Morbidity and Mortality: Human Paleopathology and Burial Treatment

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Acknowledgements

Where to begin, where to begin. To start, I have to thank my friends and family for keeping me grounded through this whole process. To my friends, thank you for being ever so patient with me. While I know you are not nearly as interested in diseased skeletons as I am, your consideration for and help with this thesis has not gone unnoticed. I am sure you will be just as relieved as I am to never hear me grumble and proclaim about my thesis ever again.

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Abstract

Infectious diseases have plagued populations across the globe for thousands of years. Tuberculosis (TB) and yaws, bacterial infections that persist in modern populations, increased in frequency in the United States during the Mississippian time period. While evidence of TB and yaws has received copious attention, the social context of these diseases has yet to be considered. The prevalence of TB and yaws at the Schild Site in the lower Illinois River Valley makes it an optimal site for study. Not only is infectious disease frequent at the site, but the site has been well documented and the social organization has been highly studied. My research continues the research of previous scholars as it delves further into the social organization of the Schild Site. I interpret the social context of disease by looking at the burial treatment of individuals infected with TB and yaws. The following research focuses on the artifact association and location of burials infected with TB and yaws as the identifier of burial treatment and the perception of diseased individuals. This preliminary research suggests that the population at Schild not only perceived diseased individuals similarly to healthy individuals, but in some cases, high status individuals were contracting these contagious diseases possibly at a higher frequency than the rest of the population. These findings open many doors for how infectious disease is perceived in prehistoric populations, and the parallels this may represent in populations of the present day.

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Introduction

The World Health Organization estimates that nearly 50,000 people die each day of an infectious disease. Human populations have been plagued by infectious disease for thousands of years (Brachman, 2003). While some infectious diseases near eradication, others continue to persist among human populations. Tuberculosis and yaws are highly infectious and detrimental bacterial diseases found in past and present populations. Tuberculosis is an aerial disease that is spread when a contagious infected person coughs, sneezes, or speaks (CDC, 2014). In comparison, yaws is a direct contact disease spread by skin-to-skin contact with an infected lesion (WHO, 2016). As these two diseases are easily transmitted through daily human interactions, rates of infection are often high in heavily populated areas.

Evidence of tuberculosis and yaws has been found in skeletal remains excavated from many archaeological sites in the eastern United States. These diseases have been dated to pre-Columbian times, which were at least 1,000 years ago (Buikstra, 1981). Infectious disease in pre-Columbian times is identified osteologically through lesions in the bone. The Mississippian time period (~800-1600 AD) has been well studied. During the Mississippian time period there was an increase in reliance on maize agriculture as well as an increase in population size and density (Larsen 2002). These trends provided an optimal environment for the emergence and transmission of infectious disease.

While the identification of infectious disease in the Mississippian has received substantial attention, the social context of these diseases in prehistoric populations has been understudied. Rather than identifying the osteological evidence of infectious disease in pre-Columbian populations, this research will delve further into the study of infectious disease by analyzing the treatment of infected individuals at the point of death. The Schild Site, located in the lower Illinois River Valley, is an optimal site to look at the burial treatment of infected individuals. By observing the burial ornamentation, location, and age of both infected and healthy individuals at the Schild Site, we can learn how prehistoric populations treated individuals with infectious disease at death. Inferences form burial treatment provides insight into how people with diseases were perceived and how these diseases were managed in life. Furthermore, it indicates the extent to which the treatment of infected individuals and population organization shape the spread of infectious disease in American society today.

Infectious Disease and Mortuary Treatment

Infectious Disease, the Human Immune Response, and Nutrition

Infectious disease results from an infection of the human body by a virus, parasite, fungus, or bacteria. These various disease agents have caused constant infectious disease amongst human populations for thousands of years, and continue to evolve and persist throughout ecological and evolutionary time. The outcome of infectious disease in human populations is based on three main variables: infectious pathogens, host susceptibility and resistance to the disease agent, and the environment in which the host and pathogen interact (Powell, 1988). A person's primary defense mechanism to combat infectious disease is the immune system. The immune system is comprised of two different responses: a specific response and a non-specific response. These responses are triggered by different pathogens and signal various cells to combat a specific disease agent. It is the responsibility of the immune system to attack any foreign pathogen that enters the body and to regulate the body to maintain function. The relationship between the immune system and infections caused by pathogens is a quintessential ecological model of the co-evolution between species. As the immune system is a critical organ necessary for survival, its ability to function is highly affected by the nutrition and overall health of the human body. Malnutrition, specifically protein and iron deficiency, have a significant negative impact on the function of the immune system (Wilbur, 2008). Consequently, diet plays a critical role in the presence and absence of disease in a population. A weakened immune response makes an individual more susceptible to infection. Certain infections manifest themselves in the human skeleton and leave osteological traces on the bones.

History and Epidemiology of Tuberculosis

Tuberculosis (TB) is one of the world's deadliest diseases, infecting one third of the world's population (CDC, 2015). It has been prevalent amongst human populations for over 5,000 years (Daniel, 2006). The origin of the disease in a human host has been traced to a primary zoonosis event with the transmission of the bacteria from animals to humans in East Africa (Bos, 2014). The disease left its earliest marks on human populations in Egypt and spread to India, China, and eventually Europe (Daniel, 2006). Extensive trade routes, exploration, and colonization resulted in vast expansion of the disease throughout the Old World. Nevertheless, while the spread of TB and its transmission was well established and documented in the Old World, evidence of TB in the New World was not as obvious.

Traditional thought assumed the spread of TB to the Americas was by way of European conquest. However, researchers and archaeologists identified substantial evidence of TB in the New World hundreds of years prior to European contact. TB was evident in skeletal remains from the South American Andes, Mayan populations in Central America, Southwestern Pueblo populations, and native populations in West-Central Illinois (Wilbur, 2008). Despite evidence of TB among these various populations in the Americas, it was unclear how the disease spread from its origin in East Africa to the Americas prior to European contact. Recent genetic analysis suggests the emergence of TB in the Americas via a second zoonotic event. DNA analysis of ancient genomes infected by TB illustrates a common ancestor of the pathogen exists within both humans and pinnipeds, or seals and sea lions (Bos, 2014). It is proposed that seals and sea lions contracted the disease from an African host species and carried the disease across the oceans to South America. Coastal peoples in Peru and Chile in close proximity to these animals, which resulted in a second transfer of the bacteria from pinnipeds to humans. From here, TB spread along trade routes from South America to North America.

TB is a disease caused by infection from the bacterium *Mycobacterium tuberculosis* (Powell, 1988). The mycobacteria manifest itself in the lungs and spreads when an infected person coughs, sneezes, or speaks (CDC, 2015). As a result, the bacteria thrives when people live in close proximity to one another. TB presents itself as a cough, weight loss, fever, hemoptysis, chest pain, and fatigue (Lutwick, 1995). After initial infection, the disease may encapsulate in fibrous tissue and remain dormant from further pathological activity, or it may spread throughout the body to affect other organs and the skeletal system (Powell, 1988). The mycobacteria can maintain itself in the human body and remain viable for decades. Under the condition of constant infection or malnutrition, the human immune defense is weakened. The ability for TB to remain viable and transmittable years after initial infection is a critical epidemiological factor for the survival of the mycobacterium. The chronically infectious nature of the mycobacteria allows it to reside in relatively small populations without depleting its host resources. Nevertheless, exposure to the mycobacteria does not always lead to infection, and infection does not always lead to active disease (Wilbur, 2008).

In order for TB to manifest in the skeletal system, the disease spreads through the bloodstream to areas of cancellous bone (Powell, 1988). The infection commonly metastasizes in the body of the vertebrae, in the ribs or spinal column, where it forms lesions on the bone.

Skeletal infection is most frequently seen in the spinal column because of its general morphology and close proximity to other commonly infected areas. Extensive destruction of the spine from TB infection may result in fusion of the lower spine. This severe TB infection is commonly known as Pott's disease. Bone involvement in TB infection is reported in relatively low frequencies, ranging from 3 percent to 7 percent of patients. With this being said, most cases of infection that result in bone involvement occur in juveniles in poorly nourished populations.

