition from the Hiwassee Island phase to the Dallas phase may suggest greater sociopolitical complexity, presumably from greater agricultural dependence and a need for better control over these resources (Schroedl 1998). Changes in mortuary patterning also serve

to separate the Dallas phase from the preceding Hiwassee Island phase. There is a transition through time toward increased differentiation between ritual and ceremonial space. Schroedl (1998) relates this differentiation to a reinforcement of social differences. In addition, Dallas sites include burials within the villages not just in the burial mounds typical during previous phases. This patterning could be interpreted as increased clan identification and the recognition of ancestors linked to certain households (Schroedl 1998).

Much of the recent research surrounding Dallas phase sites concentrates on the sociopolitical makeup both within and among these sites. Reconstruction of the political organization within Dallas centers is based in large part on mortuary analysis and is discussed below. There is also a considerable amount of discourse about the nature of sociopolitical alliances between sites. Based on differences of mortuary complexity, Hatch (1974) ranked Dallas sites by relative social complexity with Citico (40HA65), Hixon (40HA1), and Dallas (40HA3) at the higher end of the spectrum and DeArmond (40RE12), Hiwassee Island (40MG31), Fains Island (40JE1), and Sale Creek (40HA10) at the lower. This ranking was based on the assumption by Saxe (1970) that variety and complexity of burial rites parallel social complexity.

Hudson and coworkers (1985) suggested that Dallas sites were connected through a web of alliances and were ranked with lesser centers dominated by larger paramount centers. Toqua (40MR6), Citico (40HA65), and Bussell Island (40LD17) are thought to be at the pinnacle of these centers. This interpretation is based largely on Spanish reports suggesting that towns possibly in the Dallas area were linked in some

loose confederation subject to a paramount chiefdom in Coosa. Hudson and coworkers (1985) suggest that this paramount center could possibly be the Little Egypt site in Georgia, but this interpretation is not widely accepted. Boyd and Schroedl (1987) questioned this alliance scheme on both archaeological and ethnohistorical grounds. Furthermore, Little Egypt can in no way compare in scale to Etowah or Moundville and there is little evidence that Dallas sites ever coalesced the way described by Welch (1991) for Moundville in Alabama. In fact, some researchers involved with the Coosa reconstruction are now conceding that if Dallas communities coalesced, it was briefly and perhaps in symbolic nature only (Halley et al. 1990).

Rank in Dallas Societies

In order to understand the socio-political makeup within Dallas communities, it is important to discuss approaches used by archaeologists to infer evidence of social ranking. Mortuary archaeologists usually make the distinction between two key concepts "rank," which infers differential access to wealth and resources and "status," which is a composite of different social roles. Peebles (1971) argued that differential disposal activities might represent the social status of one in life. Central to this theme is the assumption that the manner in which the body was treated in death represents the deceased individual's social persona in life (Binford 1971). This argument became the central tenet for much of the mortuary analyses conducted over the last several decades. One cannot discuss the history of mortuary analyses without first discussing the idea of energy expenditure, since it is central not only to many analysis of Dallas sites but for

sites throughout the Southeast. Tainter (1978) devised the energy expenditure model through ethnographic analyses. The major tenet of the energy expenditure model is that the more prestigious the individual, the more energy will be devoted to his/her mortuary treatment (i.e., complexity of body treatment, construction and placement of the burial, material ritual contributions, and human sacrifice). In the same vein, Peebles and Kus's (1977) study utilized this idea of differential energy expenditure in mortuary practice, along with evidence of craft specialization, arrangement of architectural spaces between and among sites, and the level of agricultural autonomy, to develop archaeological correlates of chiefdoms. In order to test this argument, Peebles and Kus examined material from Moundville. By studying the locations of burials and associated grave goods, Peebles and Kus established clusters in which they placed individuals into two groups: the "superordinate" and the "subordinate"(i.e., higher and lower rank). Likewise, O'Shea (1981) argued that such vertical social differentiation is symbolized by the degree of elaboration of mortuary and the quality and quantity of funerary objects. Inversely, horizontal social differentiation (e.g., membership in clans and moieties) usually is marked by perishable material that would be unlikely to be found in the archaeological record.

Hatch's (1974) regional study of mortuary patterning marked a new era for Dallas phase investigations as to how researchers conceptualized the sociopolitical makeup within these societies (Sullivan 2001b). Using cluster analysis for nineteen Dallas sites, Hatch (1974) concluded that there were statistically significant sex and age based correlations between burial locations and funerary artifacts. Males tend to be

associated with triangular points, ceremonial blades, cores, and/or flakes, bone awls, and utilitarian celts, all of which may be indicative of male-oriented activities. On the other hand, burials of females and subadults are more likely to be associated with shell gorgets and earpins or shell artifacts in general. Hatch also found that the majority of burials located in mounds are male, while females are more likely to be interred within the villages. When females were interred in the mounds, Hatch noted the limited number of associated artifacts. The inclusion of some women and children in the mounds suggest there was a level of ascription (i.e., status determined by kinship and/or birth) in determining status in Dallas communities (Brown 1981). According to Hatch (1974), the presence of artifacts that required a high expenditure of energy, including raw and/or rare materials as grave associations (i.e., shell or bone beads, large gorgets, and conch shells) regardless of the age or sex of the interred individual, attest to the ascribed nature of Dallas's mortuary program. Burials with these items would mark the highest-ranking kin group. Less expensive shell items are found within the village among females and subadults, and not with males. This pattern led Hatch to suggest that the transmission of goods could be traced matrilineally and not patrilineally. This kinship linkage is not surprising given that most historic native southeastern populations are matrilineal and matrilocal (Hudson 1976). Nonetheless, the fact that males outnumbered females in the mounds indicated to Hatch that, in general, men seemed to have outranked women.

Scott and Polhemus's (1987) study of the social dimensions of the mortuary patterns at Toqua, a Dallas phase site located on the south bank of the Little Tennessee River in Monroe County, Tennessee, served to complement Hatch's research. The Toqua

site comprises two large platform mounds (Mound A and Mound B) and an extensive village site. Scott and Polhemus (1987) extended Hatch's energy expenditure model to include not only burial location and associated artifacts but also pit shape, pit size, and pit modification (i.e., the inclusion of wood, stone, or organic material). The study showed a dichotomy of energy expenditure between mound and village burials. Similar to Hatch's results, the majority of the mound population consisted of adult males, some of whom were interred with a large number of prestige items. Yet according to the researchers, there was not strong evidence that suggested an apical class of adult males set apart from females or other high status burials. Scott and Polhemus (1987:395) write:

> In Mound A, there are five adult males that have large pits and are distinctive in the quantity and variety of associated artifacts, such as shell, gorgets, cups, masks, a trumpeter swan wing and sandhill crane skull. However, there are also four females in Mound A and a double burial with a male and a female that are comparably accompanied. Mound B has two high ranking adult males; East village has two males and West Village has two females of high status.
>
> There are at least two possible interpretations of this patterning. First, females as well as males can be classified as high ranking through an ascriptive process in which pit location boundaries are not absolute. Alternatively, second, there is not a strong ascriptive basis for social ranking, and the females (and possibly the males) reached their high social position through achievement. Therefore, the unique class of males in the mound which would be indicative of an ascribed ranking system is not strongly manifested in the social system.

Scott and Polhemus (1987:398) argue that Toqua was comprised of two levels of social status, one consisting of "high status lineage elders" and the other as "commoners."

The inclusion of females within mounds is often viewed as evidence of ascriptive based rank and/or status gained through the marriage of high ranking males. In fact, the high rate of young adult females interred within the mound at Toqua led Parham (1982) to suggest that wives of high ranking males may have been sacrificed upon the death of their husbands. This argument was derived from Sears's (1956) and Blakely's (1977) interpretations of the Mississippian sites Kolomoki in southeastern Georgia, and Etowah in northwest Georgia.

Unlike Hatch, Scott and Polhemus underscore achievement as the dominant means of social ranking at Toqua. Data indicate a gradual increase in lithic artifact funerary associations that correlates with an increase in age among adult males. According to the researchers, this pattern would seem to suggest achievement-based status, but they admit that there is no relationship between an increase in age and burial energy expenditure. Scott and Polhemus (1987:399) conclude:

> Status at Toqua has both ascribed and achieved characteristics, which appear to exist simultaneously. Frequently studies have attempted to class sites as representing either an ascribed mode of ranking or one of achieved ranking, when in reality both will occur simultaneously within a site, for even a single individual may be endowed with both ascribed and achieved identities.

These studies demonstrate that differences in status among adult males represent a complex interaction between multiple identities based on both ascription and achievement. Yet, the ability for females to obtain achievement-based status is unclear. Utilizing data from Toqua, Sullivan's (2001b) recent study may shed light on this issue. Central to Sullivan's research is the concept of hetararchy or multiple fields or avenues of

power. The study also challenges us to reexamine Eurocentric notions of the domination of public spheres by domestic ones. The study marks a recent trend in mortuary archaeology to not only link certain burials with architectural spaces and suites of funerary objects, but also to attempt to explain the ideology behind these correlations. Sullivan argues that if Dallas sites represent matrilineal organization, as has been suggested, then it makes sense that females would have achieved their status within the domestic realm rather than the public domain. This correlation suggests that the interment of females in domestic space, rather than public space, is not necessarily indicative of differences in relative prestige. Rather, it would be more likely that higher-ranking females would be interred in the domestic sphere, "because, their prestige and political influence in these matrilineal societies derived from, and was based in, the social context of households and kin groups" (Sullivan 2001b:124). Sullivan points to the fact that although some females are interred in the mound, most of these females are young, attesting to the ascriptive nature of these burials. On the other hand, older females, those most likely to be associated with achieved prestige, are almost exclusively interred within the village. Furthermore, Sullivan suggests that differences in funerary objects between men and women mark division of labor (males associated with implements for woodworking, hunting, and implements of war, and females with culinary and other domestic tools) and do not necessarily represent differences in prestige.

Although these studies allow insight into status differentiation in Dallas phase societies, it must be remembered that burials represent the mourners' idealized representation of the person's former self. As Leach (1979 quoted in Pearson 1999)

points out, "'[If] graves are in any way an index of social status it is the social status of the funeral organizer as much as the social status of the deceased that is involved." Biological data, such as differences in nutritional stress, can serve not only to complement these studies, but also to shed light on differences, or lack thereof, that can be obscured by burial practices.

Fains Island

Fains Island (40JE1) is located in the French Broad River in Jefferson County, Tennessee, near Dandridge. The island is located in what is now Douglas Reservoir, created by the construction of the Tennessee Valley Authority's Douglas Dam. The island was 1¾ mile long and about ½ mile wide, and at the highest point twenty-five feet above the normal river level (Lewis and Wilder 1934) (Figures 2 and 3). Although reports indicate there were several known archaeological sites located below the pool area, only two sites, Fains Island and Zimmerman Island (40JE2), were excavated under the auspices of the Works Progress Administration (WPA) before dam construction.

According to the *Annual Report for the Bureau of Ethnography* (Palmer 1881), Edward Palmer for the U.S. National Museum first excavated Fains Island around 1881 (Thomas 1894; Brain and Phillips 1996). Little is known about this initial investigation. According to one report, thirty-two skeletons were found; all of these appeared to be interred within a structure on top of the mound (Holmes 1884:463; Brain and Phillips 1996). Another report lists only sixteen burials (Thomas 1894:358; Brain and Phillips 1996). Present whereabouts of skeletal material and associated artifacts

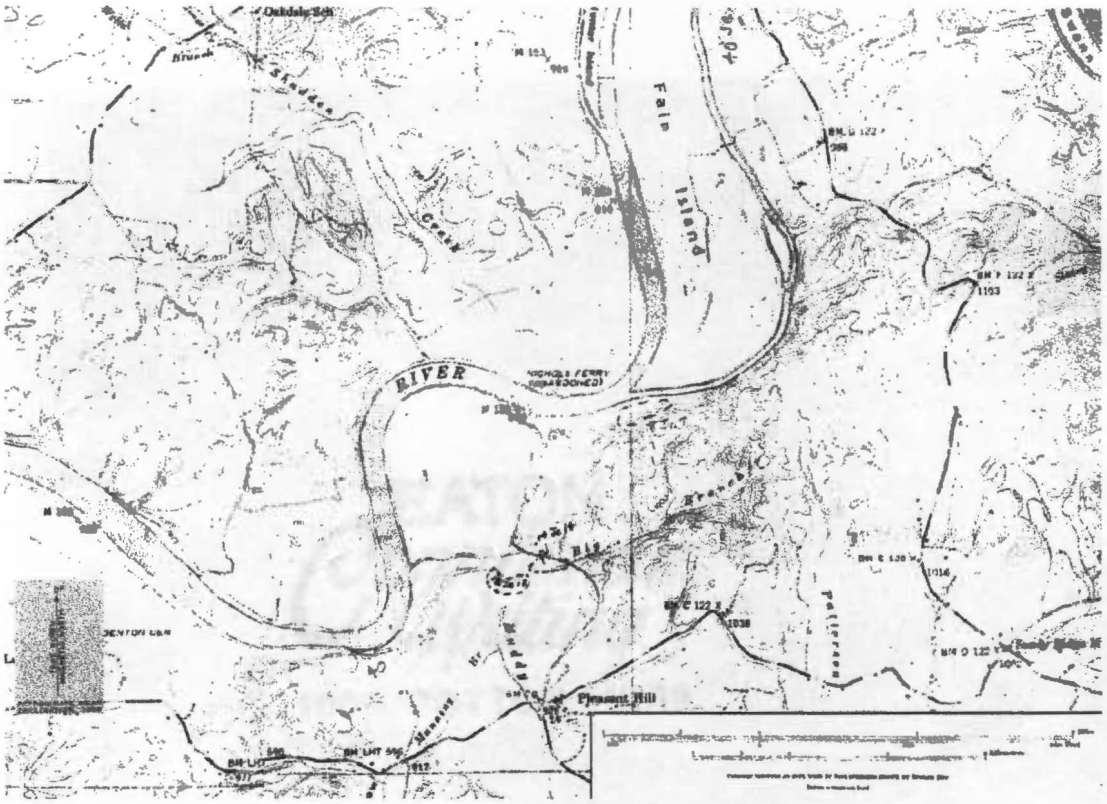


Figure 2: 1939 USGS Topographic Map, Shady Grove Quad, Fains Island UTM 17 28242E 3985398N

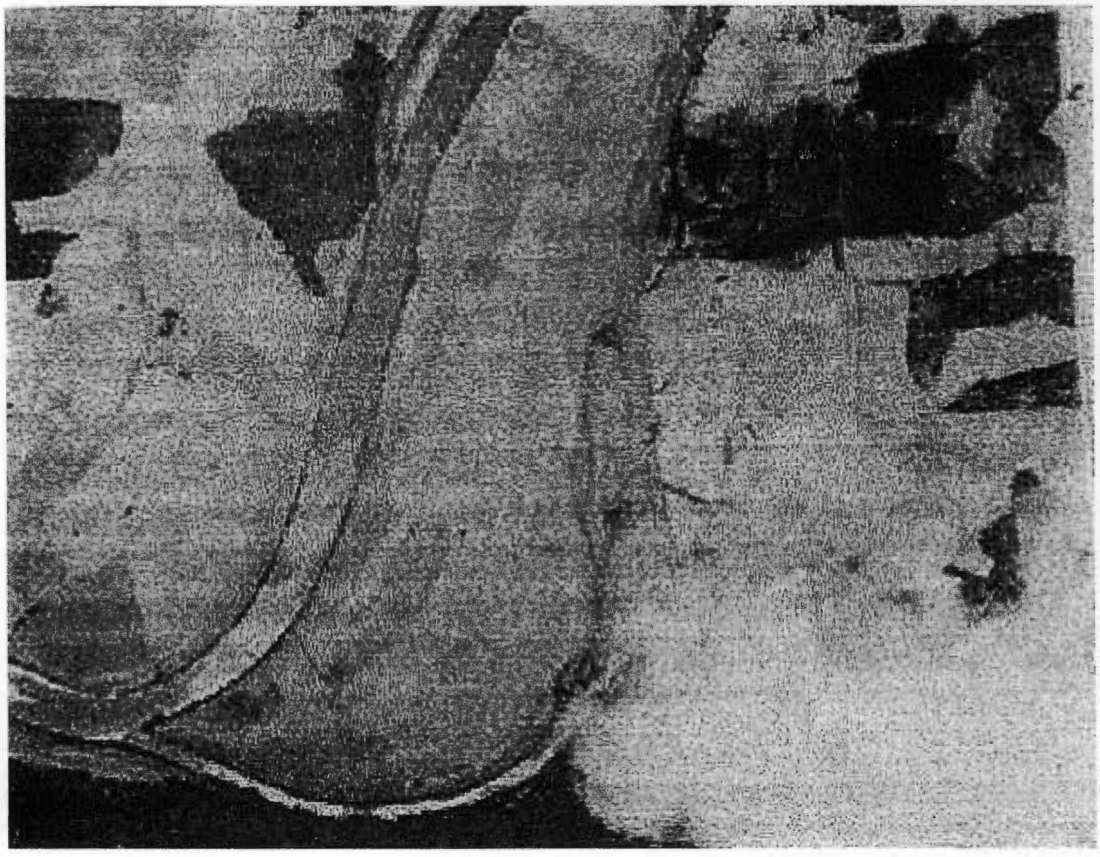


Figure 3: Arial View of Fains Island Prior to Inundation (TVA photograph collection, The Frank H. McClung Museum, The University of Tennessee, Knoxville)

from this excavation is unknown.

The second known excavation at Fains Island, under the direction of Lewis and Wilder, began in 1934, the same year as the formation of the Department of Archaeology at the University of Tennessee (figure 4). Materials gathered from this excavation, including the skeletal assemblage, associated artifacts, and incomplete excavation report, are curated at the Frank H. McClung Museum at the University of Tennessee. The archaeological emphasis at Fains was on the mound population. Only the mound itself, the periphery of the mound consisting of redeposited soil from the mound, and four test trenches in the village were excavated.

Most of the pottery from Fains Island consists of shell-tempered and some grit-tempered ceramics (Spaulding 1937). Preliminary perusal of the ceramics suggests a Dallas component and perhaps a slightly earlier Pisgah and Late Woodland component (Lynne Sullivan personal communication 2002; Cameron Howell personal communication 2003).

One radiocarbon date was obtained by Accelerator Mass Spectrometry (AMS) determination from extracted collagen of a bone awl. The AMS analyses yielded a date of 300 ± 30 (Beta-179901) or cal AD 1450-1530 (intercept cal AD 1490; calibrated at 2 sigma with the program INTCAL 98 [Stuiver et al. 1998]). Although a later date than expected, this date does fall within the tail end of the Dallas phase. It should also be noted that the dated material is located close to the top of the mound. Figure 5 shows the location and depth of the awl within the mound compared with some shell gorgets associated with the burials.