	Tuberculosis	Yaws
Epidemiology		
Pathogen	*Mycobacterium tuberculosis* and closely related spp.	*Treponema pallidum; Treponema pertenue*
Mode of infection	Respiration, ingestion	Skin lesions
Modal age at exposure	Childhood	Childhood
Model age at onset of disease	Late adolescence, early adulthood	Childhood
Duration of infectious state	Decades (with latent periods)	5-10 years
Pathology		
Initial lesions	Lungs, hilar lymph nodes	Mucocutaneous tissue
Subsequent lesions	Any organ system	Mucocutaneous tissue, bone
Prevalence of disease in endemic context	10-50% of exposed individuals	>75% of exposed individuals
Predominant skeletal response	Major: osteolytic Minor: osteoblastic	Major: osteoblastic Minor: osteolytic
Potential for mortal effect	Moderate to high	Low

Table 1. Overview of the Epidemiology of Tuberculosis and Yaws, reconstructed from Powell (1987).

History and Epidemiology of Yaws

Today, global prevalence of yaws is unknown, but a majority of unconfirmed reports trace yaws to poor communities in warm areas of Africa, Asia, and Latin America (WHO, 2015). Yaws falls under the larger category of treponemal infections including syphilis and bejel. While treponemal infections are abundant throughout history, the origins of the various treponemal infections and their divergence as individual strains of bacteria are still under debate. Syphilis appears abruptly in European populations, but skeletal remains from the New World reveal evidence of similar treponemal infections yaws and bejel. The origin of yaws and its causative bacteria is unclear. One hypothesis claims the emergence of venereal syphilis in the Old World as a result of the return home of Columbus and his crew after their initial voyage to the Americas (Emory, 2011). As a result of a cooler and relatively more hygienic European environment, the yaws bacteria adapted to survive in a new niche. This hypothesis depicts the natural selection of a disease, where yaws adapted to a new environment in order for the bacteria to persist as a species. Despite this hypothesis, a concrete origin and initial date of infection has yet to be confirmed for the emergence of treponemal infections.

Similar to tuberculosis, yaws is a bacterial disease present among prehistoric populations (Engelkens, 2011). Yaws is a tropical disease caused by infection from the bacterium *Treponema pallidum* (WHO, 2015). Unlike TB, yaws is spread by simple skin contact with infectious primary or secondary skin lesions (Powell, 1988). The bacteria cannot penetrate unbroken skin, but enters the body through minute abrasions. Yaws infection progresses through multiple stages. In the primary stage, skin lesions form at the point of entry for the bacteria. During the secondary stage, areas of infection become inflamed and bone tissues begin to thin away. While yaws is not typically fatal, it is a chronically debilitating disease. With this being said, additional infection by another pathogen may prove fatal (Powell, 1990). While lesions from the secondary stage tend to heal relatively quickly, the tertiary stage of infection results in more extensive bone destruction (Powell, 1988). The final stage of yaws typically occurs approximately five to ten years after initial infection. If left untreated, multiple lesions continue to appear on the body. The exterior of bones located closely to the skin, such as the skull, and long bones of the hand, forearm, and leg are most commonly impacted by lesions. Children are at the greatest risk of yaws infection, and after initial infection the disease progresses throughout childhood development and into adulthood. As the disease is not typically fatal, it is seen as an unpleasant circumstance rather than mortal or immoral.

There are multiple methods that can be used to determine the prevalence of tuberculosis and yaws in prehistoric populations. While genetic analysis of ancient DNA provides an ideal mechanism to identify a specific pathogen, it does not provide any information about the individual person infected by the disease. Skeletal remains provide a cumulative record of events that can be used to demonstrate the "nutritional and disease risks as well as the mechanical demands and activity patterns for both the individual and the population" (Larsen, 1987). As both these infectious diseases manifest themselves in the skeletal system, they can be identified archaeological by osteolytic lesions. In identifying tuberculosis, these lesions can be seen on ribs and through fusion of the spine (Buikstra, 1981; Raff, 2006; Roberts, 2003). Similarly, yaws lesions are seen on the skull, as well as swelling on long bones of the legs, forearm, and hands (Powell, 1988). Lesions left on the bone are critical to the identification of these infectious diseases, and make possible the study of the burial treatment of infected individuals.

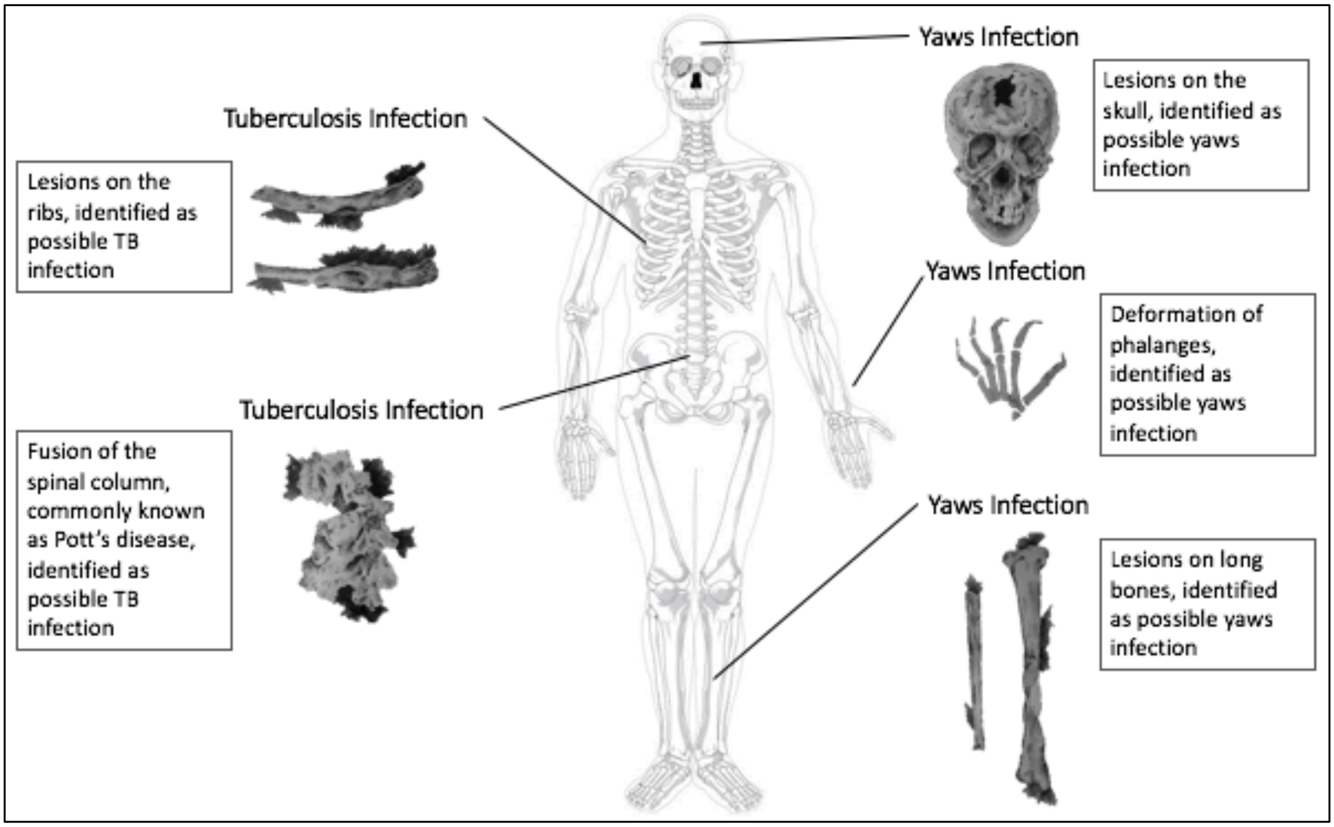

Figure 1. *Osteological Identification of Tuberculosis and Yaws, reconstructed from Larsen (2000).*

Mortuary Practices and Archaeology

The archaeological record, in particular burials, provides a way to examine the role of people who had these diseases in the past. The social status and the role an individual played in society can be seen archaeologically through burial treatment. The various attributes of the status of a human burial include the "number and specific forms of the dimensions of the social persona" which greatly vary with the organizational complexity in accordance to cultural practices of a population (Binford, 1971). There are multiple aspects that contribute to the relationship between mortuary customs and beliefs. The rights and duties between a person and his/her community in life is represented symbolically with the treatment of a burial at death (Shay, 1985; Binford, 1971). This social status is defined by the form of internment, the treatment of the body, the nature and frequency of the grave goods, and the demographic and biological attributes of the interred population in a multidimensional analysis (Chapman, 1981).

While there has been copious research on the social structure of ancient societies through mortuary analysis, the treatment of individuals afflicted by infectious disease has received little attention. Most studies of human burials focus on differences in social status and the consequent change in diet and nutritional stress (Chapman, 1981). Differences in the health of prehistoric populations is a fundamental aspect to understand the adaptive success of populations and how it has varied across time and location (Wood et al., 1992). This form of analysis does not look at the specific treatment of individuals afflicted by disease infection. It is assumed that burial customs would demonstrate the disposal of the potentially unpleasant body of the deceased (Binford, 1971). Nevertheless, a direct analysis of the treatment of diseased individuals under the criteria previously listed has yet to be performed but can provide critical information on the social status of infected individuals in Mississippian society.

Infectious Disease in the Mississippian

The study of infectious disease in prehistoric populations would be incomplete without acknowledging the human behavior and population trends that allow an increase in the frequency of infectious disease. In order to understand societal changes in human populations that would provoke infectious disease it is important to look briefly at the Woodland period. This time period describes a population of hunter-gatherers living in small communities in major river valleys (Buikstra, 1987). The end of the Late Woodland period (800 AD to 1050 AD) begins changes in lifestyle that would provide an optimal environment for the emergence of infectious diseases. At the end of this time period, there is a noticeable increase in population density and changes in settlement patterning both of which correlate with engagement of populations in maize agriculture.

Infectious disease became present in the archaeological record when the Late Woodland progresses into the Mississippian (800-1600AD). Subsistence on maize agriculture, larger living settlements, and increased interaction between populations intensifies during the Mississippian (Larsen, 2002). By the middle of the Mississippian time period (~1050 AD), maize agriculture is well established (Buikstra, 1987). In addition, there is evidence of large population aggregations and interregional trade. These three attributes are critical to the formation of the social hierarchy that vastly defines the Mississippian time period. Likewise, these three attributes provide an ideal environment for the emergence and spread of infectious disease.

During the Mississippian, the increased dependence on maize agriculture had detrimental effects on the health of populations. While maize horticulture provided a stable food source that could be undertaken with a relatively low energy expenditure, it resulted in a decrease in variation of diet and inadequate intake of essential nutrients (Powell, 1988). Populations that experienced high levels of infectious disease underwent nutritional deprivation (Larsen, 1987). Malnutrition seen in Mississippian populations typically results from inadequate intake of protein, iron, and other key nutrients. Maize does not provide an adequate source of protein or iron, two macronutrients that are critical for a functioning immune response. With this being said, subsistence on maize agriculture decreased the variety of food nutrients being consumed by prehistoric populations and did not allow for supplementation of iron and protein that a diversified diet would provide. Malnutrition weakens the immune response and makes the body more susceptible to infection. In turn, infection interferes with the body’s ability to obtain certain nutrients. Subsistence on maize agriculture started a cycle of malnutrition and disease susceptibility.

In correlation with the effect of nutrition on the emergence of disease, increased settlement size allowed for an increase in the transmission of disease. There is a positive correlation with increased population size and density, contact between communities, and subsistence on maize agriculture with the intensification of agriculture (Powell, 1988). The virulence and survival of a pathogen relies on a large enough population to sustain disease transmission and spread. While infectious disease was increased in frequency in a single population, contact between populations allowed for the spread of disease. Contact between communities was widespread during the Mississippian, ranging from southern North America to the Midwest.

The Mississippian

In addition to the aggregation of settlements and nutritional problems associated with increased dependence on maize agriculture, Mississippian communities were typically organized in a hierarchical manner (Goldstein, 1976), which archaeologists have identitied by examining variation in settlements, trade, and mortuary data. This hierarchical manner is indicative of a complex society that is built around a large urban center with temple mounds arranged around a central plaza. Surrounding the central urban center may be a variety of smaller towns or additional temple mounds. Expanding further out from the central feature and small towns are smaller villages and farmstead. These are small outlying populations with no elaborate population structure.

The increase in the complexity of a society allows for specialization in trade (Goldstein, 1976). Specialization in trade includes increased specialization in the types and variety of tools being manufactured and results in an increase in the diversity of artifacts. Exotic artifacts, items brought in to the population through travel and trade, where used to show status. Meanwhile other artifacts including hair and ear ornaments, wing bone fans, and other items of personal adornment were present as a result of an increase in the variety of artifacts. Pottery is a main artifact used to determine social status in Mississippian populations. There is great diversity in types of pottery which includes pottery decoration and vessel type. Some characteristic of pottery that are taken into consideration include the tempering of the pottery, and the function of the pottery. The function of pottery falls within two categories: those that are primarily utilitarian, and those that are ceremonial in function. Utilitarian pottery is relatively plain, smooth, and undecorated; occasionally, utilitarian pottery is seen with simple decoration of incised lines, cord marking, or decorative effigy handles. Ceremonial pottery typically contains more elaborate form, decoration, and technique in making the vessel. Forms of vessels that are observed from the Mississippian include bowls, jars, beakers, bottles, shallow bowls, and plates. There is additional variation in the construction of the various forms of pottery including handle type, rim type, base construction, lip type, and effigy motifs. Elaboration of vessels can also be seen by possible painting, engravings, incising, and other markings on the pottery.

Archaeologists examine the artifacts associated with burials and location of burials to examine social hierarchy in Mississippian societies. Mortuary practices are determined by the ornamentation and orientation of burials at a site. The quantity and quality of artifacts associated with burials can indicate differences in social status, as well as, the location of burials at a site, within a grave, and in proximity to other burials are also defining features of social status. While an increase in social complexity occurred throughout the eastern US during the Mississippian, different populations defined social rankings in various ways.

Prevalence of Infectious Disease in the Mississippian

Osteological evidence of TB and yaws have been found at a variety of Mississippian sites, including the Schild Site, Irene Mound, and Moundville. With the major societal transitions that occurred during this time period, burials have received copious amounts of research and analysis. Analysis of burials has focused primarily on the nutritional and health consequences of maize agriculture, and the social stratification of a population. While infectious disease has been identified in these various populations, there is little research on the role individuals infected by disease played in society. There are three sites in particular from the Mississippian time period that provide a unique insight on the treatment of individuals infected by disease.