Figure 4: Fains Island Project Director C.C. Wilder, Photo Taken During Excavation, 1934 (TVA photograph collection, The Frank H. McClung Museum, The University of Tennessee, Knoxville)

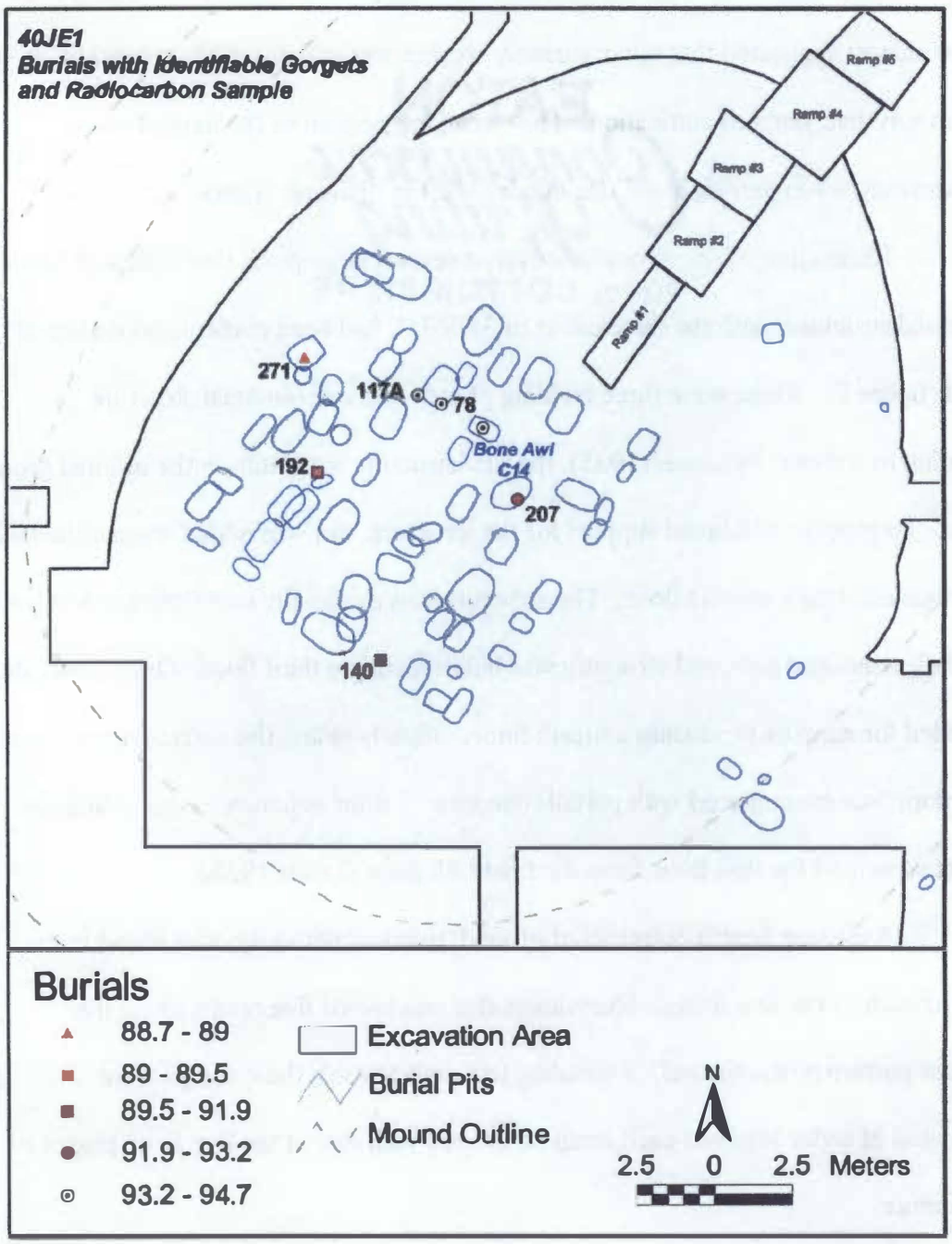


Figure 5: Location of Radiocarbon Date(Bone Awl) and Burials with Gorgets within the Mound. (burial 78 Citico Style Gorget; Burial 117 Facemask; Burial 207 Fenestrated Rattlesnake; Burial 140 Spaghetti Style; 192 Fenestrated Rattlesnake; 271 Fenestrated Rattlesnake.

The mound was located on the southern portion of the island (figure 6). Local residents suggested that approximately six feet were taken off the mound by at least seventy-five years of cultivation. The remaining portion of the mound was approximately seven feet high and one hundred feet in diameter (Lewis 1935).

Excavation of the mound uncovered several large posts that indicated that a ceremonial structure, with the dimensions of 35'x 35', had been constructed on top of the mound (figure 7). There were three building phases of the ceremonial structure. According to a report by Lewis (1935), the first structure was built on the original ground surface. To provide additional support for the structure, dirt was added around the build posts, thus creating a second floor. The structure was eventually torn down or leveled by natural elements and a second structure was built creating a third floor. Once again, dirt was added for support producing a fourth floor. Slightly below the surface of the mound a fifth floor was encountered with partial remains of a third structure. Approximately five feet separated the first floor from the final fifth floor (Lewis 1935).

A circular hearth constructed of sand, overlaid with clay, was found in the center of each of the five floors. Excavation also uncovered five ramps along the northeast portion of the mound. According to Lewis (1935), these ramps were constructed of cedar logs and each ramp connected with one of the five floor phases of the structure.

A majority of the burials was located underneath the five floors of the structure. Blitz (1999) suggests that such structures, common in many Mississippian sites, could have served multiple uses, as elite residential or council houses and/or



Figure 6: Mound at Fains Island (1934) (TVA Photograph Collection, The Frank H. McClung Museum, The University of Tennessee, Knoxville)

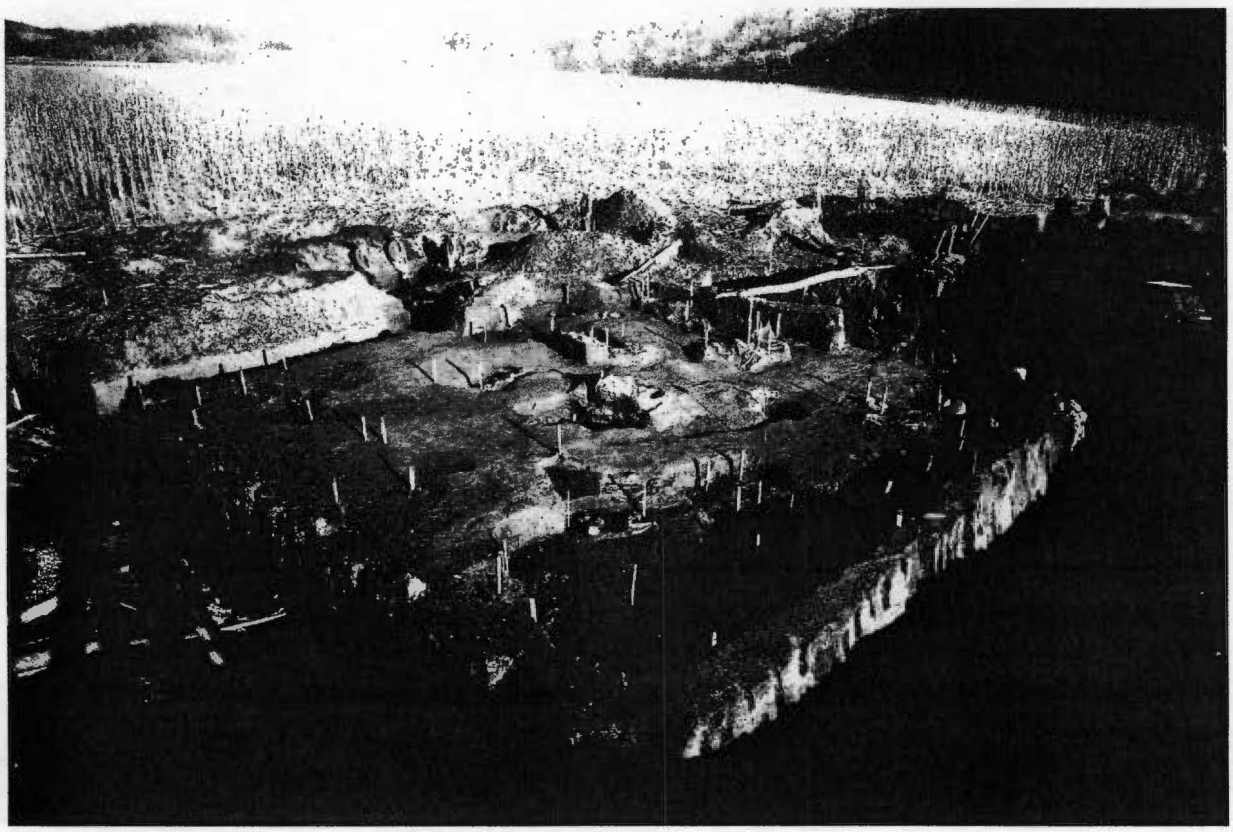


Figure 7: Ceremonial Structure Associated with the Fains Island Mound (1934) (TVA photograph collection, The Frank H. McClung Museum, The University of Tennessee, Knoxville)

temples and charnel house/mortuary facilities. The large number of burials interred within the structure suggests uses more connected to ceremonial rather than secular activities. A noteworthy aspect of the Fains Island mortuary pattern is the ordered nature of the burial pits located within the structure. The distribution of burial features at the base of the mound can be seen in Figure 8. This rectangular distribution is similar to Hixon (40HA3), another Mississippian site located in Chickamauga Basin. However, at Hixon, the burials were located only along the building periphery, whereas at Fains the entire interior building space was utilized.

Three hundred burials were uncovered during excavation. Many of the pit burials were lined and covered with bark, with wood supporting the bark covering the pit (Lewis 1935). Samples of wood were collected, but present whereabouts of this material is unknown. The majority of these burials were located within the mound; only seven were located within the village test trenches. The village trench burials consisted of five females and one infant (skeletal remains from two burials were discarded in the field). As in most Dallas sites, the majority of burials, 254 (84 percent), consisted of single interments. However, 38 (13 percent) of the burials consisted of two individuals, and 8 (3 percent) consisted of more than two individuals. It is difficult to discern how many multiple interments were created by intrusion of one burial put into another.

For burials located within the mound, the adult sex distribution is virtually equal, 75 (22.59 percent) males and 84 (25.3 percent) females. The distribution of sexes interred in the mound can be seen in Figures 9 and 10. When examining the distribution of females by age, an interesting pattern emerges. Although there are substantially more

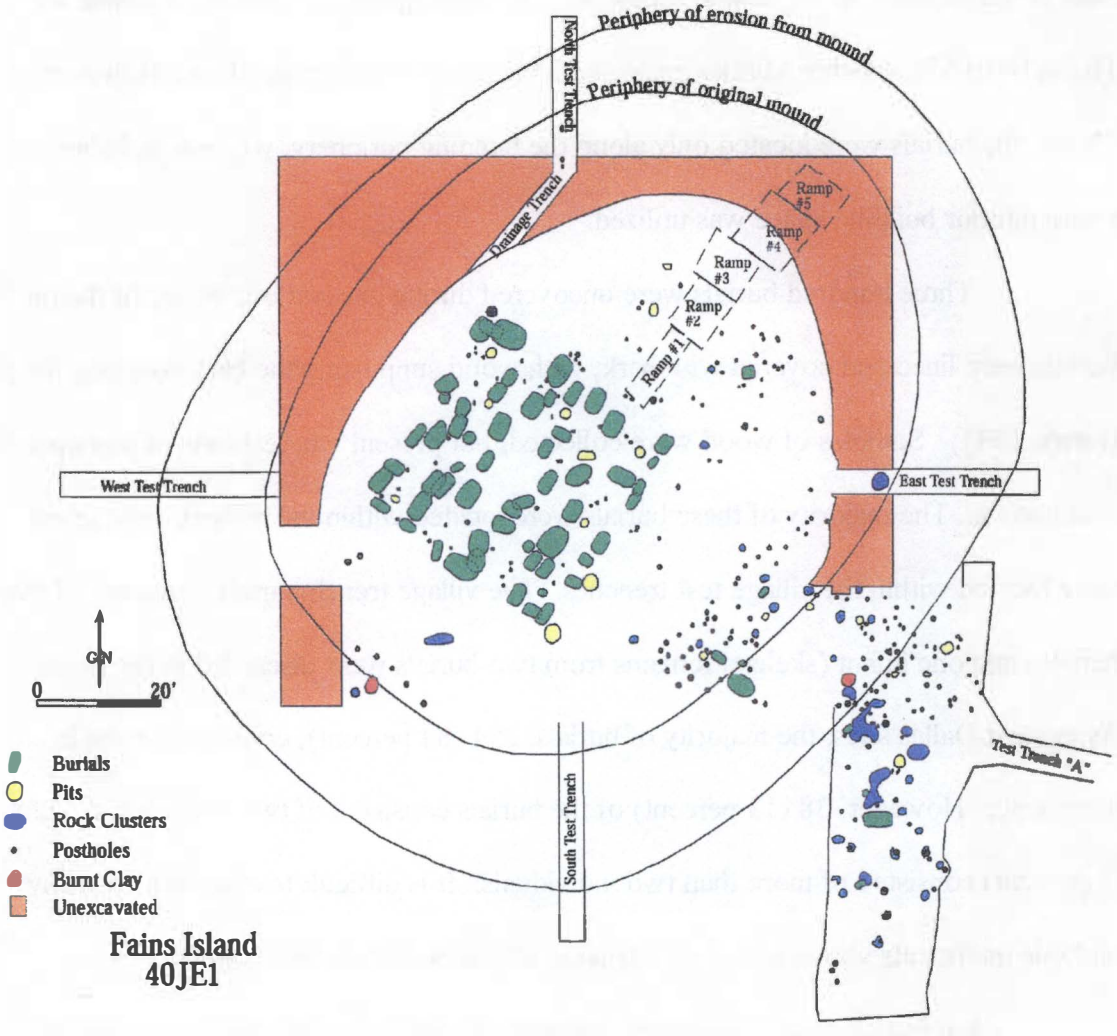


Figure 8: Map of Mound Base Recreated from Original Excavation Report

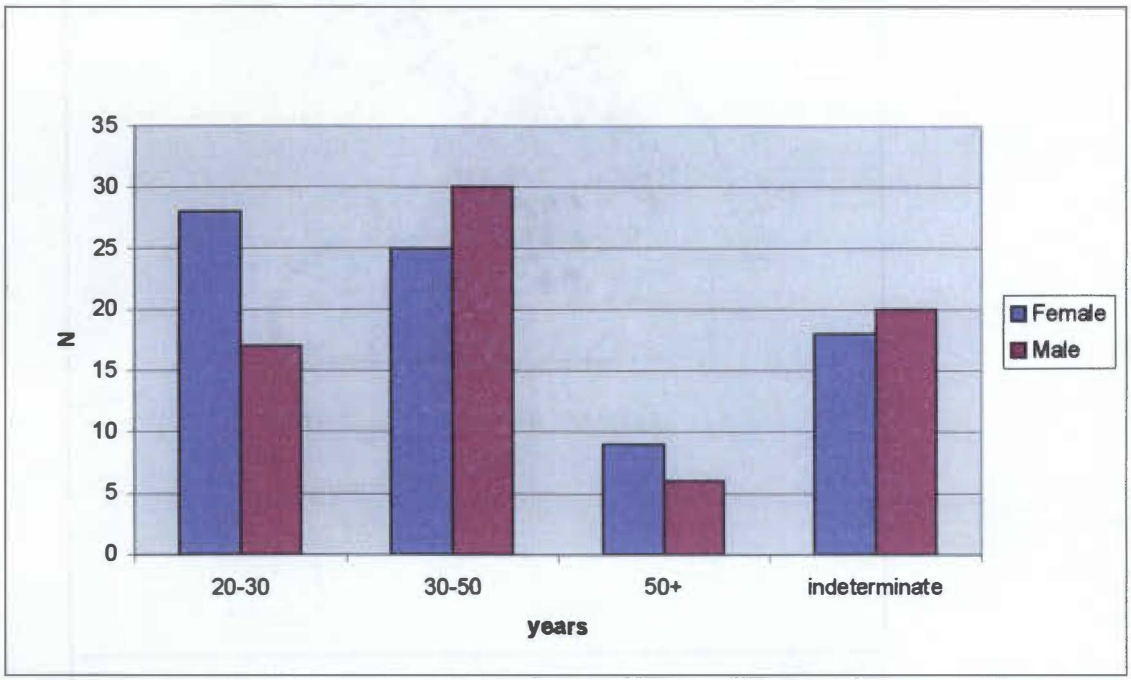


Figure 9: Sex Distribution by Age of Mound Internments (Note: individuals who fell between two ranges were evenly redistributed.

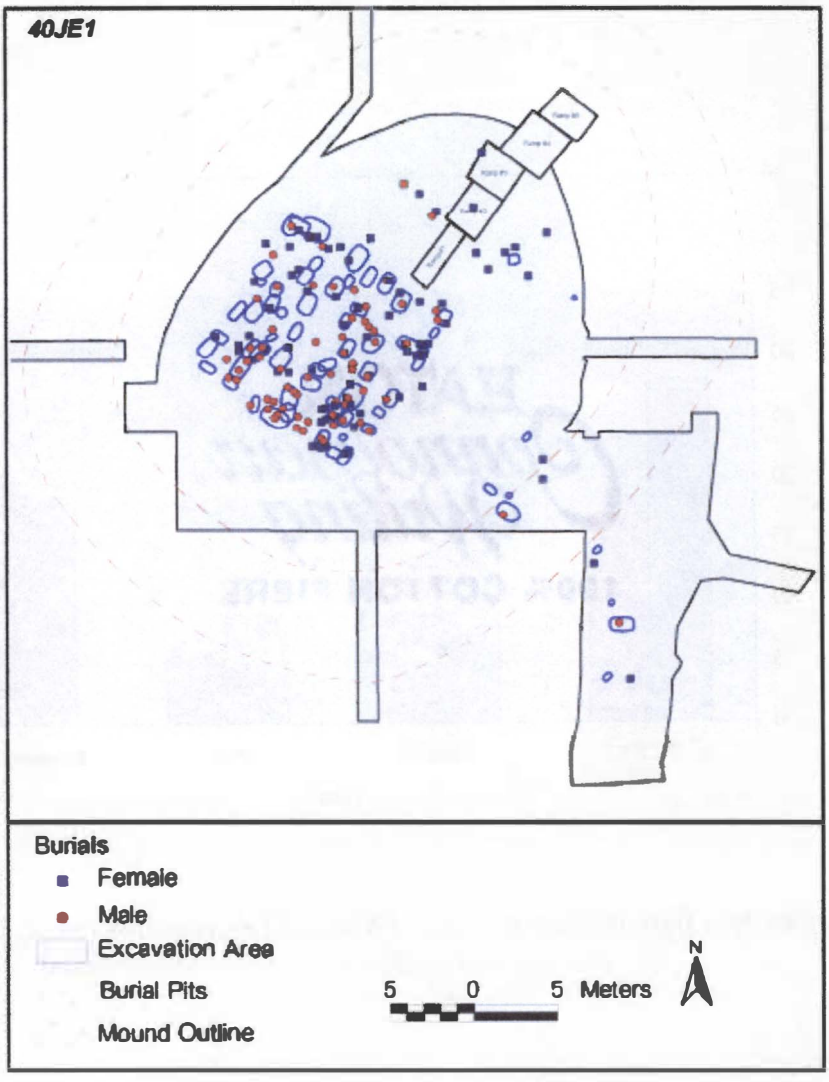


Figure 10: Sex Distribution at Fains Island

young females (i.e, 20-30) than males buried in the mound, there are also more older adult females (50+) than males. This pattern is markedly different than at Toqua. The distribution of females by age interred in the mound suggests the high representation of young adult females may be indicative of an increased risk of mortality during childbearing age rather than, as Parham (1982) suggested, a representation of sacrificial victims.