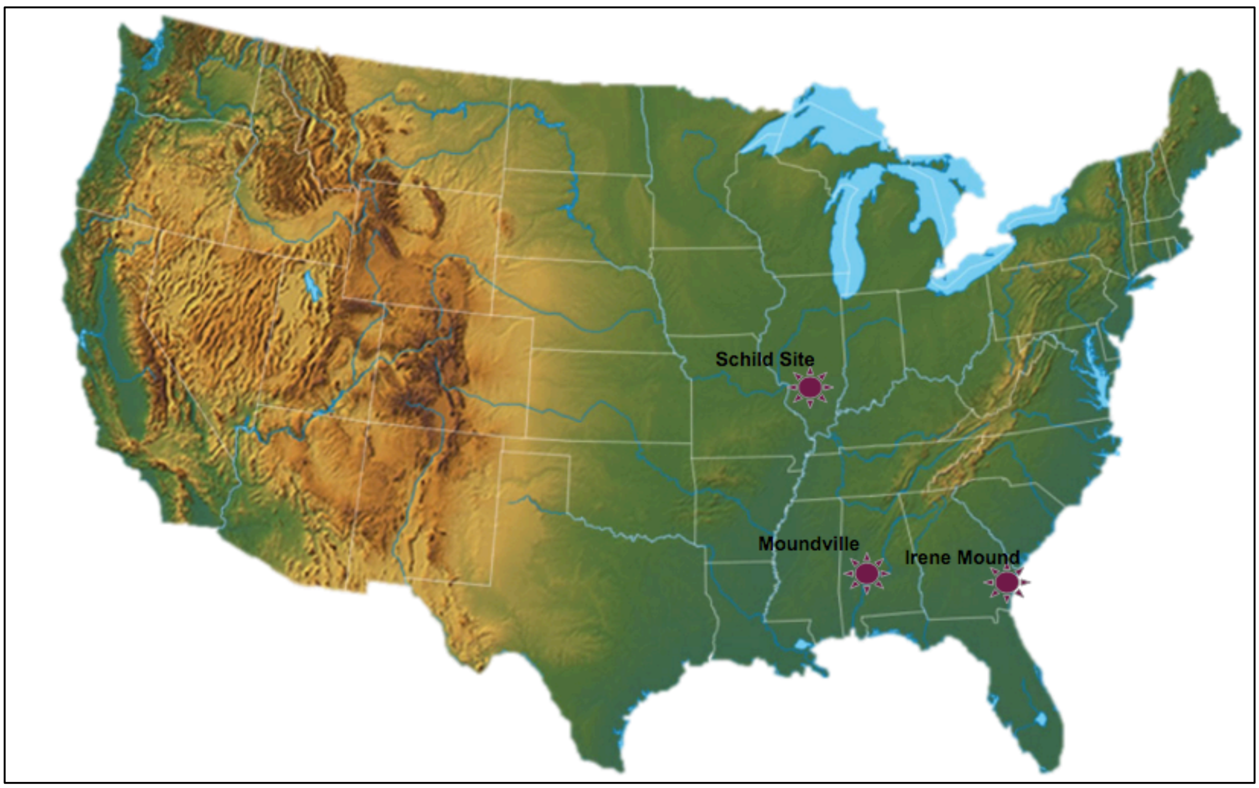

Figure 2. Map of the Schild Site, Moundville, and Irene Mound.

While a comparative study of the treatment of burials containing disease infection at various Mississippian sites would be extremely interesting, the documentation of burial information from Moundville and Irene Mound is unsufficient for the desired study. While these two sites were extensively excavated in the early 1900s and continue to be studied, there was not sufficient documentation of burials from these sites. While Irene Mound and Moundville are limited on burial documentation, the Schild Site has burial data readily available and thus is the focus of this study.

The Schild Site

Initial excavation at the Schild site was conducted by Gregory Perino in 1962 and 1963 for the the Thomas Gilcrease Institute of American History and Art in Tulsa, Oklahoma (Perino, 1971). The Schild Sites are located in Greene County, Illinois at the mouth of the Illinois River flood plain known as Dayton Hollow. Excavations took place on the Bob Schild farm, located on the eastern bluffs of the Illinois River, outside of Eldred, Illinois. Originally thought to be an excavation of Late Woodland mounds, the Mississippian cemetery was discovered at the end of the excavation of adjacent Late Woodland Mound 9.

Schild is proximate to larger urban sites Cahokia and Dickson Mounds (Perino, 1971). The location of Schild between two major urban centers contextualizes the population represented at the site. The Schild Site represents multiple communities; there is no area at the site that would have been extensive enough to have supported a population of such size. The primary focus of the excavation was on burials from the cemetery. As a result, little is known about how these people lived or the size of the Schild population. The leading interpretation of the population represented at Schild is a population of primarily farmers who occupied mainly small farmsteads. It is assumed that these farming communities helped support the larger urban populations. The location of Schild is warranted as Mississippian cemeteries were typically in close proximity to Mississippian habitation sites. The Schild cemetery is one of only two mortuary sites that have been excavated from the entire lower Illinois Valley Region. The second site, Moss cemetery, is not included in this study because of the limited population and the poor preservation of bones from the cemetery.

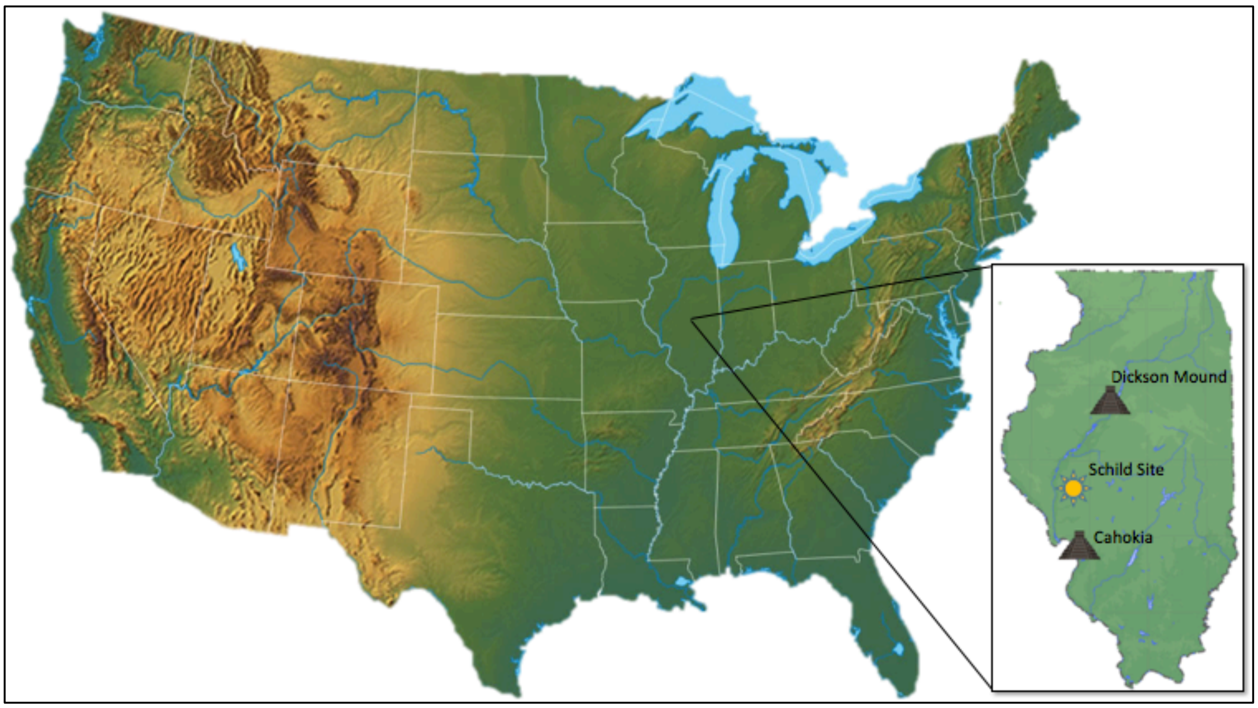

Figure 3. Location of the Schild Site in proximity to Dickson Mound and Cahokia.

The cemetery at Schild embodies a large population of over 279 individuals. Burials were divided into two parts of the Schild cemetery: Knoll A and Knoll B. Knoll A was on a natural knoll and touched the southeast edge of the Late Woodland Mound 9. Knoll B extended from the lower part of Knoll A. Knoll A was radiocarbon dated to ~1200 AD, while Knoll B was radiocarbon dated to ~930 AD. Given these two dates, Perino estimated the average of the two,

~1065 AD, as a more accurate estimation for use of the cemetery. The proximity of Schild in between two large urban centers sets up a framework of what can be expected at the cemetery. Since the site is located farther away from the large sites, fewer forms of internment are expected. In addition, it is expected that there will be less specialization and differentiation between individuals.

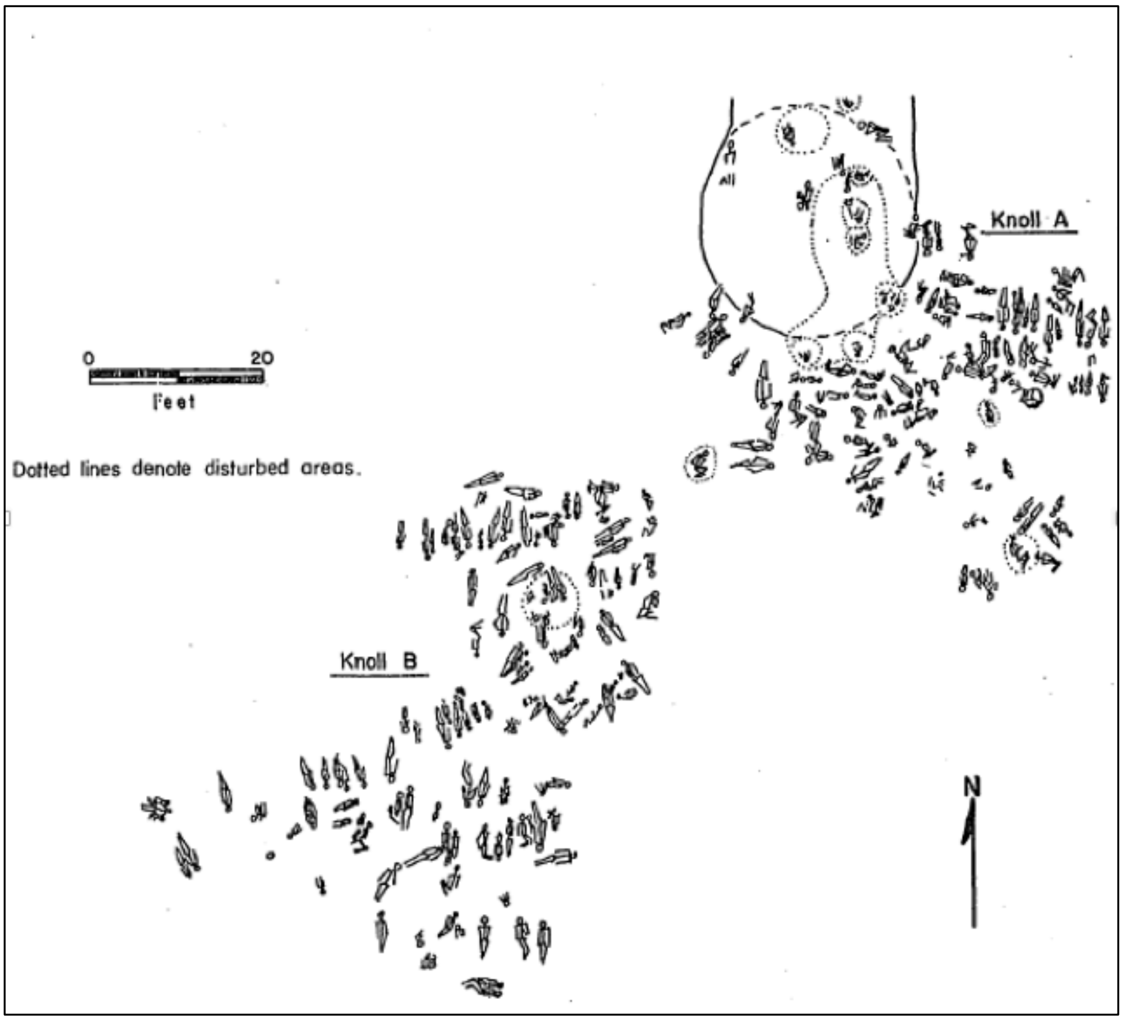

Figure 4. Map of Schild Cemetery, taken from Perino (1971).

Identification of Infectious Disease at the Schild Site

Analysis of infectious disease in prehistoric populations was originally performed by Morse in the 1960s (1961, 1967). His main hypothesis questioned the possibility of tuberculosis to have occurred in North American prior to the discovery of the Americas by Christopher Columbus in 1492. After thorough analysis of various burials, Morse claimed that there was no convincing skeletal evidence that would suggest infectious disease, specifically TB, in pre-Columbian populations. Since Morse's original analysis, the possibility of infectious disease in prehistoric North America has been revisited. Possible cases of infectious disease, TB and yaws, have been confirmed at various sites in the Mississippian. The Schild Site has greatly contributed to the understanding of infectious disease in prehistoric North America. Incidences of infectious disease at the Schild site have been identified and confirmed by Perino (1971), Buikstra (1977), and Cook (1980). More information about the excavation of the Schild Site and the identification of infectious disease can be gathered from the works of the three archaeologists listed above.

Previous Analysis of Social Organization at the Schild Site

Goldstein performed a multi-dimensional analyses of burials from the Schild Site to analyze the social organization of the Mississippian people in the lower Illinois River Valley (1976). Through Goldstein's analysis, there were evident similarities and differences between Knoll A and Knoll B. One main difference was the type of artifacts found at each knoll. The main artifacts recovered from the burials include filed teeth, ear and hair ornaments, effigy vessels, spoons and pots, beakers, local beads, shell pendants, animal wing bones, leg bones, and skulls, pipes, lanceolate knives, discoidals, bone tools, "found" blades, rubstones, flakes and flake knives, and local fauna. Knoll A contains the only burials with filed teeth, shell pendants, and animal skulls, as well as most of the limestone found in the cemetery. The knoll also contains the only charred individuals and charred vegetal materials associated with charred individuals. Charred vegetal remains are also found in Knoll B but there is no pattern of whom they are buried with. Also found exclusively in Knoll B are plain beakers, animal leg bones, "found" blades, rubstones, and hair and ear ornaments.

In addition to differences between knolls, Goldstein noticed differences in mortuary treatment based on burial age. For example, older adults were not found with ear ornaments or effigy vessels. Many grave goods are associated with adults. Infants and children were not found with ear or hair ornaments, but exclusively found with local beads and shell pendants. While there are differences in treatment associated with age, there is not much difference in accordance to sex. The differentiation in treatment between sexes is seen by differences in body disposition and the quantity rather than type of artifacts per burial. All aspects of burial treatment considered, the ultimate determinate of differences in social standing is illustrated by the quantity of artifacts and variation in types of artifacts.

The pottery associated with burials is a critical determinant seen in the Mississippian. The presence or absence of pottery, decoration, and vessel type are paradigmatic of social status at most Mississippian sites. With this being said, the quantity of pottery associated with burials, as well as the type of pottery was similar throughout most of the Schild Site. Goldstein interpreted the lack of variation in pottery as pottery not being a determinant of social status in burial treatment.

Further comparison of burials from knoll A and knoll B looked at the location, proximity, and orientation of burials. Internments at Schild were arranged into various groups. Burials located in a more restrictive burial type include individuals who were leaders, revered ancestors, or family groups by relation or through the adherence of resources. These corporate or linear descent groups controlled access to crucial resources, and provide necessary resources for the larger urban centers. There are five burial groups in Knoll A, and eight burial groups in Knoll B. Some groups contain burials of higher social standing, while other groups illustrate variation in social standing. This suggests separation of the cemetery into various groups with the operation of large corporate groups and several different groups in close proximity to one another and in some association. Despite these groups, there was a communal emphasis at the site where even burials of presumably higher status were treated similarly, and often located among other burials. The primary orientation of burials from both Knoll A and Knoll B was similar with all burials facing south, but other than burial orientation, the burial location and patterning differs between knolls. Knoll A contains a possible charnel structure surrounded by a possible mound southeast of Mound 9. A charnel structure is commonly seen in Mississippian cultures and is defined as communal structure used to prepare a body for burial. After the charnel structure served its purpose, the structure was destroyed and covered with soil, and a mound was created on top of the previous structure (Baltus, 2012). Burials located north of the charnel structure are thought to be of higher social standing (Goldstein, 1976). There is patterning in the burials located around the Mound 9, but the purpose of this is patterning is unknown. While knoll A demonstrates purposeful burial location, there is no patterning of burial location or proximity at Knoll B that would elude to difference in social status. Burials at Knoll B illustrate similar treatment of all individuals. This includes individuals who were thought to represent the members of outlying communities who did not meet the qualifications of burial near or in the charnel structure of Knoll A.