The distribution of certain mortuary items at Fains exhibits the same age and sex-based distribution described by Hatch (1974). Males were most commonly associated with implements involving tool kits. These items included: celts, projectile points, debitage, bone awls, fleshers, and scrapers. Burial 254, a middle adult male, is perhaps the most elaborate of these burials, associated with: 78 triangular projectile points, muscovite fragments scattered along the side of his torso, 3 celts, stone implements, and debitage. Strikingly absent are larger copper and other ceremonial blades of the Southeastern Ceremonial Complex (SECC) found at other Dallas sites. The SECC is a distinctive set of associated symbols and iconography found among Mississippian sites. Although Fains lies at the end of the peak of occurrence of these materials, at A.D. 1200-1400 (Sullivan 2001a), it is surprising that none of these items occur in the burials. Rather, the lack of these types of prestige goods may be due to Fains location and relative isolation from larger multi-mound centers. Male burials possibly were differentiated by the quantity of their associated funerary artifacts rather than the quality.

The only SECC items found at Fains are engraved shell gorgets and mask gorgets (figures 11 and 12). A large number of shell gorgets have been recovered from the site. Most of these date to the fifteenth century (various fenestrated rattlesnake styles, triskele, "spaghetti-style," and the masks), although there are a few fourteenth century (Big Toco and spider) and sixteenth century styles (Citico style). These gorget styles are compatible with the proposed Dallas phase occupation for the site. The majority, 69.23 percent, of these gorgets was associated with subadults. Two young, adult females and two young, adult males also had associated gorgets.

Shell ornaments and other forms of body ornamentation crosscut age and sex categories. Thomas (1996) notes this pattern in burials from the Mississippian Period in the Carolina Piedmont and Mountains. She remarks that shell beads were not significantly linked to the presence or absence of other artifacts important to status or ceremonial roles, such as shell bowls, ceremonial celts, turtle shell rattles, shell gorgets, and knapping kits. Furthermore, she notes that Mississippian iconography depicts males and females with shell ornamentation. She infers from this patterning that, "shell beads are not a necessary part of a uniform worn by important personage, whether they be chiefs, war chief, shamans, or any other. Rather, they seem to have been an optional element of costume, available to a diverse array of people through various mechanisms" (Thomas 1996:38).

Although this thesis focuses on the bioarchaeology and is not an in-depth analysis of all the collected archaeological materials, this discussion lays the groundwork for subsequent studies and better situates the Fains Island skeletal sample within a larger



Figure 11: Shell Gorgets. Clockwise From Top Left Burial 207 Fenestrated Rattlesnake; Burial 140 "Spaghetti Style "; Unknown Association Fenestrated Rattlesnake; Burial 271 Fenestrated Rattlesnake; Burial 184: Fenestrated Rattlesnake; Burial 78 Citico Style (TVA photograph collection from the Frank H. McClung Museum, The University of Tennessee, Knoxville)

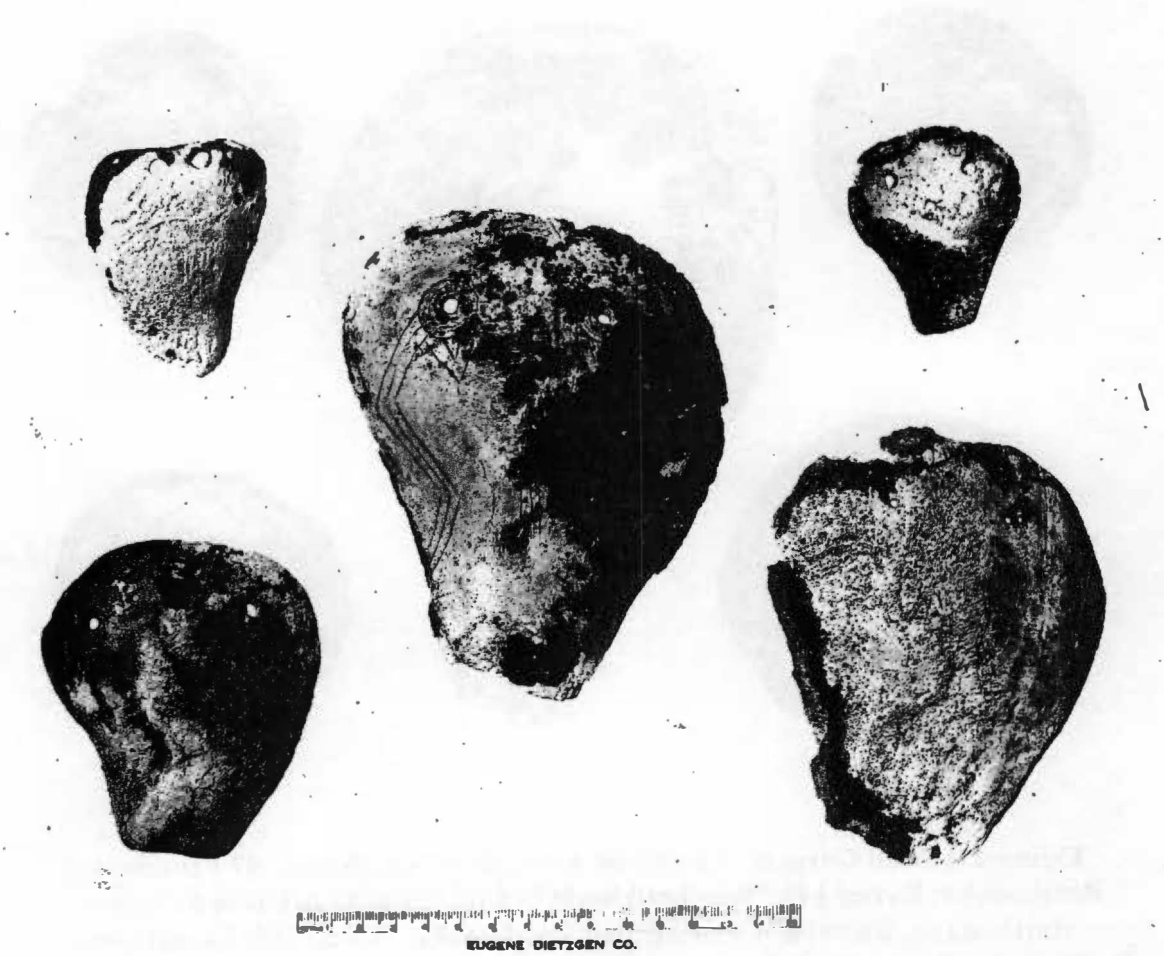


Figure 12: Face Masks Interred with Burials 117, 207, 103, 100 (TVA photograph collection from the Frank H. McClung Museum, The University of Tennessee, Knoxville)

bioarchaeological framework. The distribution of burials within the mound and of the associated funerary objects demonstrates that while patterning is similar to other Dallas phase sites, Fains Island also has unique qualities. These may reflect differences in social conditions between this site and larger multi-mound sites such as Toqua. For instance, the large number of interments in the mound, including females in all age categories, markedly differs from other Dallas phase sites (Sullivan 2001b, 2003). These differences are noteworthy, since as discussed previously, social conditions can have a direct impact on biology.

Chapter III: Variables

Introduction

This chapter provides a brief discussion of the etiology, manifestation, and anthropological literature explaining paleodemography, dental caries, antemortem tooth loss, periapical abscesses, dental hypoplasia, nonspecific infectious disease, and porotic hyperostosis. Other pathologies observed, but not occurring in substantial numbers, are discussed in the following chapters.

Paleodemography

Paleodemography involves establishing demographic parameters (i.e., mortality, fertility, and population size) of past populations (Milner et al. 2000). It is a field of inquiry that utilizes archaeological reconstruction, ethnohistorical documents, and skeletal analysis. Although there is much detailed discussion about the development of paleodemography (e.g., Hoppa 2002; Konigsberg and Frankenberg 2001; Milner et al. 2000), the brief outline presented here is relevant to critiques of skeletal paleodemography and the trajectories this field of study pursues today, as they pertain to this thesis.

The life table is now an ubiquitous tool in paleodemography, following several pioneering studies (Ascadi and Nemskeri 1970; Swedlund and Armelagos 1969). This approach was extremely attractive because it helped researchers organize datasets in order to make inferences about morbidity and mortality of past populations (Milner et al. 2000). Many reviewers recently have expressed concern over the limitations of the life

table method. Some of the criticisms of paleodemographic reconstruction focus on difficulties inherent in working with archaeological samples. These difficulties include differential preservation that leads to an under-representation of children (Milner et al. 2000) and the use of life tables with small sample sizes (Peterson 1975). Other critiques highlight problems of adult age estimation techniques for skeletal remains. For example, Bocquet-Appel and Massat's (1982) critique of paleodemography cites three main topics including: bioarchaeological age-at-death distribution as simply the reflection of the reference sample (i.e., "age mimicry"); the imprecision of aging methods; and that the result of these problems lead to under-representation of older adults. Finally, some have criticized the fact within life table analyses the basic assumption is that the population is stationary (i.e., zero population growth) and as a result may reflect fertility more so than mortality (Sattenspiel and Harpending 1983).

As a reaction to these limitations, researchers propose using computer simulation and maximum likelihood estimation to model population structures, and the use of hazard models for skeletal samples (Wood, Holman, Weiss, Buchanan, and Lefor 1992; Konigsberg and Frankenberg 2001; Gage 1988). Maximum likelihood estimation is "a body of statistical techniques..." that "...provide a natural and powerful way to fit parametric mortality models" (Milner et al. 2000:485). Milner and coworkers (200:485) give a concise explanation of this process:

> Maximum likelihood estimation requires us to specify the probability of obtaining each individual age observed in a skeletal sample. A general mathematical expression for the probability of observing a skeleton of a particular age can be derived from whatever parametric model is chosen for the analysis.

The probabilities are likelihood functions. This process is repeated until the parameters are maximized. The maximum likelihood is the parameter that is most likely to have occurred (Milner et al. 2002). A hazard model is then fit using these parameters. Wood and coworkers (1992:45) cite several benefits for using hazard analysis including:

> 1) it provides a general framework within which to model the dynamic etiologic processes underlying demographic events, and 2) it is associated with a surprisingly general likelihood function that permits efficient, unbiased estimation of the effects of interest, even in the face of multiple forms of censoring.

The models calculated through hazard analysis include the hazard rate and survival rate. The hazard rate is the risk that an event will occur at a specific time (or age) that it has not previously occurred (e.g., age specific hazard of death). The survival function is the probability that an event has not occurred for a specific time (Wood, Holman, Weiss, Buchanan, and Lefor 1992:46).

One hazard model that has been found particularly useful in paleodemography is the Siler model (Gage 1988). The Siler model is based on the assumption that an individual's risk of death is based on three competing causes: a juvenile component, a senescent component, and a constant hazard rate. The limitation of the Siler model is that it is not sensitive enough to capture the "adolescent mortality hump" and a possible deceleration of mortality among older individuals (Milner et al. 2000). Despite these limitations, "The Siler model hits just about the right level of detail for paleodemography: it shows us the overall pattern of mortality while preventing us from being distracted by all the squiggles in the age-specific curve" (Milner et al. 2000:484). In light of this

discussion, maximum likelihood estimation and a hazard model will be used for Fains Island demography in lieu of the standard life table approach.

Dental Caries

Dental caries is a "disease process" characterized by the demineralization of enamel or dentin by organic acid in which the ultimate result is cavitation (Larsen et al. 1991). In most cases, carious activity begins at the enamel surface. The earliest phase appears as a whitish opacity that represents the loss of hydroxyapatite crystals (Patterson 1982). As demineralization progresses, the smooth enamel surface becomes etched (Hillson 2001). The demineralization process follows enamel prisms, beginning at the tooth surface and extends to the dentoenamel junction. This demineralization process leaves permanent destruction of the enamel and underlying dentine. It can affect the underlying dentine. Odontoblasts respond by producing secondary dentine in order to protect the pulp chamber. As the necrotic tissue progresses into the dentine it may compromise the pulp chamber (Aufderheide and Rodriguez-Martin 1998).

A prerequisite for dental caries is dental plaque, a byproduct of the complex interaction of indigenous oral bacteria (e.g., *Streptococcus mutans, Lactobacillus acidophilus)*, and diet (Larsen et al 1991). The degree, speed, and location in which caries can occur is the result of many modifying factors including, but not limited to, crown morphology and size, developmental enamel defects, and occlusional surface attrition (Larsen et al 1991, Powell 1985, Rowe 1975). Certain food textures and food

processing techniques may also contribute to increased cariogenic activity (Rose et al. 1991; Powell 1985; Corbett and Moore 1976).

Dental Hypoplasia

Ameloblasts (i.e., cells located in the inner layer of the enamel organ responsible for enamel formation) lay down enamel by secreting a proteinous matrix (Avery 2000). The matrix eventually mineralizes resulting in 97-98 percent hydroxapatite crystals. The crystals are stacked, demarcated by stria of retzius (normal weekly resting periods of the secretion of enamel) (Avery 2000). This process of amelogenouses is especially sensitive to metabolic insults. Dental hypoplasia marks a pathological disruption of the secretion of enamel created by acute periods of stress, heredity conditions, or localized trauma. The latter two causes are relatively uncommon, therefore, a high occurrence of hypoplasia within a population are likely to be associated with systemic stress (Larsen 1997). Hypoplasias are considered an indicator of nonspecific stress in that they can be caused by multiple factors including infectious disease, neonatal disturbances, and malnutrition (Goodman and Armelagos 1989).

Hypoplasisa can vary in thickness from small pits to large, deep grooves around the tooth, though typically these defects manifest themselves as horizontal grooves around the tooth (Goodman and Armelagos 1989). The presence of enamel hypoplasia is particularly useful in bioarchaeological analysis since unlike growth arrest, they do not remodel. Thus, once formed they survive throughout one's life only to be obscured by tooth wear and loss.

Nonspecific Infectious Disease

Evidence for infectious diseases in skeletal material is omnipresent in paleopathological literature (e.g., Buikstra and Williams 1991; Martin et al. 1991; Ortner and Putschar 1981; Powell 1988). Many pathogens (i.e., bacterial, viral, parasitic) afflicted past populations causes impacts on soft body tissue. Individuals may have rapidly recovered or just as rapidly died with no evidence that the infection occurred. In contrast, chronic, invasive infectious diseases can be transmitted to the bone via the bloodstream (Ortner and Putschar 1981).

Similar to soft tissue, bone tissue inflames via a cellular reaction caused by the invading pathogen (Ortner and Putschar 1981). Certain infectious diseases such as tuberculosis and treponemal infections leave markers on the bones that are indicative of that particular bacterium, but the pathological changes brought about by many infectious diseases are indistinguishable from one another (Ortner and Putschar 1981).

There are various routes for bone infection, including direct trauma, through association of adjacent soft tissue infection, and via the bloodstream from a remote infection (Ortner and Putschar 1981). The two most common types of generalized bone infection are periostitis and osteomyelitis. Periostitis refers to the inflammatory response of the outer periosteal sheath of bone, called the periosteum. Osteomyelitis is a deep infection of both the outer layer and inner medullary cavity (Aufderheide and Rodriquez-Martin 1998; Ortner and Putschar 1981), although Sandison (1968) has argued that such arbitrary categories are unnecessary since bone is a single biological unit. Here, these

distinctions will be viewed as differences in degree rather than kind. Both degrees of infection are associated with the simultaneous process of bone destruction and subperiosteal bone deposition. In osteomyelitis, this response in accompanied by pus formation that flows through a perforation termed a cloacae. New subperiosteal bone forms as loosely organized woven bone. With healing, the new bone incorporates into the underlying tissue and takes on the microstructure of smoothed, albeit somewhat inflated, compact bone (Martin et al. 1991). The severity can range from mild, involving pitting of the outer table and tracks of hypervascularity, to severe cases associated with extreme bone deposition and deformity. Both periostitis and osteomyelitis can occur in any bone, but it is most commonly manifested in long bones (Ortner and Putschar 1981).

Porotic Hyperostosis

Perhaps one of the best-studied indicators of nutritional stress is dietary anemia, or its skeletal manifestation, porotic hyperostosis. Anemia is the result of poor iron levels that can result from inadequate iron consumption, genetic factors, or pathological conditions such as parasitic infection and weanling diarrhea. Low iron levels or hemoglobin, the major component in red blood cells, affect the ability to properly carry oxygen to tissues in the body. This process results in red bone marrow hypertrophy, exerting pressure on the surrounding bone. Within the cranial vault, the thickening of the inner diploe layer marks this expansion. To compensate for this expansion, there is a thinning and pitting of the outer cranial vault (Staurt-Macadam 1985). Porotic hyperostosis appears as tiny pinpricks or complete destruction of the outer

table. The lesions are usually symmetrical in distribution and usually occur in the frontal, paritial, and occipital bones of the skull vault. Similar in etiology is cribra orbitalia, which are lesion occurring in the orbital roof (Stuart-Macadam 1989).

In adults, a buffer of fatty yellow marrow absorbs the expansion of red bone marrow (Ascenzi 1976). Yellow marrow does not appear in subadults until puberty. Since children lack this buffer, the expansion of red marrow affects the overlying structural integrity (Ascenzi 1976). Thus, lesions produced by porotic hyperostosis in adults probably represent healed lesions from childhood episodes of anemia (Staurt-Macadam 1985).

Summary

The biological indicators discussed above are applied to the Fains Island sample. The prevalence of these markers provides insight regarding the quality of diet and life of the Fains Island population. The specific methods employed to assess these indicators are discussed in the following chapter.

Chapter IV Materials and Methods

Inventory and Description of Remains

Three hundred burial features were excavated at Fains Island. The skeletal remains for seven burials were discarded in the field. Another seven burials were eliminated from this study due to commingling of several individuals or lack of provenience. Thus study this included 338 individuals. Preservation of bone ranged from very good to very poor; many bones unfortunately were poorly preserved. Not only natural taphonomic processes, but also the use of a plow considerably damaged many burials. The WPA lab also reconstructed some bones. These taphonomic processes, recovery techniques, and reconstruction may have masked pathological and traumatic events, and precluded specific age and sex determination for many individuals. Another bias is that most burials came from the mound. Since most Dallas communities used both the village and the mound in their mortuary program, the actual number of individuals may represent only a small portion of the original population of the Fains Island site.

Sexing and Aging

Dr. Maria Smith, with support of a National Science Foundation Grant, previously inventoried all of the skeletal material at the McClung Museum in 1980's. In order to minimize interobserver error, two researchers had to agree upon age and sex estimations for each individual (Maria Smith, personal communication 2002). My study utilizes the sex and age estimations made by Dr. Smith.