In sum, Goldstein concluded that the organization at Schild is representative of an egalitarian society. Egalitarianism is assumed for the non-elite at most Mississippian sites with communal organization through kinship relations. Given this assumption, burial treatment should be relatively consistent at the site.

Goldstein and others have performed in depth analysis of Schild to determine social organization for the broader Mississippian. While copious studies on the social organization have been performed in regards to burial treatment based on age and sex, the burial treatment of diseased individuals has been greatly understudied. In the following research, I examine specifically those burials that contain disease infection in order to determine the social organization and role of infected individuals at the Schild Site.

Methodology

In my examination of the treatment of disease infected individuals from the Schild Site, I continue the research of previous scholars. Using the data and analysis generated by Perino and Goldstein, I look how the organization of society at the Schild Site influenced the burial treatment of individuals with TB and yaws.

Perino and Goldstein have provided a complete documentation of burials from the Schild Site. Their documentation is a godsend for any academic interested in some light reading on the the Schild Site, let alone a student eager to write an undergraduate. The documentation of Schild includes clearly marked burial maps with the positioning of all burials at each knoll of the cemetery. The location, proximity, and orientation of the burials are identifiable on the maps of the site. In addition, Perino included the raw data of burial information from which I performed further analysis. These spreadsheets are easily accessible and understandable with documentation of the location and orientation as well as the quantity of artifacts found with each burial. All of this information combined provides a clear mental image of what the Schild Site looks like at present, and most importantly, what the site would have looked like in the past.

Goldstein's previous analysis of social organization at Schild is of particular interest for my research. Based off of the excavations performed by Perino, Goldstein provided an ideal analysis of individual burials at the site. She organized Perino's work to look at burial age and sex, location, orientation, and proximity, and the quantity and quality of associated funerary objects. Goldstein's analysis highlights what burial attributes are important to identify differences in social status. This previous analysis provides a comprehensive inquiry of the treatment of disease infected individuals at the Schild Site.

Similar to the method modeled by Goldstein in her analysis of spatial structure and social organization, I analyze specifically the burials from the Schild Site with evidence of disease infection. As Goldstein has already performed a thorough analysis of the social organization at the Schild Site, I base my analysis off her previous identifications of social status to compare the treatment of people with and without infectious disease. While the population at the cemetery has been deemed egalitarian, the main defining attribute of a burial of higher social standing is represented by the quantity of additional artifacts found in ornamentation of the burial as well as the presence or absence of pottery and vessel form. Another burial feature that Goldstein took into consideration in her analysis is the proximity, orientation, and location of burials. While there is patterning in burial positioning, Goldstein found this patterning to represent familial groups or clans, but not necessarily burials of higher status. Goldstein confirmed the holistic social organization of the cemetery as being representative of an egalitarian farming community as the vast majority of burials demonstrate a similar burial profile. Despite confirmation of an egalitarian society at Schild, it is important to understand that egalitarian societies still have some variation between burials. Goldstein noticed this variation in her analysis of the location of burials and artifacts associated with burials of higher social standing. My analysis looks at disease infected burials to determine if these burials are representative of an individual of higher social standing. For these individuals, I continue with Goldstein's analysis by comparing the burials of presumably higher social standing between healthy burials and diseased individuals. I determine the social standing of burials by first looking at the quantity of artifacts associated with infected burials and the presence of pottery and vessel type, and in the location of burials as a conclusive analysis of the site. Through my analysis, I hypothesize that infected burials received better treatment than healthy burials at the Schild site.

Data and Analysis of Burials at the Schild Site

Prevalence of Infectious Disease

Prevalence of infectious disease at Schild provided the foundation for my analysis. While my population size is relatively small, the prevalence of infectious disease at the Schild Site makes it an optimal site for study. To my benefit of having a relatively small population size, I am able to take individual burials into consideration to identify people of higher social standing that deviate from standard burials. There are 279 burials from the Schild cemetery considered in my analysis. Of these 279 burials, 14 burials have evidence of disease infection meaning approximately 5% of the population at the Schild Site died having been infected by TB or yaws. To put this into perspective, Liberia, the country with the greatest death toll from the Ebola epidemic, had a death toll of 4,809 deaths by the end of the outbreak (WHO, 2016). Liberia has a population 4.298 million people, meaning 0.1% of Liberia's population died of Ebola (World Bank 2016). With the mention of Ebola, it is important to briefly note the nature of disease. Ebola is a highly virulent disease and infection results in rapid mortality; TB and yaws can remain in the human body for years without causing mortality. In comparing the prevalence of these disease, the timeframe of diseases is an important factor for the impact a disease has on a population. My analysis does not aim to project the infection rate of TB or yaws in prehistoric populations, nor does it aim to diminish the impact of other infectious disease outbreaks. My analysis considers the impact of two infectious diseases in a population that was naïve to the potential impact infectious diseases can impose on a population. With this, I am looking at the individuals in a population that developed severe infection by TB or yaws to the point in which the infection created lesions on the individual's bone, or resulted in eventual death. An individual's lifespan between initial disease infection and death is unknown. During this gap in time is when infectious diseases are contagious and able to infect other individuals. In my best effort to reconstruct this lost time, I look at mortuary treatment to understand the life of an infected person based on the treatment of their burial at death.

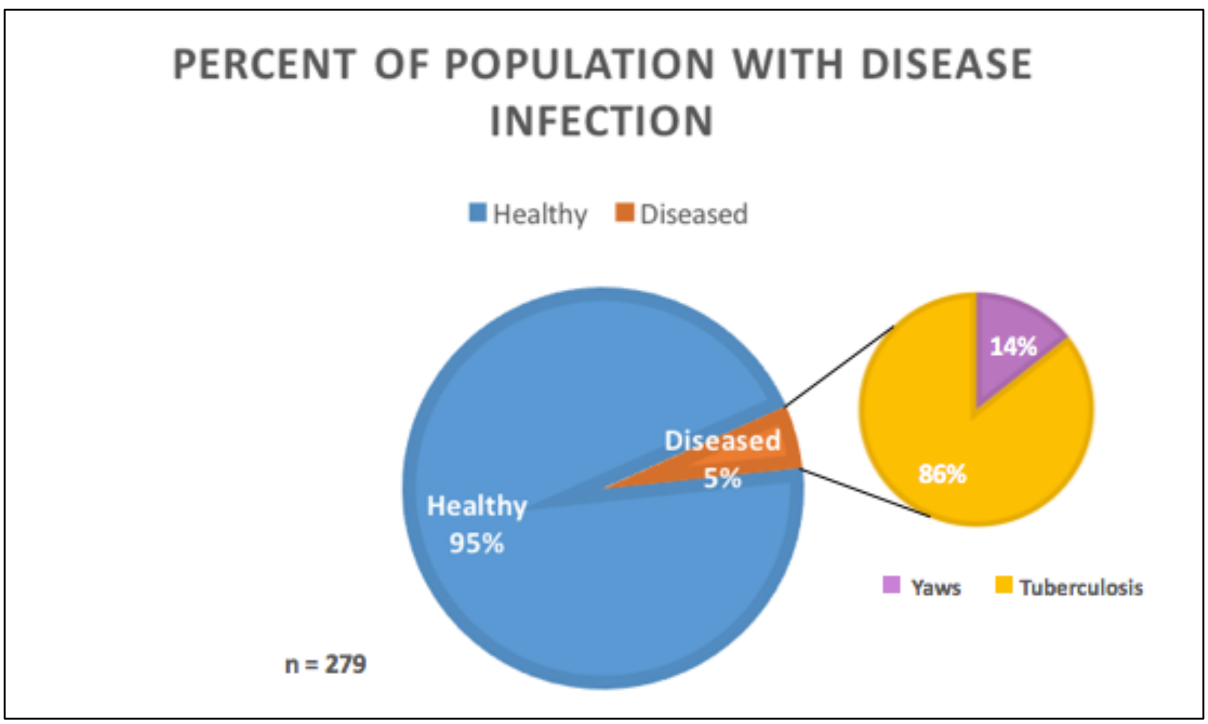

Figure 5. Percent of Population with Disease Infection.