Adult sex estimation was based on morphometric indicators of the pelvis, skull, and femur and humerus head. Given the difficulties in the determination, sex diagnosis was not attempted for subadults (Maria Smith, personal communication 2002).

Skeletons were classified into six categories: three subadult categories [infant (0-2), child (3-12), and adolescents (12-20), depending on preservation a more specific age was given] and three adult categories [young adult (20-30yrs), middle adult (30-50yrs), and old adult (50+)]. In aging subadults, preferential treatment was given to dental development criterion. Maximum diaphysial long bone length and epiphyseal closure also were used. Adults were aged by morphological changes of the pubic symphysis. Upper and lower age limits were ascertained by fusion of the clavicle and cranial sutures (Maria Smith, personal communication 2002).

Paleodemography

A maximum likelihood analysis was used to calculate hazard models for the population. This type of analysis allows for a wide variety of age ranges. Age estimation of the Fains Island can be as narrow as a one-year range in some subadults to as broad as 20-120 years in adults with poor preservation. A hazard analysis was generated using the computer program *mle version 2.1* (Holman 2000). A four-parameter Siler model (Gage 1988) was used to estimate juvenile and adult demography. This model was then used to calculate survivorship and hazard rates. The equations for survivorship, hazard rates, and probability density function (PDF) are as follows:

$$S(a)=\exp\left(-\alpha_1/\beta_1(1-e^{-\beta 1a}) + \alpha_3/\beta_3(1-e^{\beta 3a})\right)$$

$$h(a)= \exp \alpha_1 (-\beta_1 a)+\alpha_3 \exp(\beta_3 a)$$

$$f_0(a) = (\alpha_1 e^{-\beta_1 \alpha} + \alpha_3 e^{\beta_3 \alpha})$$

$$x \exp [-\alpha_1/\beta_1 (1-e^{-\beta_1 a})+\alpha_3/\beta_3 (1-e^{-\beta_3 a})]$$

where a is the age at death, α_1 and β_1 are parameters that represent juvenile mortality and α_3 and β_3 represent the senescent component. Following Herrmann and Konigsberg (2002:247), the constant hazard parameter (α_2) was not included in the equation, since "this parameter is rarely estimable from paleodemographic data." To assess adult mortality between sexes, a two-parameter Gompertz model was used. The Gompertz model is the senescent component in the Siler model without the negative Gompertz juvenile component.

The demographic data, by the cohort categories discussed above, were entered as frequencies with beginning and ending ages. For individuals who were aged 50+, the individual was treated as 50-120 years. Likewise, when an individual was aged "adult," the individual was treated as 20-120 years.

Comparisons were then made between females and males. Data were also obtained through the systematic collection inventory at the McClung Museum for two other Mississippian period sites, Toqua and Hixon. Once again, comparisons were made between demographic parameters for these populations with those of Fains. To test significance of differences, a Chi-Square test and Likelihood Ratio test were used:

Chi^2 Distribution $(-2(\ln G_0 - G_1))$

Finally, comparisons were made between the three Mississippian communities and modern day ethnographic from the !Kung, Agta (Early and Headland 1998), and Ache (Early and Peters 2000). Given Howell's (1976) uniformitarian principle in paleodemography, the assumption is that while demographic processes vary across populations, variation is constrained in predictable ways. Therefore, extreme deviation of the three Mississippian populations with historic data could be the outcome of biases due to aging techniques and differential preservation, but also can lead to insights as to atypical age and sex distribution of particular burials (e.g., mound burials) or to other circumstances such as mass internments due to warfare (Milner et al. 2002).

Pathology Identification

All bone was examined after Ortner and Putschar (1981), Ortner (2003), and Aufderheide and Rodriguez-Martin (1998), for identification of morbidity. Only pathological markers that could be discerned macroscopically were analyzed. The nature and location of pathologies were then recorded. A copy of the database containing the raw data collected from this analysis is archived at the Frank H. McClung Museum, The University of Tennessee, Knoxville. For certain pathologies, specific recording criteria were used and are discussed below.

Dental Caries

Dental caries can range from an opaque spot or roughened surface, to minute holes, to full-scale cavitations. For the purposes of this study, only those lesions in which

loss of enamel, that could be ascertained through macroscopic analysis and the use of a dental probe, were recorded. While this procedure underestimates caries prevalence, it is more consistent with other studies, thus facilitating comparison, and it is less subject to interobserver error (Hillson 2001; Rudney et al. 1983; Whittaker et al. 1981). If carious activity was questionable due to taphonomic processes, the lesions were not recorded. I recorded caries for each tooth class: incisors, canines, premolars, and molars. Posterior teeth are more susceptible to carious activity than anterior teeth because of complex occlusal morphology. In populations with low cariogenic activity, caries are usually confined to the posterior teeth. At increasingly higher rates, anterior teeth are affected (Patterson 1984). Therefore, specification of a particular class of teeth affected by carious lesions allows for the determination of more specific patterns within a skeletal population.

In individuals with maxillas and/or mandibles present, antemortem loss was recorded when there were signs of osseous healing or resorption of the alveolus and changes in the position of adjacent teeth. Although some researchers (e.g., Lukacs 1995) suggest adding antemortem tooth loss into carious indices, Hillson (2001) argues that such calculations are based on assumptions that are difficult to test; it is often difficult to determine whether antemortem tooth loss is due to carious activity. Other researchers (e.g., Whittaker et al 1981) argue that gross attrition, periodontis, and trauma are more likely to be the culprit. Heeding Hillson's (2001) suggestion, I recorded evidence of antemortem loss separately from caries activity.

Dental Hypoplasia

I assessed permanent anterior teeth from Fains Island for the presence or absence of enamel hypoplasia. Macroscopic analysis was done by diagnosing hypoplasia from circumferential lines, bands, or pitting that resulted in decreased enamel thickness (Aufderheide and Rodriguez-Martin 1998; Goodman and Armelagos 1985). Hypoplasias were simply recorded as to the presence or absence of at least one or more for each incisor and canine.

Periostitis of Long Bones

Each bone with a periosteal reaction was recorded according to severity, the location on the bone, number of bones affected per individual, and whether the infection was active or healed. Severity was broken into three categories: slight, moderate, or severe. These categories were adapted from criteria discussed by Martin et al. (1991). Separation into these three categories was made by the nature of the reaction and destruction, the amount of reaction and destruction, and the extent of tissues involved. The severe category was designated to multiple infected bones and osteomyeletis. The degree of healing was broken into three categories: active (unremodeled), some amount of healing (both active and remodeled tissue), or completely healed. Special attention was paid as to whether the area impacted was most probably caused by infectious disease or by a localized traumatic event, which is a generally unilateral, localized reaction associated with fracture healing. If differential diagnosis was possible regarding a specific infectious disease (i.e., treponematosis or tuberculosis), then it was recorded as

such. Since not all long bones were represented for each individual, periostitis was analyzed as total bones affected rather than number of individuals.

Porotic Hyperostosis

The severity of porotic hyperostosis was scored as slight, moderate, and severe after the criteria used by Martin and coworkers (1991). The slight category was assigned to appearance of small pinprick-like cavities in a nonrandom pattern that were confined to a small portion of the cranial vault. The moderate category was given to lesions that were more pronounced and extended to larger areas of the cranial vault, as well as the thinning of the outer cortical bone where the inner diploe table was evident. The severe rating was assigned to those cases in which the outer table was destroyed to such an extent that the underlying trabecular was almost completely exposed. Martin and coworkers (1991) caution about the importance of distinguishing porotic hyperostosis in adults as opposed to age-related osteoporotic-pitting. Therefore, in cases with evidence of porotic hyperostosis in adults, vault thickness and the distribution of lesions were carefully considered. Porotic hyperostosis was also recorded as to active, a combination of active and healed, or completely healed. Obviously, only those individuals with extant crania could be examined for presence of porotic hyperostosis.

Analysis

The data accumulated on these stress indicators were used to assess the relative health status of the Fains Island sample. Intra-site comparisons were also made in

regards to sex and age. Individuals for whom sex could not be ascertained were excluded from the sex comparisons. Statistical analyses to assess the significance of differences between groups included a contingency table, Pearson's chi-square test, and for smaller sample sizes, Fisher's exact test. The threshold α was set at .05. Inter-site comparisons were then made between the findings of this study and similar studies of Dallas and other Mississippian communities.

Status

Another dimension of this study is status differentiation, specifically whether particular hierarchal social groups had lifestyles that significantly differed in terms of nutrition and stress. As discussed, many studies of Dallas communities have compared mound and village interments with indicators of stress. Since archaeological evidence for social inequality is observable in mortuary ritual (e.g., Binford 1972; Brown 1981 Hatch 1974; Nelson 1997;O'Shea 1981; Peebles and Kus 1977; Saxe 1970), the basic assumption was that those buried within the mound represented a higher rank than those within the village. Since the excavation at Fains was predominantly mound-based, it is impossible to compare the mound/village dichotomy.

Another aspect of funerary treatment used to interpret rank and status is the presence of funerary objects. This interpretation is based on two suggestions: that the type of funerary treatment represents one's social persona in life (Binford 1972); and that the amount of energy expenditure in funerary treatment is correlated with an individual's rank in life (Tainter 1978). Nonetheless, the relation between funerary objects and rank

is complex, and treatment of the dead can be mediated through other factors including: circumstances of death, manipulation of the living, specific political situations, and ideology regarding death and identity (Brown 1995; Pearson 1999). The assumption of this study is that biological indicators of stress can lend insight to this process. This study examines if the presence of associated funerary objects indicates differential treatment in life that may have lead to buffering of certain biological stressors. In order to accomplish this analysis, the relationship between presence and absence of funerary objects and selected biological indicators of stress were examined with a correlation coefficient. All burials that contained multiple individuals were excluded from this analysis. The analysis did not focus on correlations between biological variables and functional funerary object categories because preliminary data screening indicated that, other than ornamental goods, the inclusion with burials of certain suites of materials appears to be largely sex and age dependent. Therefore, differences in the occurrence of stress with these functional categories would simply reflect age and sex differences rather than differences in morbidity due to rank or status.

Chapter V: Results

Age and Sex Distribution

The overall distribution of the sample by age range and sex is given in Figures 13 and 14. The study included 241 adults (71.3 percent) and 97 subadults (28.6 percent). The sexable adults consisted of 89 females, 75 males, and 90 individuals of indeterminate sex.

Paleodemography

A 4-parameter Siler model was fit using the *MLE* computer program. Comparisons were made between the demographic parameters of the skeletal series from Fains Island and the Dallas phase sites Toqua (40MR6), (both the mound and all interments) and the late Hiwassee Island-early Dallas site, Hixon (40HA3) (the mound population only). The parameters, log-likelihoods, and standard errors are given in Table 1. Likelihood ratio tests were performed to compare the differences between Fains and the three other populations (Table 2). Figures 15 and 16 gives the survivorship and hazard curves for the different populations.

Only one comparison, the entire population of Toqua, was statistically different from Fains. In fact, Toqua's entire survivorship rate is substantially lower than all three mound populations. Most likely, this difference is most readily attributed to burial practices within Dallas phase communities rather than differences in stress. There is a higher percentage of children in the entire Toqua sample, suggesting that mound populations have an under-representation of children. This is an important consideration

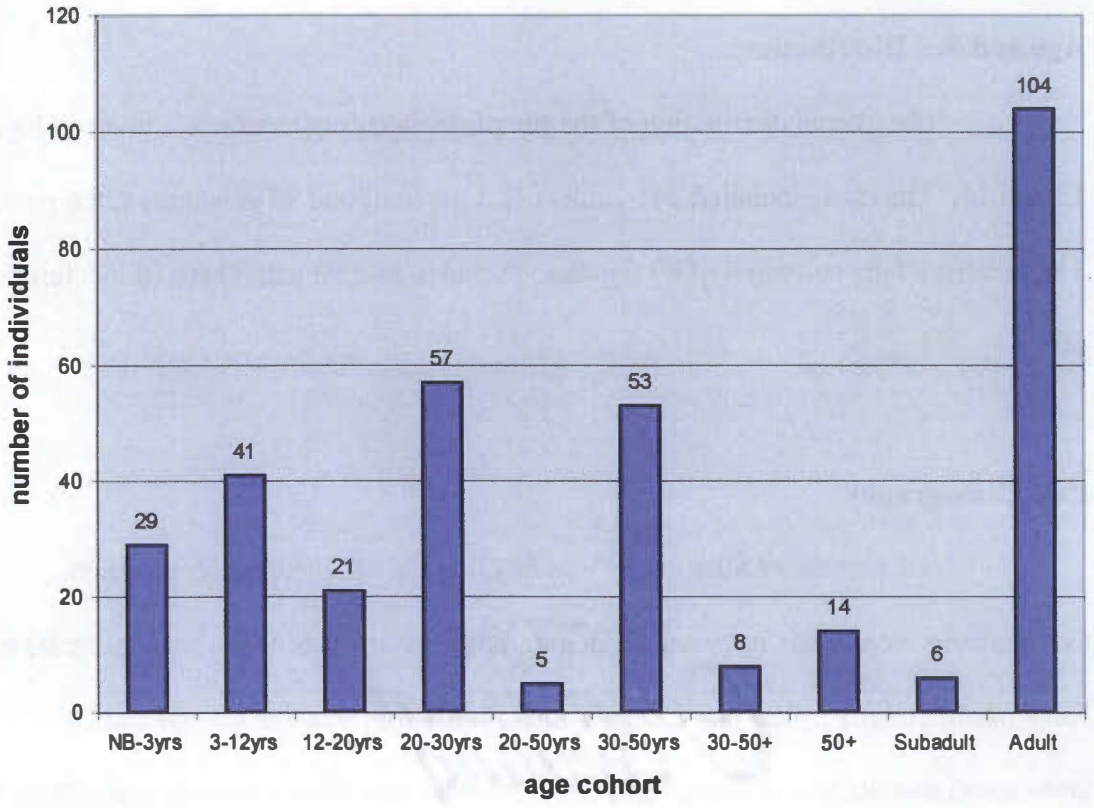


Figure 13: Age Distribution of Fains Island.

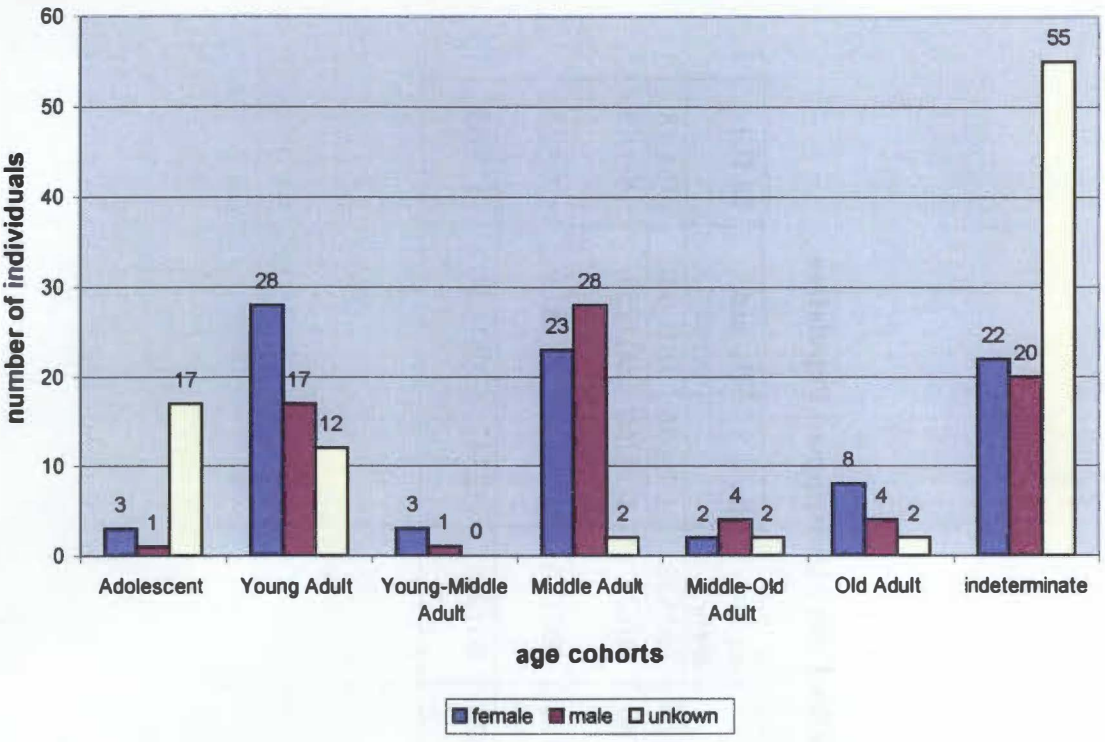


Figure 14: Age and Sex Distribution Fains Island.

Table 1: Siler Model Parameter Estimates for Each Mississippian Population

	α_1	α_1 std error	β_1	β_1 std error	α_3	α_3 std error	β_3	β_3 std error	ln (L)
Fains	.03689	.01210	.27790	.12694	.004184	.001522	.076620	.010194	-468.18
Toqua (all)	.18602	.02177	.429634	.00477	.004789	.00129	.074766	.007754	-904.40
Toqua (mound)	.047164	.02380	.290451	.18247	.004118	.002154	.07911	.01481	-169.23
Hixon (mound)	.021809	.00835	.041629	.07216	.000678	.0019487	.12347.	.061604	-138.65

Table 2: Results of the Likelihood Ratio Tests between Populations

Likelihood Ratio Test	Fains and Toqua (all)	Fains and Toqua (mound)	Fains and Hixon
In (L) combined	-1400	-637.683	-607.57
Lambda	54.7	.54	1.48
p-value	< .001	.9694	.8302

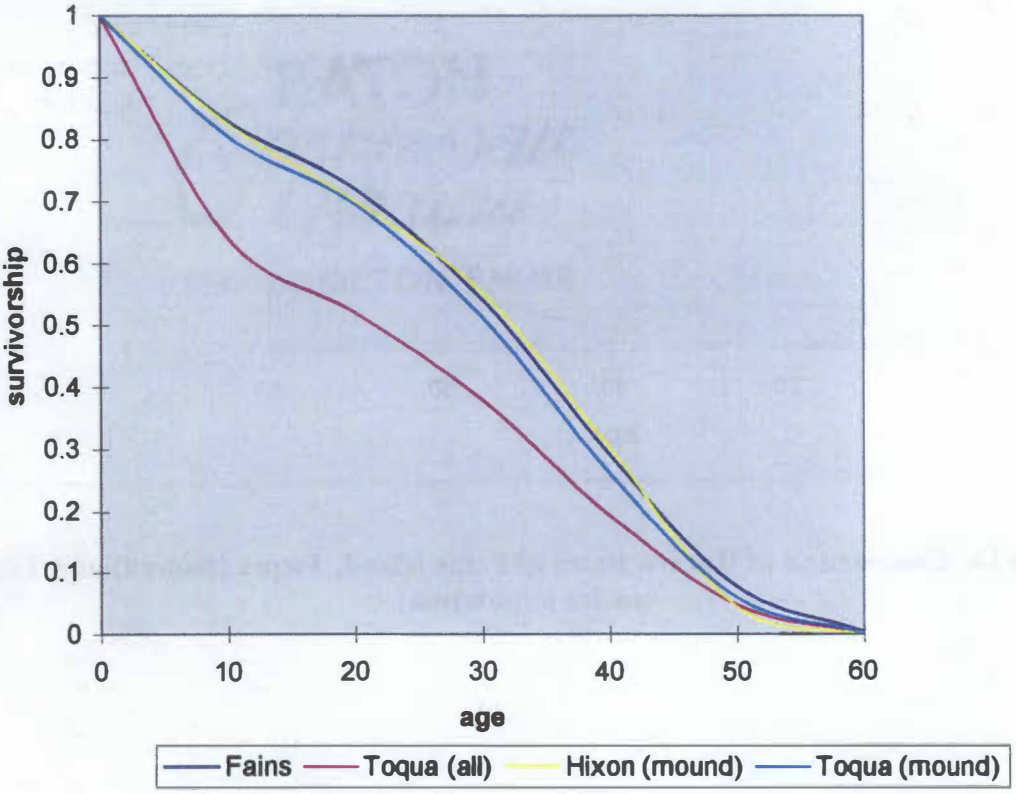


Figure 15: Comparison of Population Survivorship

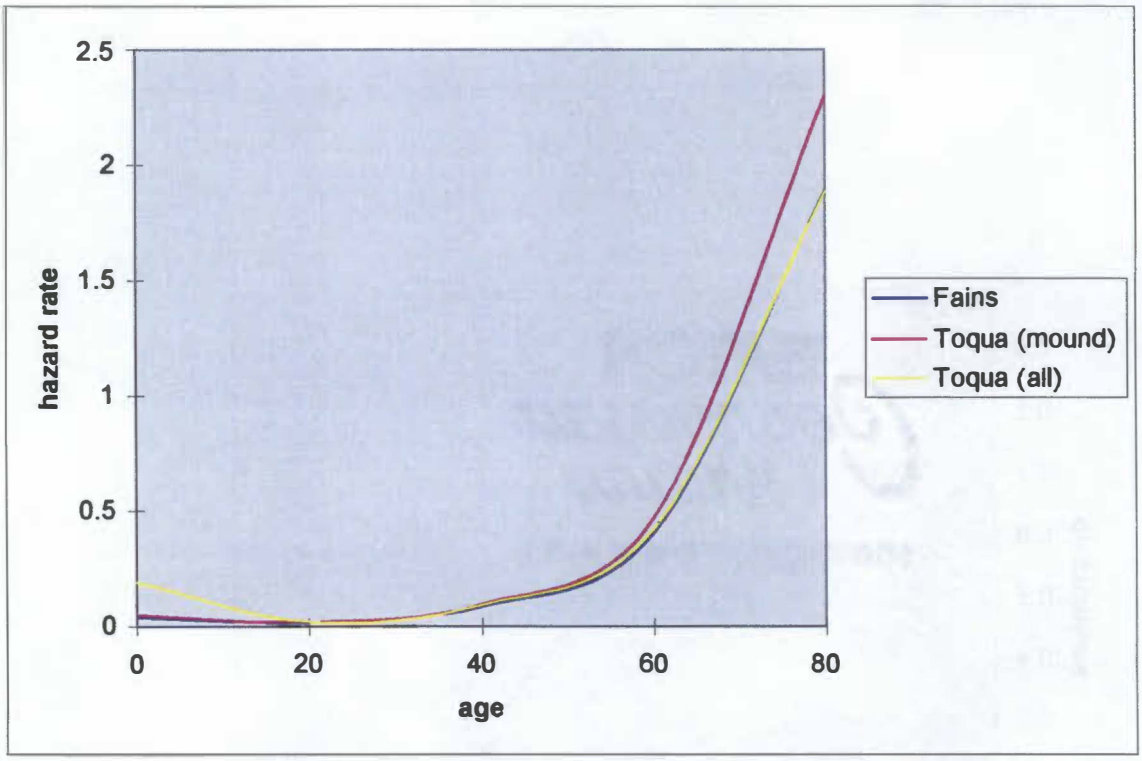


Figure 16: Comparison of Hazard Rates of Fains Island, Toqua (mound) and Toqua (entire population)

since survivorship curves can be substantially impacted by an under-representation of the juvenile component (Moore et al. 1975).

Comparisons of both survivorship and PDFs between the four Mississippian populations and the Agta, Ache, and !Kung is given in Figures 17 and 18. The comparison demonstrates that not only does the mound population have an undernumeration of subadults, there is also an underrepresentation of older adults in all four Mississippian burial populations.

Next, a 2-parameter Gompertz model was fit in order to compare sexes. Figure 19 illustrates the survivorship curve of females and males, starting at age 15. The likelihood ratio test indicates no significant difference between the sexes at Fains (Table 3).

Caries Rates

A total of 3,933 permanent teeth was examined for caries. Of these teeth, 451 (or 11.47 percent) exhibited evidence of carious lesions. A mean caries percentage per person score was calculated for males and females and by age cohorts. These mean percentages were then used to calculate the overall mean percentage for age groups and sexes. The distribution of mean percentages by age can be seen in Figure 20. As suspected, the caries distribution by tooth class follows the same pattern as many agricultural societies where caries rates increase from anterior to posterior teeth. On average, old to middle adults had more caries and an increase in anterior teeth affected. Next, differences in mean percentages were calculated between sexes using a chi-square

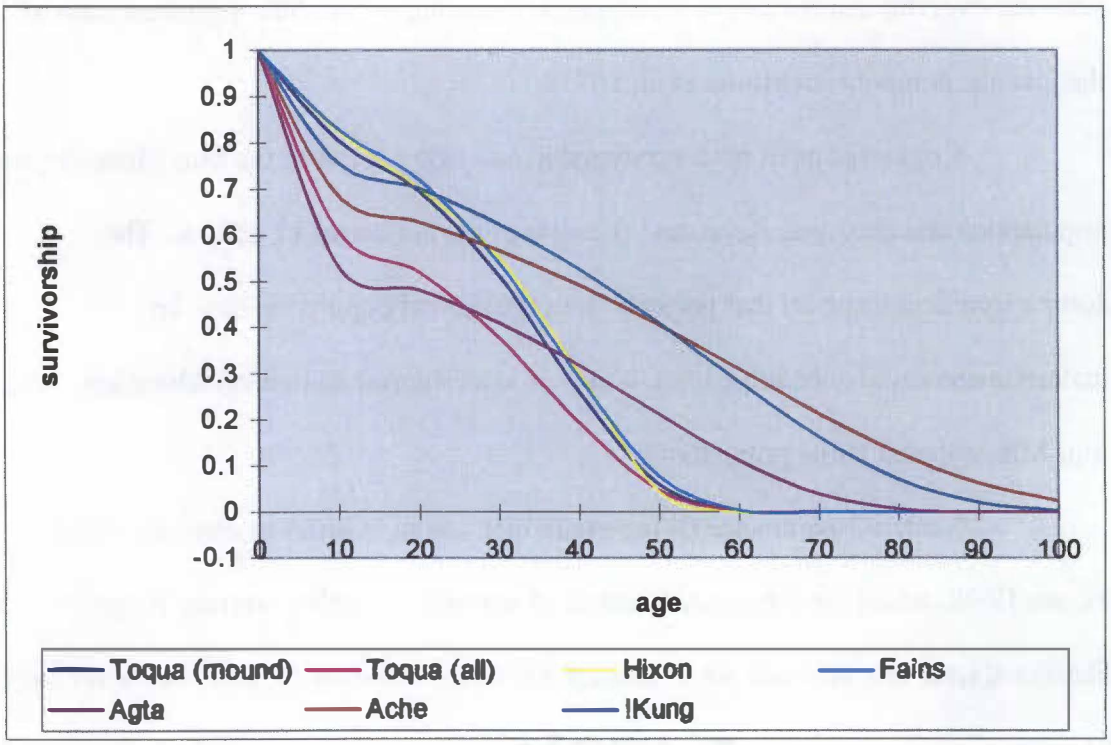


Figure 17: Survivorship Comparisons Between Fains, Toqua, Hixon, and Historic Ethnographic Data

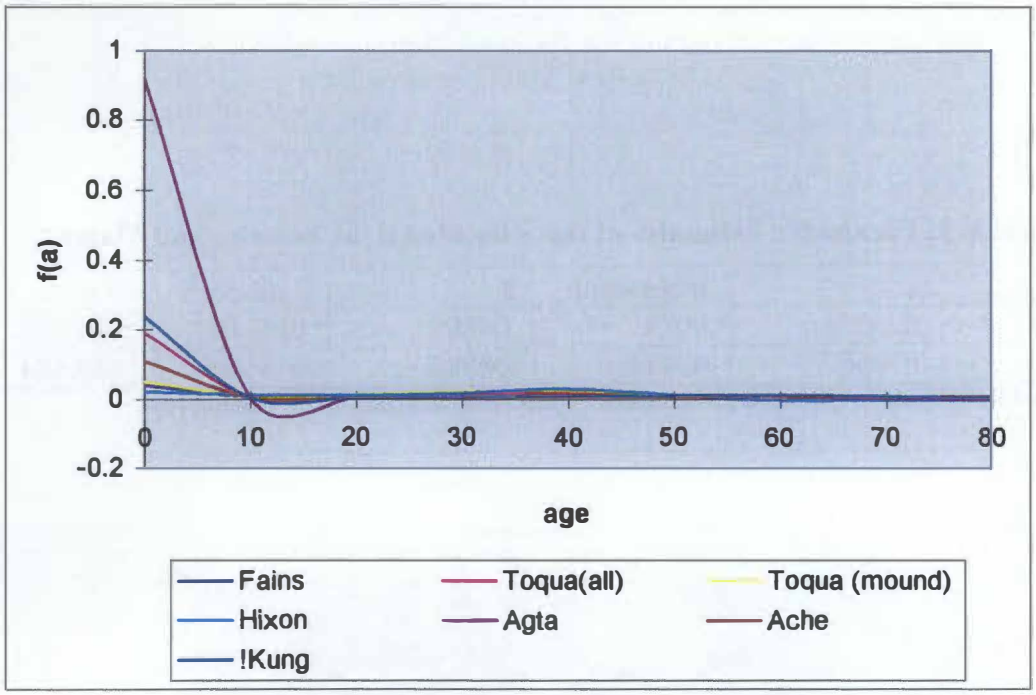


Figure 18: Comparison of PDF Between Dallas Communities and Modern Ethnographic Data

Table 3: Parameter Estimates of the Siler Model for Females and Males

	α	α std error	β	β std error	1n(L)
Females	.023223	.0078	.04889	.016319	-81.234
Males	.010587	.00453	.08982	.018369	-53.684

Likelihood Ratio Test: 1n (L) combined samples = –136.7329 lambda=3.628 p-value.1628

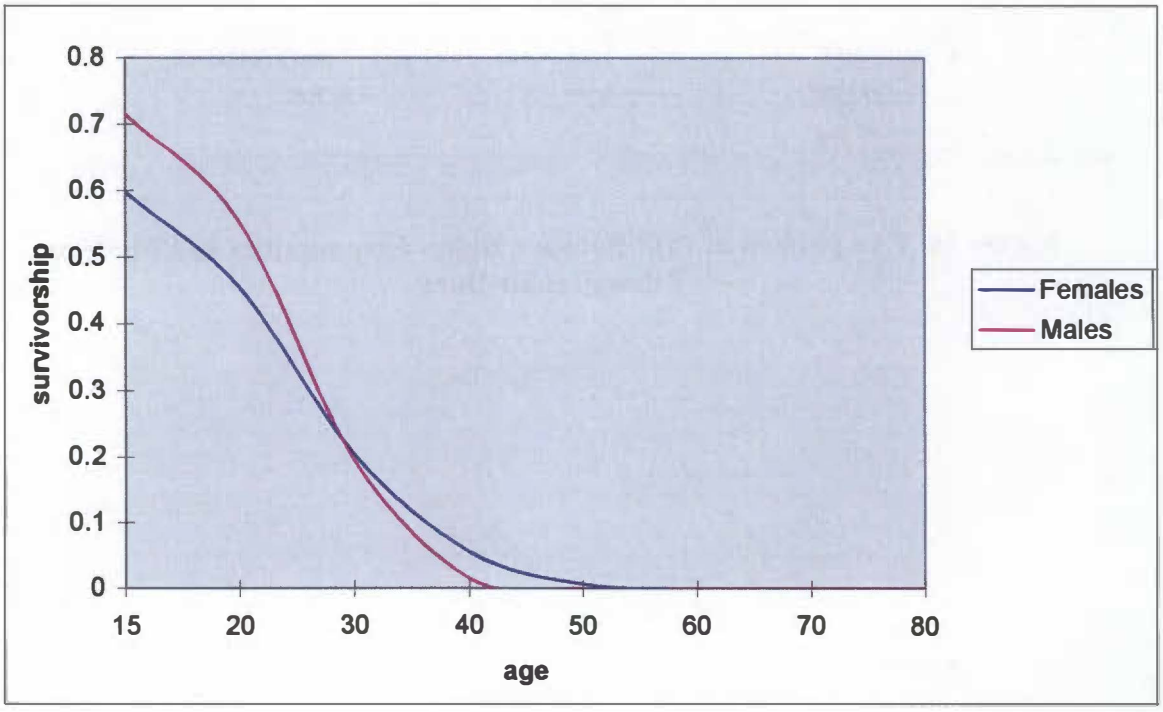


Figure 19: Comparison of Male and Female Survivorship

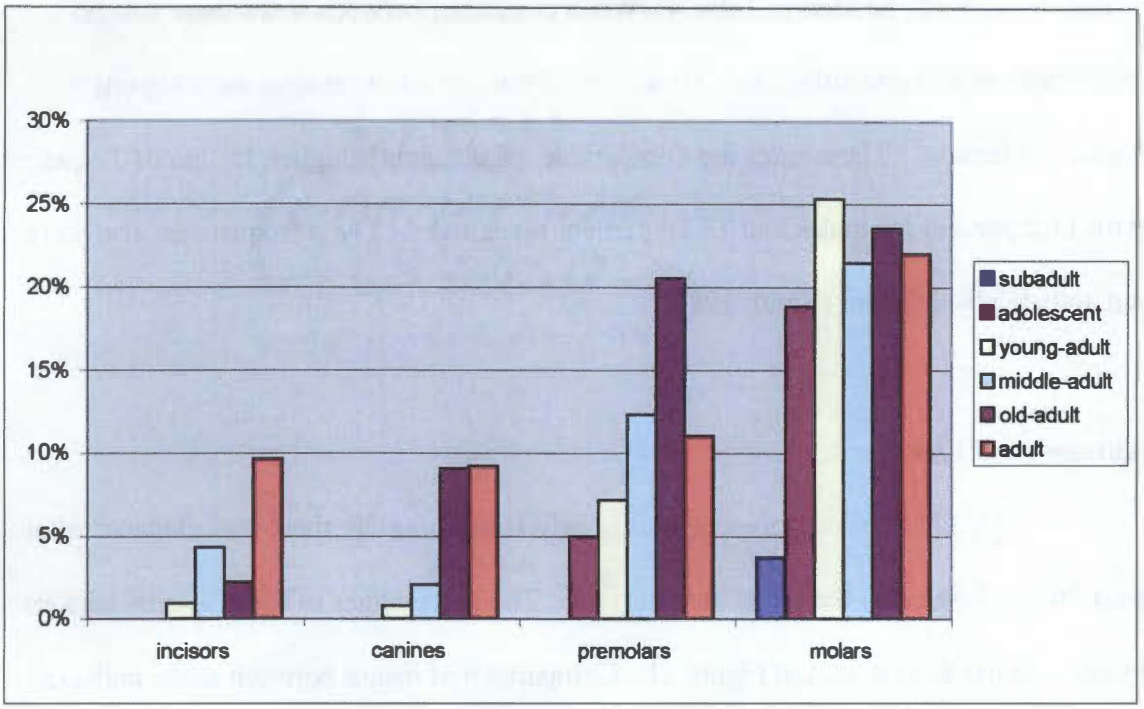


Figure 20: Distribution of Caries by Tooth Class and Age

test. Results can be seen in Table 4. When compared between sexes there was no statistically significant difference. However, all but one of the classes were slightly higher for females. These rates are comparable, albeit slightly higher, to that of Toqua with 11.2 percent for males and 13.26 percent for females. These frequencies also were not statistically different (Smith 1982).

Antemortem Loss

Of 3713 sockets present among individuals over 20, there was evidence of at least 361 (9.7 percent) teeth lost antemortem.. The precentages of tooth loss by sockets by age cohorts can be seen in Figure 21. Comparison of means between sexes indicated no statistically significant difference (chi-square p-value=.412).

Dental Hypoplasia

A total of 212 individuals had permanent incisors and/or canines that allowed analysis of enamel hypoplasia. Of these individuals, 120 (56.6 percent) showed evidence of one or more linear hypoplasia (figure 22). Figure 23 shows the relationship between percentage of enamel hypoplasia and age range. When examined by age range, there is a slight decrease of individuals exhibiting one or more hypoplasias from adolescent to old adult. This decrease may suggest that individuals who suffered an acute bout of stress in childhood were less likely to survive to later adulthood. Comparisons by sex give a rate of 53 percent for females (42 of 72) and 67 percent for males (40 of 59). When evaluated statistically, no significant difference was found (χ^2 p-value =. 319).