The demography of healthy and infected burials at the site provides insight as to who was infected, when infection occurred, and how long a person lived with infection. The vast majority of burials from the healthy population are children and adults while the majority of diseased individuals are adults, or fall under an "unknown" category. With this, the number of males and females found in both the healthy and diseased population is relatively similar; half of the burials are similar in number of male and females present at the site, while the other half falls under an "unknown sex" category.

	Healthy (n = 265)	Diseased (n = 14)
Age		
Child (0-12)	106	1
Adult (12-50)	102	7
Old Adult (50+)	36	3
Unknown	21	3
Sex		
Male	56	4
Female	69	6
Unknown	140	4

Table 2. *Demography of Healthy and Diseased Burials.*

Quantity of Artifacts as a Determinant of Social Status

In order to determine if infected individuals are of higher social standing, I compared the presence of absence of artifacts associated with healthy and diseased burials. After performing a chi-squared test, there was no statistical evidence at the 5% level in the presence or absence of artifacts between disease and healthy individuals ($p = 0.127$). This lack of significance reflects the small sample size of the population. A look at the frequency of artifacts is a better representation of the trending significance in artifacts for burial treatment. More diseased burials were buried with artifacts than were healthy individuals. For diseased burials, 86% were buried with artifacts, while 66% of healthy individuals were buried with artifacts. Only two diseased burials, Burial #77 and 194, were buried without any artifacts. Meanwhile, 90 healthy burials were not buried with any artifacts.

Next I looked at the quantity of artifacts associated with burials. I performed a t-test to compare the quantity of artifacts between diseased and healthy burials. In this comparison, there was statistical significance at the 5% level in the quantity of artifacts ($p = 0.03$). Nevertheless, the overlap in the standard deviations of diseased and healthy burials suggests that there is not significant difference in the quantity of associated artifacts. What is most interesting is the average number of artifacts buried with diseased and healthy individuals. On average, diseased individuals were buried with 5.64 artifacts, while healthy individuals were buried with 2.87 artifacts.

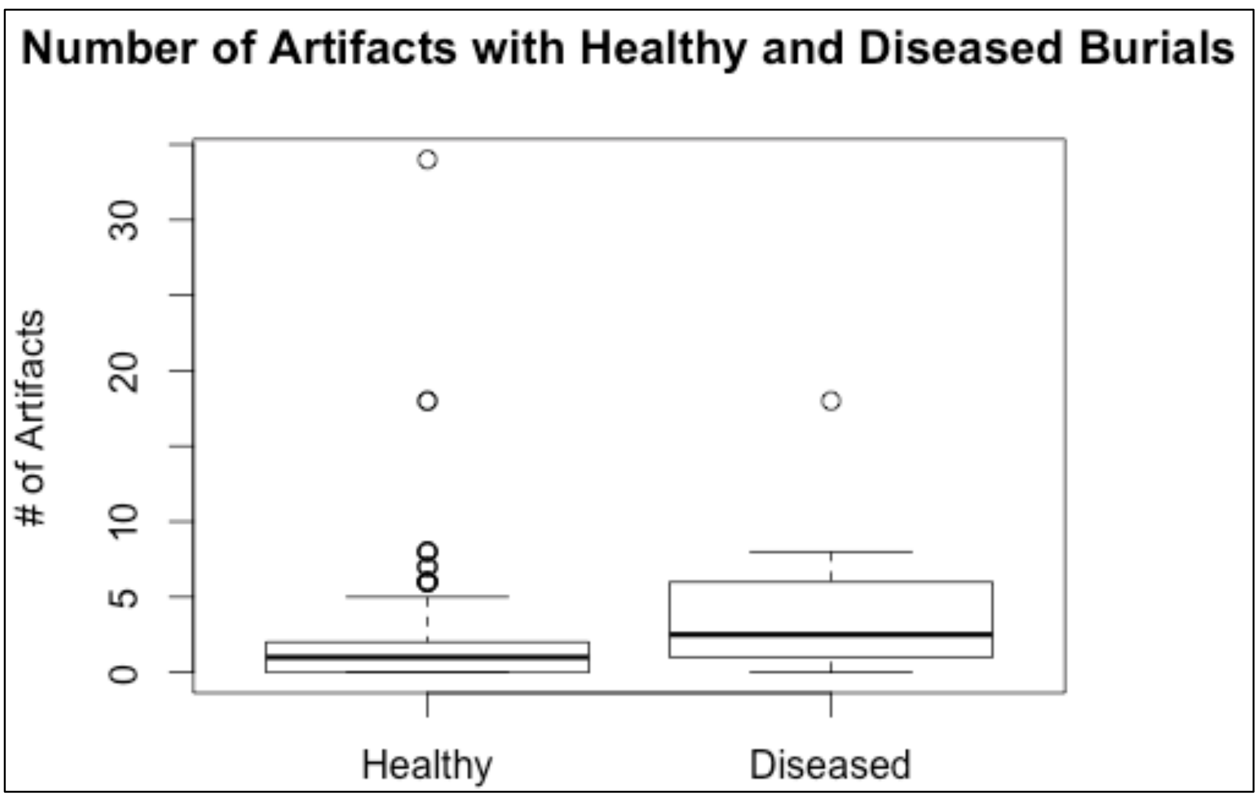

Figure 6. Boxplot of Artifact Distribution of Healthy and Diseased Individuals.

There are multiple burials that acts as outliers for artifact quantity. These outliers are of particular importance for the interpretation of an individual of higher social standing. The plot of diseased individuals demonstrates greater differentiation in artifact quantity for diseased burials than for healthy burials. In the plot of healthy individuals, it is evident that there is relative agreement in artifact quantity. Since the majority of the population at Schild is represented by healthy burials, determination of both healthy and diseased burials is based off of the distribution of artifacts associated with healthy individuals. There are three groups that need to be taken into consideration for artifact association: burials without artifacts (0 artifacts), burials with a near average number of artifacts (1-5 artifacts), and burials with an outlying number of artifacts (>5 artifacts). There are 90 healthy burials (34% of healthy burials) without artifacts and 2 diseased burials (14% of diseased burials) without artifacts. There are 137 healthy burials (52% of healthy burials) and 7 diseased burials (50% of diseased burials) with artifacts in the range of 1-5 artifacts.

The burials of particular interest are the outlying burials with greater than 5 artifacts. Among diseased burials, there are 5 burials (36% of diseased burials) with more than 5 associated artifacts. Of these 5 burials, 2 are male, 2 are female, and 1 is an indeterminate sex. In comparison, there are 38 healthy burials (14% of healthy burials) with greater than 5 associated artifacts. Of these 38 burials, 20 are male, 5 are female, and 13are an indeterminate sex. For diseased burials with greater than 5 artifacts, Burial #96 has 11 artifacts, Burial #165 has 6 artifacts, Burial #195 has 9 artifacts, Burial #256 has 18 associated artifacts, and Burial #262 has 7 artifacts. Of the healthy burials with greater than 5 artifacts there are 4 healthy burials that fall into the upper 50% percentile of the distribution of diseased burials. Burial #66 buried with 18 artifacts. Burial #183A is buried with 21 artifacts. Burial #198 is buried with 13 artifacts. Burial #279 is buried with 34 artifacts.