Table 4: Mean Percentages of Caries Rates By Sex

	Female % of caries	Male % of caries	χ2P-value
Incisors	4.93%	5.09%	.294
Canines	3.51%	2.19%	.458
Premolars	12.44%	9.36%	.385
Molars	26.49%	18.15%	.198
All	14.53%	14.40%	.329

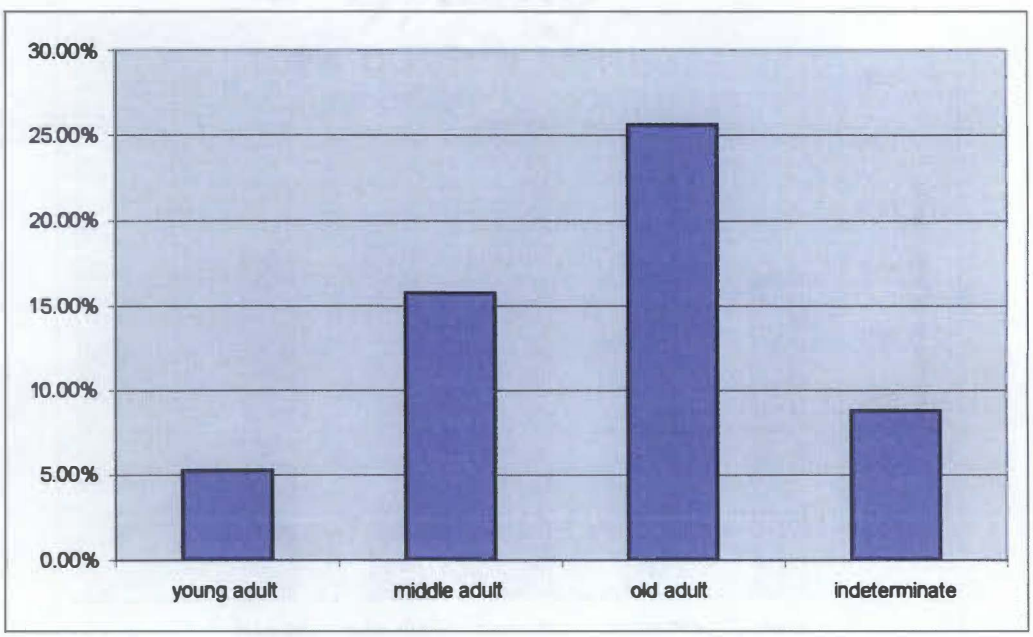


Figure 21: Percentage of Antemortem Tooth Loss by Number of Tooth Sockets Present

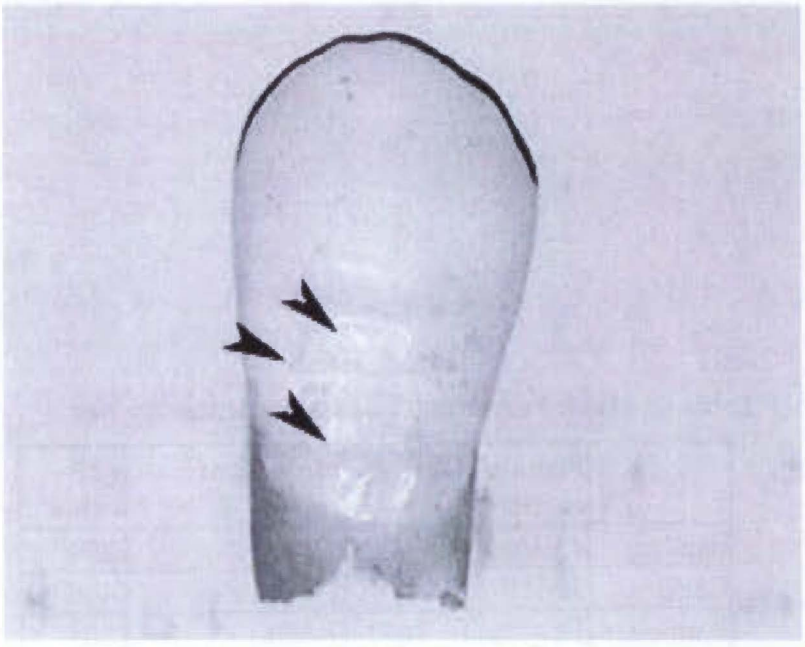


Figure 22: Burial 24b Subadult Mandibular Canine Featuring Multiple Linear Hypoplasia

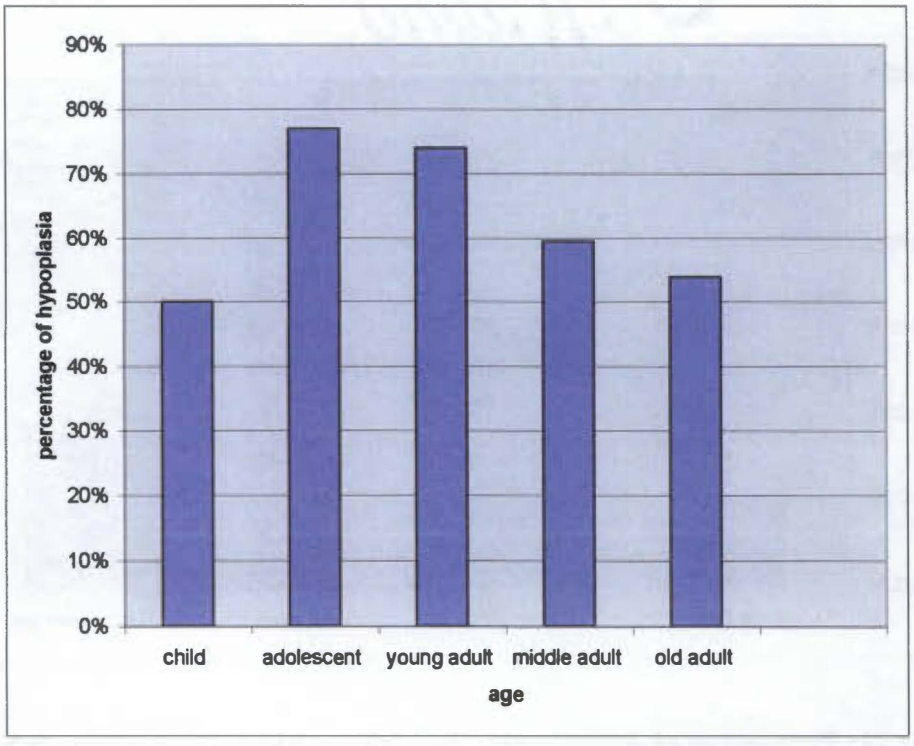


Figure 23: Percentage of Hypoplasia by Age

Non-Specific Infection

A total of 2,293 long bones was examined for periostitis. Of those, 81 (3.53 percent) displayed some degree of periostosal reaction. Table 5 gives descriptive frequencies of periosteal reaction of long bones by severity and activity. In terms of severity, 38.27 percent of all infected bones exhibited slight manifestation of periostitis, followed by moderate manifestation (37.03 percent), and severe (25.69 percent) (figures 24 and 25).

The most common bone affected is the tibia, a pattern that is typical in many archaeological series. Ortner and Putschar (1981) offer two likely explanations. First, the tibial shaft is close to the skin surface and is, therefore, cooler than a bone that is encased in muscle and fat, and, secondly, bones close to the skin surface tend to be more often exposed to direct trauma. In regards to activity, most reactions were in the active stage or a combination of active and healing at the time of death. This pattern suggests a chronicity in these infections.

Two individuals, burial 261, a middle adult female, and burial 7, an adult of indeterminate age and sex, exhibited severe periostitis of both tibia, which was marked by extensive circumscribed buildup of lamellar bone along the entire anterior and medial surfaces. The bony buildup was thick and had become fused with the older cortex. This manifestation, termed "saber shins," has been attributed to treponematosis (Aufderheide and Rodriguez-Martin 1998; Ortner and Putschar 1981). Other long bones of burial 261, including both femurs, fibulas, humerii, and the right ulna, exhibited extensive periosteal thickening. Among the long bones present with burial 7, only one other bone, the right

Table 5: Distribution of Long Bone Periostitis by Severity and Activity

	Humerus	Radius	Ulna	Femur	Tibia	Fibula
No pathology	389	299	330	472	356	366
Slight	2	3	1	4	18	3
Moderate	5	0	1	4	17	3
Severe	4	2	3	4	4	3
Active	6	3	1	5	21	8
Combination	5	2	4	5	12	1
Healed	0	0	0	2	6	0

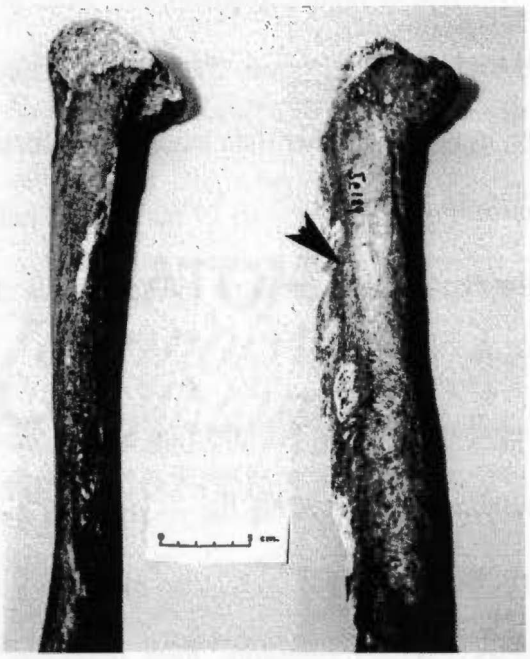


Figure 24: A Normal and Infected Tibia (Burial 189)

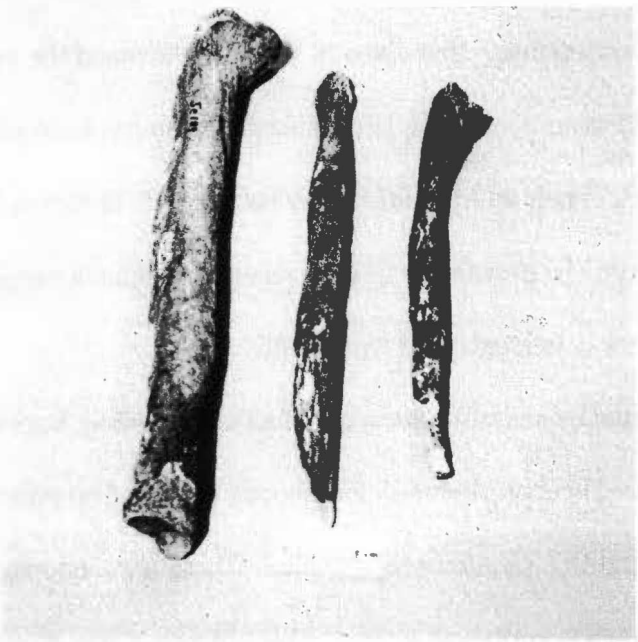


Figure 25: Severe Osteomyletis of the Tibia, Fibula, and Ulna of Burial 189

humerus, was affected. Neither individual exhibited caries sicca of the cranial vault, which is also indicative of treponemal infection. Prevalence of treponemal infection within the population may, in fact, be higher than indicated by these two individuals since sometimes only a small percentage (5 percent to 19 percent) of individuals with treponematosis develop the classic stellate lesions and saber tibia characteristic of this pathogen (Ortner and Putschar 1981).

Comparison between age and tibia infection can be seen in figure 26. Percentages of tibia reaction are highest among the youngest (0-3yrs) (21.5 percent) and oldest (50+)(26.2 percent). Both categories were also more likely to exhibit more severe reaction. This trend suggests two interpretations. First, these age groups were more stressed and less likely to withstand infection, or, somewhat counter-intuitively, these individuals had a higher immunity that allowed them to withstand the infection long enough for it to manifest on bone. The latter interpretation has been proposed by Wood and coworkers (1992). Their interpretation may be the most likely explanation for the oldest adults. However, the prevalence of tibia reaction in infants suggests the first explanation, since these individuals died early in life.

Comparisons by sex of frequencies of all affected long bones and the severity can be seen in table 6. The majority of all long bones exhibited no infection (95.56 percent) for females and (97.78 percent) for males. There is a tendency for females to exhibit a higher rate in all severity categories. This difference was significant at the .05 level (χ^2 p-value=.03). It should be noted, however, that only a small percentage of long

Figure 26: Age Distribution of Tibial Periostitis

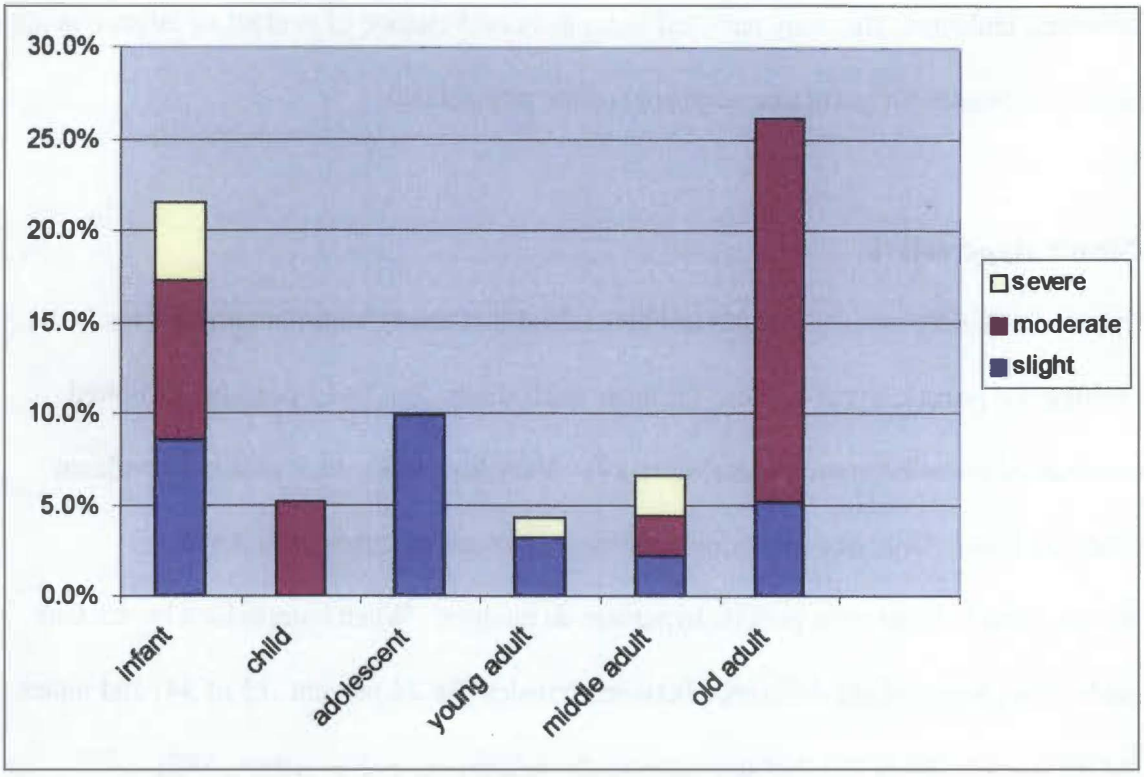


Table 6: Sex Distribution of Periostitis

	Slight	(n)	Moderate	(n)	Severe	(n)	No Pathology	(n)
Female	1.48%	(11)	.94%	(7)	2%	(15)	95.56%	(711)
Male	.46%	(3)	.79%	(5)	.95%	(6)	97.78%	(617)

bones exhibit infection for both males and females. Differences in rates of periostitis may be explained by differences in lifestyle and/or allocation of labor (e.g., agricultural activities, childcare) that may have led to an increased chance of contact of infectious or parasitic diseases for particular segments of the population.

Porotic Hyperostosis

Ninety-two individuals at Fains Island had enough cranium present to examine for porotic hyperostosis. Of those individuals, 36 (39.13 percent) exhibited evidence of porotic hyperostosis (figure 27). Very few orbits were extant to evaluate cribra orbitalia. Only one individual exhibited evidence of cribra orbitalia and is incorporated here into the porotic hyperostosis analysis. When comparison by sex was made, there was a slight difference between females (38.23 percent, 13 of 34) and males (44.82 percent, 13 of 29), but not statistically significant, (χ2-p-value=. 392).

Table 7 presents a breakdown of severity and activity by age. In regards to severity, the majority of cases is slight to moderate in manifestation. Only four individuals (5.33 percent) displayed porotic lesions that could be categorized as severe. These severe cases were confined to adolescent and young adult categories. In terms of activity, remodeling follows a significant pattern. All subadults who exhibited porotic hyperostosis died within the active stage, while all middle and old adults exhibited healed lesions. This pattern is to be expected since the manifestation of porotic hyperostosis in adults appears to be remnants of childhood anemia. What is interesting is that all of the

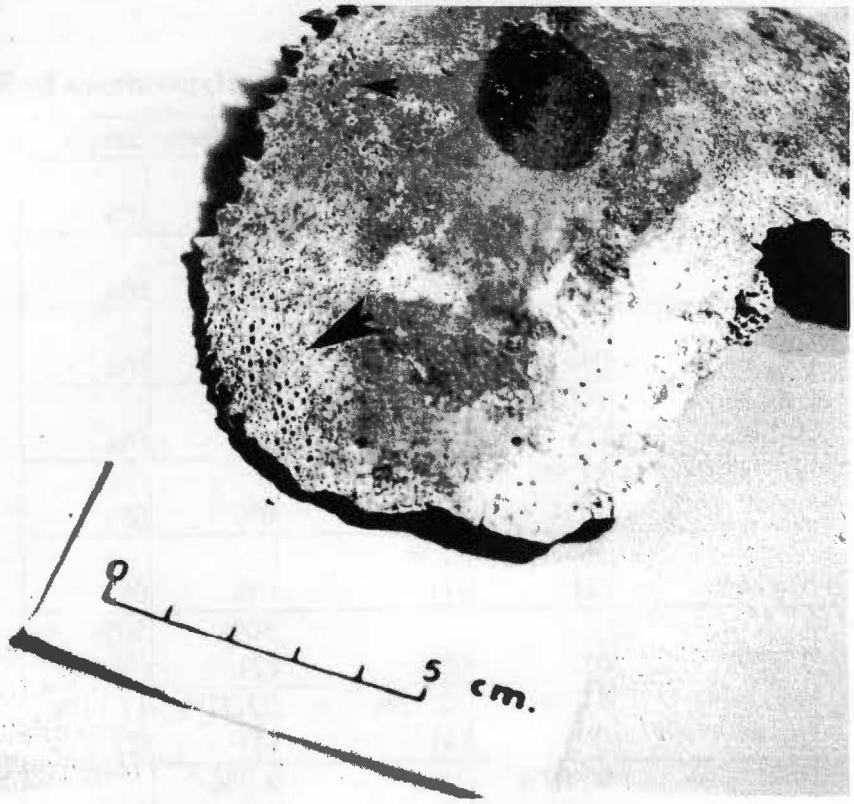


Figure 27: Active Porotic Hypostosis on the Occipital of Subadult (Burial 72)

Table 7: Age Frequencies of Porotic Hyperostosis by Severity

Age Category	None	Slight	Moderate	Severe
Nb. -.9	50% (1)	50% (1)	0%	0%
1-1.9	50% (2)	25% (1)	25% (1)	0%
2-2.9	0%	100% (1)	0%	0%
3-4.9	100% (1)	0%	0%	0%
5-9.9	87.5% (7)	12.5% (1)	0%	0%
10-14.9	75% (2)	25% (1)	0%	0%
15-20	0%	0%	50% (2)	50% (2)
20-30	44.44% (8)	22.22% (4)	22.22% (4)	11.11% (2)
30-50	66.67% (16)	25% (6)	8.3% (2)	0%
50+	60% (6)	10% (1)	30% (3)	0%
Total	57.33% (43)	21.33% (16)	16% (12)	5.33% (4)

Table 8: Percentages of Porotic Hyperostosis Healing Stages by Age Distribution

	Active	Mixed	Healed
Child	100%	0%	0%
Adolescent	50%	0%	50%
Young adult	0%	60%	40%
Middle adult	0%	0%	100%
Old adult	0%	0%	0%

cases within the severe category appeared in young adults and adolescents, the category that also has the most admixture of remodeling. If the level of cranial involvement is representative of severity of the disease, then it would stand to reason that those that are the most vulnerable (i.e., children) would manifest the most severe cases. This pattern is not the case at Fains Island. Perhaps cranial involvement is more directly correlated with duration than with severity.

Trauma

Along with degenerative joint disease, trauma is one of the most common pathological conditions in skeletal series (Brothwell 1981; Ortner and Putschar 1981). Ortner and Putschar (1981:55) subdivide the occurrence of trauma into three categories: (1) complete or partial fracture; (2) dislocation or displacement of the bone; and (3) disruption of nerve and/or blood supply. The distribution of traumatic lesions can give considerable insight into patterns of violence that may significantly affect a community or a segment of the population's ability to thrive. Furthermore, patterns of traumatic lesions may reflect cultural practices, interpersonal and/or external violence, and occupation.

Given the fragmentary nature of the Fains Island skeletal series, assessing trauma was problematic. In order to err on the conservative side, most of the recorded trauma consists of healed lesions. Of course, actual rates of traumatic injury may be significantly higher since diagnosis of trauma in many cases depends on the individual's ability to survive the insult. Table 9 gives descriptions of skeletal trauma exhibited

Table 9: Trauma at Fains Island.

Burial Number	Sex	Age	Description
3B	Male?	Young adult	Healed small depression fracture on R frontal
10	Female	Middle adult	Bowed R radius possibly due to healed fracture
84	Male	Middle adult	Osteoarthritic lipping on 2 thoracic vertebral bodies, perhaps due to trauma, does not impact vertebral disc
25A	Female	Adult	Traumatic arthritis of R elbow
29	Female	Middle adult	Healed contusion on L frontal
36	Female	Middle adult	Possible healed blunt force trauma on occipital
267	Female	Middle adult	Severe periostitis of distal end of posterior shaft of R femur due to traumatic injury
256	Male	Middle adult	Possible cutmarks/scalping along on left and right sides of coronal suture
170	?	Adult	Traumatic arthritis on R olecranon process

within the population along with pertinent age and sex information. Two individuals, burials 3B and 29, had small, healed ectocranial depression fractures of approximately the same size and shape on frontal bone (figure 28). Smith (2001) found a similar pattern at other Dallas sites in the Chickamauga Basin. She attributes these to deliberate non-lethal blows, perhaps similar to Walker's (1997) findings in the Santa Barbara Channel. He suggests that these lesions may be indicative of ritualized interpersonal conflict resolution.

Most of the other trauma can be attributed to multiple factors, induced by accident, physical activity, or interpersonal violence. There was no discernable evidence of inflicted projectile points. Two individuals, Burials 256 and 36, are perhaps the only indication of external violence. Burial 256, that of a male middle-adult, exhibited evidence of possible scalping, with possible bilateral, transverse cutmarks along the coronal suture. A female middle, adult, burial 36, has a possible healed trauma on the occipital (figure 29).

General Pathology

Table 10 presents a summary of disease classes not presented above. Although the research presented here is based on a population perspective, a few interesting individual cases warrant some discussion. General/unknown osteitis of the axial skeleton, for the most part, consists of lytic lesions of the vertebra, clavicle, and ribs, and osteomyelitis of the crania that may be caused by a number of viral, bacterial, and parasitic pathogens. Although some vertebral bodies had destruction of outer cortex



Figure 28: Healed Depression Fracture on Left Frontal of Burial 29.



Figure 29: Healed Depression Fracture on Occipital of Burial 36

Table 10: Other Pathological Defects Associated with the Fains Island Skeletal Series

	Male	Female	Subadult	Indet. Adult	Total
General/Unknown Osteitis –Axial	1	5	1	1	8
Ankoloysis	0	3	1	0	4
Osteoarthritis	8	11	0	2	21
Dental Anomaly	1	4	1	0	6
Auditory Exostosis	3	0	0	2	5
Spina Bifida Occulta	1	0	0	0	1
Spondylolysis	1	0	0	0	1
Button osteoma	2	0	0	0	2
Tumor	0	0	0	1	1
Dental calculus	4	0	0	3	7
Periapical abscesses	12	17	0	2	31

and trabecular bone with no evidence of bone regeneration, no vertebra were found with collapsed bodies and sharp angles that are indicative of tuberculosis. Burial 227 exhibits lytic lesions of the sacrum and ankolysis of the sacroiliac joint with some arthritic lipping.

Six dental anomalies were present, mostly consisting of impacted and supernumerary teeth. Burial 172, a young female adult, exhibits the most interesting of these anomalies (figure 30). In the mandible, there is an impacted first premolar that is too crowded to emerge, a supernumerary premolar breaking through bone in the posterior portion of the mandible and a second underdeveloped peg molar. Other congenital defects include one case of spina bifida (burial 263).

Finally, burial 37 has a "ballooned" benign osteoma above the mastoid process of the left temporal bone (26.79 mm in diameter) (figure 31). The affected area consists of a swollen area with a smoothed outer cortex and an inner matrix of coarse, vascularized trabeculae bone. According to Eshed et al. (2002), this type of osteoma is post-traumatic or developmental in etiology and is markedly different in etiology and morphology from the two other button osteoma found at the site. Whereas button osteomas are common in archaeological samples, slow growing and asymptomatic, ballooned osteomas are relatively rare and progressive in growth. Victims frequently are affected with dizziness, headaches, and other symptoms (Eshed et al. 2002).

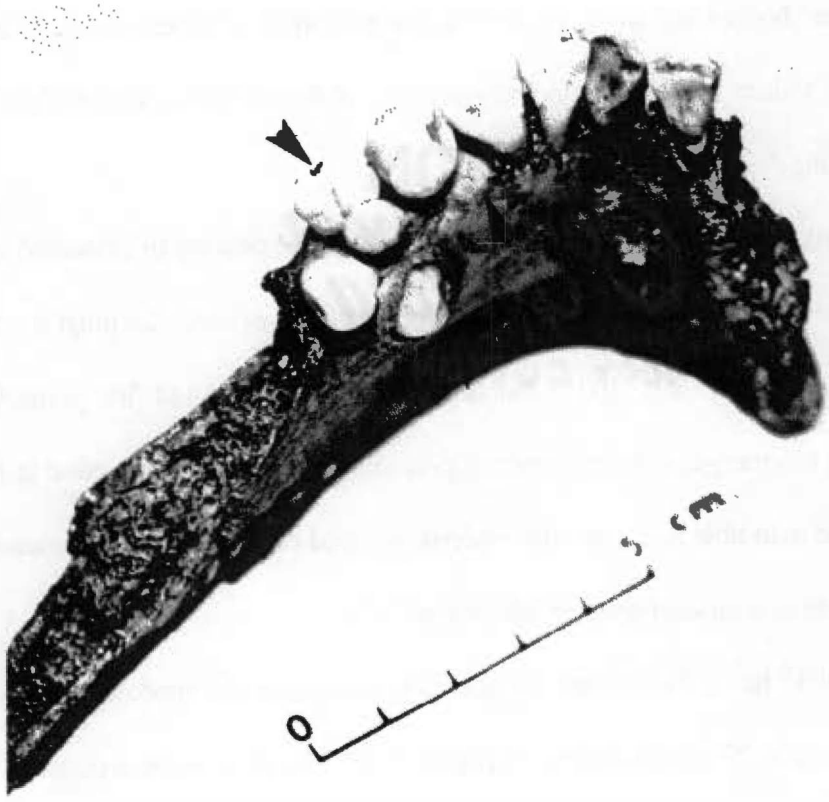


Figure 30: A Young Female (Burial 172) with a Supernumerary and Impacted Premolars.

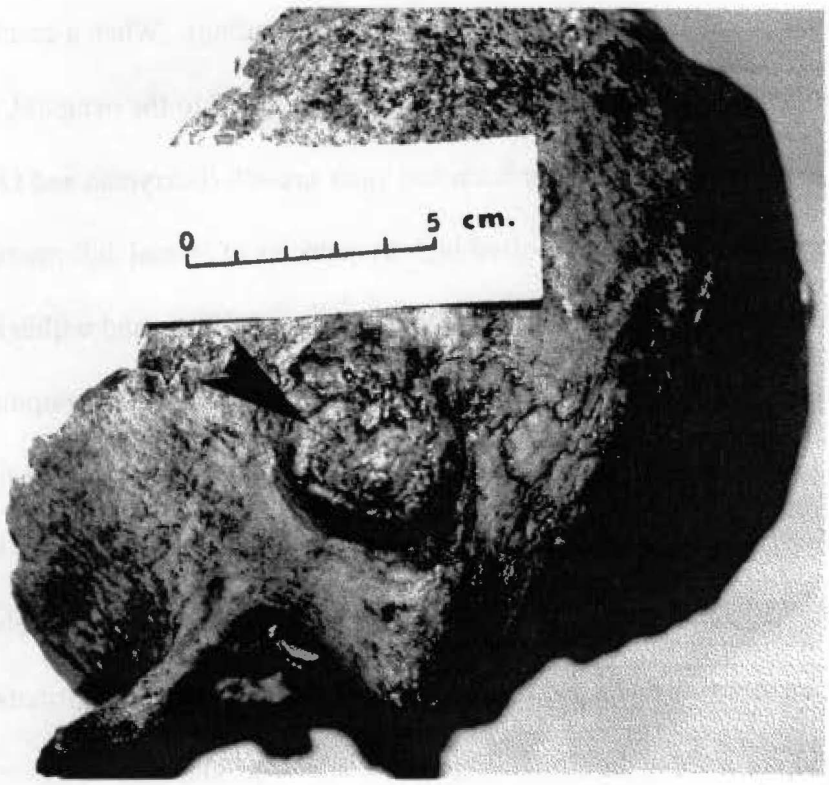


Figure 31: A Benign Osteoma above the Left Mastoid Process of Burial 37.

Cranial Deformation

Also present in the Fains sample was cranial deformation, a cultural practice that distorts the contours of the skull vault. This effect is usually achieved by binding the infant's head or the use of hard boards (i.e., cradleboarding). When a cradleboard is used, it produces a distinct pattern. As pressure is applied to the occipital, the skull bulges to the sides to compensate brain and vault growth (Berryman and Owsley 1984).

Researchers have reported high frequencies of cranial deformation within Mississippian communities (Parham 1982; Owsley et al. 1984), and within Dallas communities; these levels range from 55 percent to 75 percent of the population (Langdon 1989). Both Parham (1982) and Langdon (1989) found higher frequencies of cradleboarding in village burials, which they interpreted as associated with low status individuals. At Fains Island, only six individuals exhibit evidence of cradleboarding. Cranial deformation at Fains predominantly consisted of occipital deformation that generally did not involve the frontal (figures 32 and 33). This type of deformation is common in Dallas sites and has often been interpreted as unintentional (Langdon 1989; Parham 1982). Although frequencies of cradleboarding crosscut sex, only one individual, that of a child, had grave goods associated with their interment; however, the small number of crania that exhibited deformation precludes evaluation. This low frequency can be attributed to two factors. First, very few crania were intact enough to allow evaluation of cradleboarding. Secondly, the exclusion of village burials from the sample may have substantially affected its frequency.

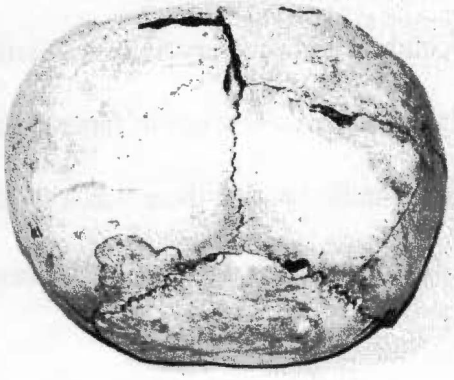


Figure 32: Posterior View of Occipitally Deformed Cranium of Burial 1(Subadult).

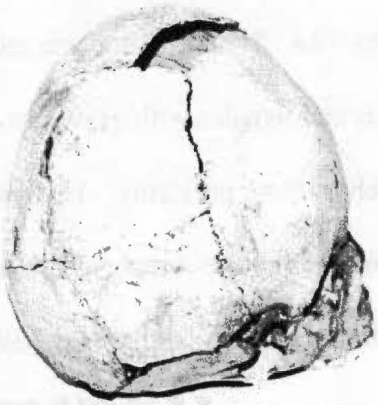


Figure 33: Lateral View of Cranium Burial 1, Subadult Showing Occipital Deformation

Rank and Status

Table 11 gives the results of correlations performed between skeletal indicators of stress and the occurrence of funerary objects. Statistical analysis was also done separately by sex and the presence or absence of funerary objects. Initial perusal of occurrence of biological variables indicates that there was a slight difference in stress between the two categories. However, none of these differences were statistically significant.

When separated by sex, these differences are more visible. For example, the rates of all morbidity indicators, with the exception of enamel hypoplasia, are higher for females interred without associated funerary object than those females with funerary objects. In fact, the rate of periostitis is higher for females without funerary objects (7.4 percent) than in all other categories. Statistical analysis indicates that there is a negative correlation between periostisis and females with grave goods. In other words, females with grave goods are less likely to have periostitis. However, a note of caution is warranted. This correlation may simply be a representation of differences in age rather than relative differences in cultural conditions that may have served as a buffer to stress. Perusal of the distribution of grave goods among females shows that young females were more likely to be interred with funerary objects than their older counterparts. As discussed previously, periostitis is most common with older adults. Although not statistically significant, this may also explain why females with funerary objects are more likely to have enamel hypoplasia than those without enemal hypoplasia, since hypoplasia is more prevalent in younger individuals.

Table 11: Statistical Relationship Between Social and Biological Variables

	Entire Population		
Biological Variables	**w/ funerary objects**	**w/out funerary objects**	**Score**
Dental Caries	17%[1]	20%[1]	-.076
Antemortem Loss	1.16[2]	0.88[2]	.033
Enamel Hypoplasia	61.53%[3]	63.77%[3]	.024
Periostitis	3.5%[1]	4.26%[1]	-.075
Porotic Hyperostosis	27.60%[3]	36.40%[3]	-.094
	Females		
Biological Variables	**w/ funerary objects**	**w/out funerary objects**	**Score**
Dental Caries	21%[1]	22%[1]	-.023
Antemortem Loss	0.82[2]	1.7[2]	-.160
Enamel Hypoplasia	75%[3]	54.29%[3]	-.094
Periostitis	3.75%[1]	7.4%[1]	-.210*
Porotic Hyperostosis	14.29%[3]	33.33%[3]	-.199
	Males		
Biological Variables	**W/ funerary objects**	**w/out funerary objects**	**Score**
Dental Caries	9%[1]	15.2%[1]	-.239*
Antemortem Loss	2.26[2]	.74[2]	+.206*
Enamel Hypoplasia	56.25%[3]	81.25%[3]	-.260*
Periostitis	1.56%[1]	3.73%[1]	-.028
Porotic Hyperostosis	23.07%[3]	42.86%[3]	-.206*

*significant at the .05

[1] denotes mean percentage of elements affected divided by number of elements present

[2] denotes mean score

[3] denotes actual percentage of individuals affected

Males show an inverse pattern to that of females. Older males are more likely to be associated with grave goods than younger males. Antemortem tooth loss is more prevalent in older males and males with funerary objects, since the inverse is true for them. Males interred without funerary objects exhibit high rates of stress indicators. This pattern is especially true for porotic hyperostosis and enamel hypoplasia (81.25 percent and 42.86 percent, respectively), both significant correlations. Once again, the youth of males interred without funerary objects may be a likely explanation. Nonetheless, the low periostitis and caries rates in males interred with funerary objects cannot be simply explained by age differences. Males interred with funerary objects have the lowest rates of periostitis (1.56 percent), which is significant at the .05 level. It is possible that males with funerary objects were the hunters of the group. Perhaps with long distance hunting trips these men were in the village less and thus had less contact with the conditions that foster the spread of infectious and parasitic diseases. Although not statistically significant, abscence of these men from the village for extended periods may also explain the lower rates of dental caries since domestic plants may have not always been readily available. The fact that these older males were often interred with hunting implements (e.g., projectile points, debitage), may attest to their role as hunters. Differences in the rates of morbidity indicators thus suggest that there is some correlation between type of funerary treatment and biological stress, but it is important to note that low sample sizes may have significantly inflated percentages.

Summary

The prevalence of dental caries suggests that the Fains Island community was highly dependent on maize agriculture. This dependence may have contributed to markers of stress (i.e., porotic hyperstosis, periostitis, and enamel hypoplasia) also found amongst the Fains Island sample. Certain pathological markers appear to be age dependent. Younger individuals are more likely to exhibit enamel hypoplasia and porotic hyperstosis. This pattern is not surprising since these are diseases of childhood. Conversely, older individuals are more likely to exhibit dental caries and antemortem loss, a pattern common in most archaeological series. High rates of tibia infection are most likely to occur with the oldest and youngest categories.

Correlations of the examined biological indicators and sex showed some slight differences. Comparisons of paleodemography, enamel hypoplasia, antemortem tooth loss, and porotic hyperostosis yielded no statistically significant differences between sexes. Although not statistically significant, caries rates are slightly higher with females. Furthermore, females exhibit higher rates of periostitis, which is statistically significant at the .05 level. These differences may be the result of differences in gender roles. Comparison between all interments with funerary objects and selected biological indicators produced no significant correlations. When separated by sex there are some significant correlations. Differences in age and social roles are likely explanations for these correlations. A more detailed discussion of these findings is given in the following chapter.

Chapter VI: Discussion and Conclusion

The purpose of this study was to assess the overall health status of the inhabitants of Fains Island and to examine possible differences in stress indicators between segments of the population. The examination of paleodemography and paleopathological variables facilitated this goal. The following discussion highlights the results presented in the previous chapter with regard to findings within other Mississippian communities, especially Dallas phase sites.

General Health

A total of 338 individuals was examined for paleopathological indicators of stress including caries, antemortem toothloss, periostitis, porotic hyperostosis, and trauma. These indicators were chosen because they could be macroscopically discerned. Other pathologies were noted, but they were not central to the analysis. Paleodemographic parameters also were generated by using a maximum likelihood analysis to calculate hazard models for the population.

This discussion must first be framed within the limitations of bioarchaeological reconstruction, many of which have been highlighted by Wood, Milner, Harpending, and Weiss (1992). These limitations included unknown hazards of selective mortality and hidden heterogeneity (i.e., individual variation in the risk of morbidity and mortality via genetic makeup, socioeconomic status, differential exposure to disease, and other environmental and biological factors). Although this problem is not easily rectified, several steps were taken to examine different segments of the population

that may have contributed to differential risk factors, including those based on sex, age, and rank. Second, populations represented by burial samples are obviously composed of individuals who did not survive and, therefore, may not necessarily be representative of the living population. Furthermore, in a case like Fains Island, where only a portion of the site was excavated, the skeletal series is a sample within a sample, and therefore, true pathological rates may be higher or lower. Although we will never know the true sample, to alleviate some of the bias caused by excavation techniques, when possible, comparisons included similar populations (i.e., mound populations). Finally, individuals that exhibit skeletal lesions obviously survived long enough to manifest these markers. More problematic is the absence of particular skeletal lesions. This absence could suggest two interpretations: the causal condition was absent, or, inversely, the individual could not survive the insult long enough to manifest skeletal markers. It is important to keep all of these limitations in mind.

The survivorship probability at Fains Island is similar to those of the Toqua and Hixon mounds. Furthermore, likelihood ratio tests indicate no statistically significant difference among the three populations. Only one sample, the entire Toqua population (i.e., mound and village), is significantly different. This finding is probably due to the underrepresentation of subadults within mound-based samples rather than inherent differences in health between populations.

Comparison with modern ethnographic data also demonstrated that not only is there an undernumeration of subadults, but older adults are also underrepresented. This latter pattern is possibly due to the difficulties in skeletal age estimation in which older

adults may be consistently under aged. As discussed, this is one of the critical concerns expressed by Bocquet-Appeal and Massat (1982). Methods described by the *Rostock Manifesto* (Hoppa and Vaupal 2002; see also Muller et al 2002; Konigsberg and Frankenberg 1994) for age estimation, which combines scores of age-dependent skeletal traits and statistical methods, may more accurately reflect a skeletal population's age distribution. For the purpose of this study, previous researchers already determined age at death estimates for each individual skeleton. These age indicators were then used to obtain a demographic profile. Although seemingly counterintuitive, the Rostock protocol calls for the opposite. First, age indicator stages are assessed for each skeleton. Next, estimates are made for the probability of assigning the skeleton into a specific osteological age-indicator stage. This analysis is done by picking an age structure from a known age reference sample, whether anatomical (e.g., Terry, Hammen-Todd collections) or cemetery populations (see Usher 2002), for the paleodemographic target sample best suited for reproducing the observed age indicators. Once the demographic profile is constructed, individual age estimation can be made. This approach is supposed to further reduce the effects of "age mimicry." The Rostock protocol was recently applied to a paleodemographic analysis of the Averbuch Site (40DV60) in central Tennessee (Konigsberg et al. 2003). Future demographic analysis for Dallas phase sites may benefit from using this approach

Carious lesions among Fains Island inhabitants occur at a rate of 11.47 percent per extant teeth. This rate falls within the common range of Mississippian societies: approximately 15 percent (Larsen 1997:69). Likewise, the range of teeth

impacted is similar to that of other agricultural communities. Not many studies have investigated caries rates among Dallas communities, making comparisons difficult. Smith's (1983) results for males and females at Toqua are similar to, albeit slightly higher, than Fains. Furthermore, at least 335 teeth were lost antemortem in the Fains' sample, and some undoubtedly attributed to carious activity and dental disease. Rates of caries suggest a high rate of dependence on maize, but no substantial difference between Fains and other Mississippian sites. Both carious rates and antemortem loss demonstrated age-based differences. Middle and older adults exhibited an increased rate of both carious lesions and antemortem loss.

A total of 120 (56.6 percent) individuals with extant permanent incisors and canines exhibit one or more dental hypoplasias. Table 12 shows a comparison between hypoplasia rates at other Mississippian communities, including two Dallas sites (Toqua (40MR7) and Citico(40MR7)). These comparisons suggest that children at Fains may have been slightly more stressed than at Toqua or Citico, but the hypoplasia rates at Fains fall within a middle range and in no way compare to the rates of highly stressed communities at Dickson (11FO34) and Averbuch (40DV60).

All long bones were examined for periostitis. Each bone with periosteal reactions was recorded in terms of healing and severity. Then bones were analyzed by the number of bones impacted rather than number of individuals affected. On a bone-by-bone basis, the tibia was most commonly affected, a frequent pattern described by Ortner and Putschar (1981). In terms of severity, most of the bones impacted had slight manifestation of periosteal reactions followed by moderate and severe reactions. Tibia

Table 12: Comparison of Hypoplasia Rates with Other Mississippian Communities

Site	% hypoplasia	Reference
Toqua (40MR6) (mound population)	25.5%	Betsinger 2002
Citico(40MR7) (mound population)	38.9%	Betsinger 2002
Moundville	54%	Powell 1988
Fains Island (40JE1)	**56.6%**	**Present Study**
Dickson Mounds (11FO34)	79%	Goodman et al. 1980
Averbuch (40DV60)	87%	Hamilton 1999

periostitis was most common in the youngest and oldest age categories. These age groups were also more likely to exhibit more severe manifestations of periostitis. Older individuals with such severe infections suffered pain and some immobilization; however, the fact that these individuals were able to survive long enough to exhibit such degradation of bone attests to their ability to survive infectious insult. Only two individuals exhibited a particular periosteal reaction termed "saber shins" that may be attributed to treponemal infection. Other researchers attribute treponemal infection in Mississippian communities to a nonvenereal endemic variant rather than syphilis (Powell 1988). Although rates of treponemal infection may have been greater at Fains than indicated by the sample, such infections probably had no bearing on mortality.

Table 13 shows the rate of tibial and femoral reactions at Fains compared to four other Mississippian sites, from Tennessessee and the Moundville village site. The Tennessee sites are: Toqua (40MR6)(Dallas phase); Averbuch (40DV60) (Middle Cumberland phase); Ledford Island (40BY13) and Rymer (40BY11) (both Mouse Creek phase). Of all the populations, Fains exhibits the lowest percentage of periosteal reaction (5.8 percent). This rate is significantly lower than Moundville, Toqua, and Averbuch. This pattern may be due to differences in population size, length of occupation, and relative location, variables that may contribute to the spread of infectious disease in some populations.

Porotic hyperostosis is often associated with dietary deficiency and/or a synergistic relationship between infection and iron loss. Out of 92 diagnostic individuals,

Table 13: Comparison of Frequencies and Percentages of Tibial Periosteal Reaction for Fains and other Mississippian Populations

Site	# of bones	# of infected bones	%
Moundville**	562	285	50
Toqua (40MR6)*	371	164	44.2
Averbuch (40DV60)*	1060	221	20.8
Ledford Island(40BY13)*	75	15	24.6
Rymer (40BY11)*	26	9	20
Fains Island (40JE1)	**879**	**51**	**5.8**

*frequencies and percentages from Boyd (1984:165)
** frequencies and percentages from Powell (1991::43-43)

39.13 percent exhibited evidence of porotic hyperostosis. Table 14 presents a comparison of percentages of porotic hyperostosis between Fains Island and four other East Tennessee Mississippian sites, the Dickson mound site in Illinois, and Moundville in Alabama. This comparison demonstrates that Fains Island falls within the medium range of percentage of individuals infected for these sites. Thus, evidence of porotic hyperostosis suggests that the population at Fains was no more stressed than those at other Mississippian sites.

A age-graded difference in the manifestation of porotic hyperostosis within the population was present. Subadults and young adults exhibit the most severe representation of the disease and all of the active stages. This pattern is consistent with the interpretation of porotic hyperostosis as a reflection of illness experienced by children (Stuart-Macadam 1985).

Fortifications such as palisades, artistic representation of warfare activities, and the presence of certain material goods support the ubiquitousness of Mississippian warfare. Perhaps the most unambiguous evidence of warfare is the presence of lethal injuries within skeletal populations. Within the Fains sample, only a few individuals exhibited evidence of trauma. Only one individual could possibly be interpreted as showing direct evidence of intergroup violence. This individual exhibited possible bilateral, transverse cutmarks that could indicate scalping at the coronal suture. The conservative approach taken here in diagnosing trauma possibly excluded some cases of traumatic injury. Poor preservation makes it difficult to discern perimortem trauma. Nonetheless, low evidence of external conflict may be a pattern within Dallas phase sites.

Table 14: Comparison of Porotic Hyperostosis between Fains Island and Other Mississippian Populations

Site	% of Porotic hyperostosis	Reference
Citico (mound population) (40MR7)	0%	Betsinger 2002
Moundville	9.25%	Powell 1991
Toqua (mound population) (40MR6)	31.40%	Betsinger 2002
Fains Island (40JE1)	**39.13%**	**Present Study**
Dickson (11FO34)	51.5%	Goodman and Armelagos 1989
Hiwassee Island (40MG31)	65.76%	Langdon 1989
Dallas (40HA3)	74.77%	Langdon 1989

Smith (2001), who investigated evidence of trauma from Dallas phase sites in the Chickamauga Basin, found the frequency was relatively low (3.8 percent).

Most of the other trauma at Fains can be interpreted as the result of a variety of causes including interpersonal conflict, physical activity, or accidental trauma. Two individuals exhibited small, healed depression fractures on the frontal that may be indicative of interpersonal rather than intergroup violence. Smith (2001) suggests this interpretation based on a similar pattern at other Dallas sites.

Mass interments may also indicate warfare or epidemic. At Fains, 3 percent of the burials consisted of mass interments (three or more individuals). This rate is relatively high for Dallas phase sites. For example, Smith (2001) found no burials with more than two individuals in Dallas sites in the Chickamauga Basin. The close proximity of burials at Fains, many confined within the structure on the mound, makes intrusive activity or grave reuse a more likely explanation than warfare or epidemic. The use of a plow in excavation may also have contributed to the commingling of individuals.

Other pathologies were noted although they are not central to this study. These included congenital and dental diseases, osteoarthritis, and tumors. Several individuals exhibited lytic lesions on vertebras and ribs that unequivocally suggest the prevalence of nonspecific infection. No vertebra exhibited the classic markers of tuberculosis.

Sex and Stress

The likelihood ratio test used to compare paleodemographic parameters generated no statistical difference between sexes. On a purely observational note, comparison of survivorship curves does suggest some differences in survivorship rates at different life stages of men and women. For females, there is a decreased survivorship during childbearing years. Around 30 years of age, survivorships of men and women are virtually equal and, in fact, women surpass men in later years of life suggesting that women experienced greater longevity.

Differences in survivorship can be explained by purely physiological differences between sexes; however, some differences in stress markers may be more readily explained not by differences in sex per se, but by differences in gender. Recent research suggests that women may be able to better resist nutritional deficiencies and infections because of differences in immunolgical and hormonal activity (Ortner 1998). Due to these differences, females are more likely to survive chronic infectious disease than men. Thus, significantly poorer health in females may be a representation of socially constructed differences in food consumption and/or lifestyle.

Unfortunately, since sex determination for juveniles is problematic, it is impossible to compare juvenile mortality and illness by sex. However, through paleopathological analysis of childhood diseases that remain visible on the skeleton into adulthood, it is possible to examine potential differences in the rates of these lesions that may reflect differences in treatment during childhood (e.g., son or daughter neglect). The lack of statistically significant differences between sexes in the occurrence of enamel

hypoplasia and porotic hyperostosis indicates that children were equally stressed, regardless of sex. Of course, it is possible that porotic hypostosis and enamel hypoplasia indicators are not sensitive enough to demonstrate differential treatment of children.

Statistical analyses generated one significant difference: periostitis. It is possible that a female's higher immunity as discussed by Ortner (1998) may have allowed females to withstand infectious insult long enough to manifest markers on bone. If this is the case, then differences between periostitis rates are a manifestation of biological differences in sex. However, there is another explanation. Ortner (1998) presents modern day and archaeological male-female prevalence ratios for infectious disease and periostitis. Most of these ratios tend to be equal or higher for males. This suggests that social conditions that led to the differential exposure of females to infectious agents at Fains may have been at work. As stated previously, among many populations there is a significant correlation between sedentism and population aggregation and the prevalence of infectious disease.

Division of labor may be a contributing factor to higher rates of periostitis in females. Females' connection with the village through farming activities and childcare may have led to increased contact with infectious and parasitic diseases. Unfortunately, very few studies have examined social conditions that may foster differential exposure to infectious agents. Perhaps this is due to the complexity of the association between infectious agents and cultural factors influencing differential exposure to infectious agents. Unlike "nutritional buffering" and interpersonal violence, the distribution of infection within a population is less subjected to either conscious or unconscious control

(Cohen and Bennett 1993). However, some researchers have examined the interaction between social conditions and differential risk. For example, Larsen (1998) showed a slight although not statistically significant difference between females and males (23 percent and 24 percent), respectively. During the early contact periostitis rates became more prevalent in males (23 percent) compared to females (14 percent). Larsen suggests that the increase in prevalence of periostitis in males can be attributed to social conditions that led to the exposure of males to novel pathogens formally not found in villages.

Since periostitis is a nonspecific indicator of stress, it is impossible to determine the specific cause of the infection. Differential exposure for females could have come from multiple pathways. It is possible that some periostitis can be attributed to communicable diseases such as endemic syphilis and other diseases that require close contact between individuals. A female's role as agriculture producer and childcare provider may have kept her in closer contact with crowded village conditions and especially with children who are more prone to infection. However, many of these village diseases are not necessarily spread from person to person, rather many of these diseases can be carried by organisms that are associated from parasitic infection from human feces and accumulated waste. A person spending the entire day within the village may have had more opportunities to encounter these diseases than those who lived within the village but spent the majority of their day or days away from the village (Cohen and Bennett 1993). Thus, the females' tie to the village as childcare providers and farmers may explain the higher frequency of village diseases.

Although not statistically significant, this pattern may also explain the slightly higher rates of dental caries among females. As agricultural food producers, foods that are high in sucrose may have been more readily available to females. This interpretation was also given by Larsen (1998) to explain differences in caries rates among prehistoric Mississippian communities in Georgia.

Furthermore, the ethnographic records on historic southeastern American Indians supports the interpretation that females predominantly controlled agricultural spaces and were the primary agricultural food producers (Hudson 1976). Thus, these differences may be explained by differences in gender roles rather than differences in gender inequality. The fact that females were just as likely to be interred within the mound also attests to this lack of inequality.

Interestingly, ratios of periostitis are the opposite at Toqua (40MR6) Males exhibit higher rates of periostitis for males (46.3 percent) compared to females (33.9 percent) (Betsinger 2002). It is possible the infection was so prevalent that cultural factors had less of an impact. Further insight can be gained through future research conducted for other Dallas communities to examine if female to male ratios of infection are similar to Fains or Toqua. The examination of the impact on gendered division of labor could benefit from a closer examination of other skeletal indicators such as musculoskeletal stress markers, robustness, and degenerative arthritis.

Rank, Status, and Stress

Research on Dallas phase sites suggests that these communities were organized as chiefdoms with high-ranking kinship groups and with rank possibly gained through both achieved and ascribed means (Hatch 1974; Scott and Polhemus 1987). Several studies investigated the mound\village dichotomy regarding differences in stress in Dallas communities. Very few studies have examined correlations between the presence of funerary objects and biological indicators of stress (but compare, Betsinger 2002). The assumption is that the occurrence and kinds of funerary objects may impart information on an individual's social role in life. Within this study, the assumption was that those of higher rank received preferential treatment that served as a buffer to certain types of stress. However, the relationship between rank and funerary objects can be extremely nuanced, and therefore, must be approached with caution. Furthermore, the inter- and intra-site political configuration of Mississippian sites and the presence of elite groups has been a source of considerable debate (cf., Anderson 1994; Blitz 1993, 1999; Milner 1998; Muller 1997; Saitta 1994). Some researchers (e.g., Blitz 1993; Saitta 1994) argue that perhaps the traditional two-class model of elite-commoner may not necessarily be evident in many Mississippian communities. Part of this argument comes from Blitz's (1993) work at Lubbub Creek. He suggests that the control of prestige goods was less centralized than previously thought. Although Saitta (1994) admits that obviously more work needs to be done, he suggests that the distribution of resources may be more "voluntary" and based in large part on communal organization. Another consideration is

that there is the possibility that mound burial in itself indicated a higher level of rank regardless of funerary objects.

Nonetheless, when separated by sex, correlation coefficients between the presence and absence of funerary objects and selected stress markers did generate some statistically significant results. Periostitis was more likely to occur in females interred without funerary objects than with funerary objects. Inversely, although not statistically significant, enamel hypoplasia was positively correlated with funerary objects. Males interred without funerary objects generally manifested higher rates of pathological markers than those with funerary objects. Statistical analyses examining males with funerary objects generated significant negative correlations with dental caries, enamel hypoplasia, and porotic hyperostosis. Age distribution of funerary objects was given as a likely explanation for some of these correlations. Furthermore, labor allocation may play a role in these correlations. It also is important to keep in mind that small sample sizes may have an effect on these observations.

Conclusions

Due to excavation limits, the Fains sample consisted of predominantly mound interments. This limitation along with others inherent in biological reconstruction undoubtedly led to some bias in this study. Nonetheless, there are some general conclusions that can be made regarding the health of the Fains Island population. The pattern and rate of carious lesions and the presence of dietary deficiency diseases, such as porotic hyperostosis, suggests that the Fains inhabitants were highly dependent on maize-

based agriculture. Evidence of nonspecific infectious diseases such as periostitis suggests that population size, a sedentary lifestyle, and hygienic conditions fostered these diseases to a certain extent. This evidence points to a population that unquestionably was stressed; however, comparisons with other Mississippian communities indicate that the Fains' sample was relatively no more stressed than these other communities.

Research has shown a decline in quality of life for some populations with the transition of subsistence activities. Yet, not all populations are impacted equally and the amount of stress experienced by a population can be governed by a variety of cultural and economic variables. For instance, the location of Fains Island possibly served as protection from hostile groups. This protection may explain the low evidence of lethal trauma. Comparisons between populations did yield some slight differences in morbidity. Low levels of nonspecific infectious diseases may demonstrate some differences in population pressure and hygienic conditions. High rates of hypoplasia compared to other Dallas sites indicate that the Fains sample experienced periods of acute stress. Fains Island's isolation from other sites may have served to foster this stress. Situated on an island, the site undoubtedly had rich alluvium soil ideal for agriculture. The quantity of arable land in the narrow bottomlands of the French Broad River, however, may be less than valleys with less rugged terrain. Periods of low agricultural production may be correlated with periods of acute stress for children. Nonetheless, hypoplasia rates are not nearly as high as those rates of highly stressed communities such as Dickson Mounds and Averbuch.

Intra-population comparisons suggest that age was an important mitigating factor in the distribution of skeletal lesions. Hypoplasia rates were most prevalent with adolescents and young adults, suggesting that children who experienced acute stress in childhood were less likely to survive into later adulthood. Likewise, the most severe and active cases of porotic hyperostosis occurred in subadults. This pattern was expected since porotic hyperostosis is often interpreted as a childhood disease. Inversely, dental caries and antemortem tooth loss were more closely associated with older individuals. Periostitis was most commonly associated with the youngest and oldest categories.

Comparisons between sexes and selected pathological variables produced only one statistically significant result. A likelihood ratio test also found no difference between paleodemographic parameters and sex. This result suggests that while different social conditions may have existed between males and females, these did not have a significant impact on health. The only significant difference, periostitis, between the sexes may be explained by differences in physiology, gender roles, or an interaction of the two. When separated by sex, correlations between the presence of biological indicators and the presence or absence of grave goods also yielded some statistically significant differences. Likely explanations for these correlations are the distribution of funerary objects with age groups, and possible differences in division of labor. These explanations may be likely than explanations regarding differential rank and "nutritional buffering." In this particular case, geographic location and the political structure of the Fains Island population may play a part in the observed pattern. It is possible that Fains Island was less socially demarcated than larger sites such as Toqua. The relative

isolation of Fains Island from the political influence of relative larger sites also may explain why there is a wider range of age and sex categories interred in the mound and the lack of elaborate ceremonial funerary objects as compared with Toqua.

To better understand the factors involved in affecting the health of the Fains population, further archaeological studies must be conducted regarding the population, length of occupation, and Fains' relationship with other Dallas sites and to Pisgah and Qualla phase (AD 1000-1500) sites, located in western North Carolina. Furthermore, this study would benefit from the analysis of Zimmerman's Island, also located in the Douglas reservoir, and a consideration of its association with Fains Island. Nonetheless, this analysis of Fains Island provides the basis for such comparisons and is a first step in fitting this site within the larger network of Dallas communities and thus contributing to an understanding of their variation.

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