Burial #	*Disease*	*Location*	*Age*	*Sex*	*Artifact #*	*Pottery Present?*
41	*TB*	*Knoll A*	*Unknown*	*Unknown*	*1*	*No*
52	*Yaws*	*Knoll A*	*12-50 yrs*	*Male*	*2*	*Yes*
77	*Yaws*	*Knoll A*	*Unknown*	*Unknown*	*0*	*No*
96	*TB*	*Knoll A*	*12-50 yrs*	*Female*	*11*	*Yes*
100	*TB*	*Knoll A*	*12-50 yrs*	*Female*	*5*	*Yes*
141	*TB*	*Knoll A*	*1-12 yrs*	*Unknown*	*5*	*No*
165	*TB*	*Knoll A*	*12-50 yrs*	*Male*	*6*	*Yes*
194	*TB*	*Knoll B*	*12-50 yrs*	*Male*	*0*	*No*
195	*TB*	*Knoll B*	*12-50 yrs*	*Female*	*9*	*Yes*
201	*TB*	*Knoll B*	*12-50 yrs*	*Female*	*5*	*Yes*
233	*TB*	*Knoll B*	*50+ yrs*	*Female*	*5*	*Yes*
256	*TB*	*Knoll B*	*50+ yrs*	*Male*	*18*	*Yes*
262	*TB*	*Knoll B*	*Unknown*	*Unknown*	*7*	*No*
269	*TB*	*Knoll B*	*50+ yrs*	*Female*	*5*	*Yes*

Table 3. Burial Information for Diseased Burials.

Burial #	*Location*	*Age*	*Sex*	*Artifact #*	*Pottery Present?*
58B	*Knoll A*	*+50 yrs*	*Male*	*6*	*Yes*
66	*Knoll A*	*12-50 yrs*	*Female*	*18*	*No*
70	*Knoll A*	*12-50 yrs*	*Male*	*10*	*Yes*
71	*Knoll A*	*1-12 yrs*	*Unknown*	*7*	*Yes*
76	*Knoll A*	*12-50 yrs*	*Female*	*7*	*Yes*
88	*Knoll A*	*1-12 yrs*	*Unknown*	*6*	*Yes*
101	*Knoll A*	*12-50 yrs*	*Male*	*6*	*Yes*
106	*Knoll A*	*12-50 yrs*	*Unknown*	*7*	*Yes*
116	*Knoll A*	*1-12 yrs*	*Unknown*	*6*	*Yes*
122	*Knoll A*	*Unknown*	*Unknown*	*7*	*Yes*
136	*Knoll A*	*+50 yrs*	*Male*	*6*	*Yes*
148	*Knoll A*	*1-12 yrs*	*Unknown*	*9*	*Yes*
156	*Knoll A*	*12-50 yrs*	*Male*	*6*	*Yes*
158	*Knoll A*	*+50 yrs*	*Female*	*6*	*Yes*
159	*Knoll A*	*12-50 yrs*	*Male*	*8*	*Yes*
172B	*Knoll B*	*1-12 yrs*	*Unknown*	*7*	*Yes*
180	*Knoll B*	*12-50 yrs*	*Male*	*6*	*Yes*
182	*Knoll B*	*12-50 yrs*	*Female*	*10*	*Yes*
183A	*Knoll B*	*12-50 yrs*	*Male*	*21*	*Yes*
183B	*Knoll B*	*<1 yrs*	*Unknown*	*6*	*Yes*
198	*Knoll B*	*1-12 yrs*	*Unknown*	*13*	*Yes*
199	*Knoll B*	*12-50 yrs*	*Unknown*	*8*	*No*
211A	*Knoll B*	*>50 yrs*	*Male*	*9*	*Yes*
212	*Knoll B*	*12-50 yrs*	*Male*	*7*	*Yes*
222	*Knoll B*	*12-50 yrs*	*Female*	*10*	*Yes*
226	*Knoll B*	*12-50 yrs*	*Male*	*8*	*No*
234	*Knoll B*	*Unknown*	*Unknown*	*6*	*Yes*

244	*Knoll B*	*12-50 yrs*	*Male*	*9*	*Yes*
245	*Knoll B*	*Unknown*	*Unknown*	*10*	*Yes*
246	*Knoll B*	*<1 yr*	*Unknown*	*7*	*Yes*
250	*Knoll B*	*12-50 yrs*	*Male*	*7*	*Yes*
265	*Knoll B*	*>50 yrs*	*Male*	*6*	*Yes*
267	*Knoll B*	*12-50 yrs*	*Male*	*8*	*Yes*
272	*Knoll B*	*12-50 yrs*	*Male*	*8*	*No*
279	*Knoll B*	*>50 yrs*	*Male*	*34*	*Yes*
281	*Knoll B*	*12-50 yrs*	*Male*	*7*	*Yes*
282	*Knoll B*	*<1 yr*	*Unknown*	*6*	*Yes*
293	*Knoll B*	*1-12 yrs*	*Unknown*	*6*	*Yes*

Table 4. Burial Information for Healthy Burials with >5 Artifacts.

Pottery as a Determinant of Social Status

Included in the overall quantity of artifacts is the presence and absence of pottery. After running a chi-squared test, there was no significant difference at the 5% level in the presence of pottery between infected and healthy individuals ($p = 0.11$). Looking at the frequency of pottery, 9 infected burials are buried with some form of pottery; that is approximately 64% of infected burials are buried with pottery. A summary of the infected burials and pottery associations is as follows. Burial #41, 77, 194 and 262 are not buried with any pottery. Burials #96, 165, 195, and 256 are buried with pottery present. Diseased burial #262, a burial with a greater quantity of artifacts, is not buried with any form of pottery. Diseased burial #52, one of two yaws burials, is buried with only a spoon in associated with a pot. Burial #77, the second yaws burial, does not have any pottery present. Burial #96, 100, and 195 are buried with a decorated jar/pot, an effigy vessel, and a spoon. Burial #141, 233, and 256 are buried with a decorated jar/pot and a spoon. Burial #165 is buried with a plain jar/pot and a spoon. Burial #201 and 269 are buried with a decorated jar/pot. For healthy burials, only 113 individuals, less than half, were buried with pottery.

The type and decoration of pottery was also tested under a chi-squared test. There was significance at the 5% level in the type of pottery found with diseased and healthy individuals ($p= 0.000$). In order to gain a more complete understanding of the significance, it is necessary to perform a multiple comparisons test to see differences in individual pottery types. Nevertheless, it is unlikely to see statistical significance because the sample size too small. The frequency of pottery type provides a more complete analysis. Infected burials #96 is buried with a decorated pot, an effigy vessel, and a spoon associated with the pot. Burial #165 is buried with a plain pot with a spoon associated with the pot. Burial #195 is buried with a decorated pot, an effigy vessel, and a spoon associated with the pot. Burial #256 is buried with a decorated pot and a spoon associated with the pot. Healthy burial #66 does not have pottery. Burials #183A and #279 are buried with a decorated pot/jar. Burial #194 is buried with an effigy vessel.

Location of Burials and Social Status

Given the small sample size of infected burials from the site, a more significant analysis of burial location and proximity is obtained through observation of the location of burials on the map of the site. At first glance of the map of burials from Knoll A and Knoll B, there is no apparent trend in the location of infected burials in comparison to healthy burials at the site (Figure 4 & 5). Infected burials #165, 194, 195, 201, 233, 256, 262, and 269 are all located in Knoll B. Burial #256 is a diseased burial with 18 associated artifacts. Knoll B contains 4 out of the 5 diseased burials with greater than 5 associated artifacts.

There is greater emphasis on the purposeful location of burials in Knoll A. Infected burials #96 and 100 are located north of the charnel structure, while burials #141 is bordering the northwest corner of the charnel structure. Burial #96 is an infected burial with 11 associated artifacts. Burial #52 and 77, the only two burials infected by yaws, are located around Mound 9. Healthy burials whose location is of interest are those previously mentioned as having an outlying number of greater 5 associated artifacts. Rather than list off all 38 healthy burials with a quantity of artifacts greater than 5, these burials can best be viewed on the map of the Schild Site for Knoll A and Knoll B. In Knoll A there are 5 healthy burials with greater than 5 artifacts buried north of the charnel structure. There are 4 healthy burials with greater than 5 artifacts buried around Mound 9. There are also 4 healthy burials with greater than 5 artifacts south of the charnel structure. Finally, there are 2 healthy burials in knoll A with greater than 5 artifacts that do not fit into any patterning. In Knoll B, there are 22 burials with greater than 5 artifacts located without any specific patterning. Burial #66 boarders the northern edge of the charnel structure in Knoll A. Whereas Burials #183A, 198, and 279 are all located in Knoll B.

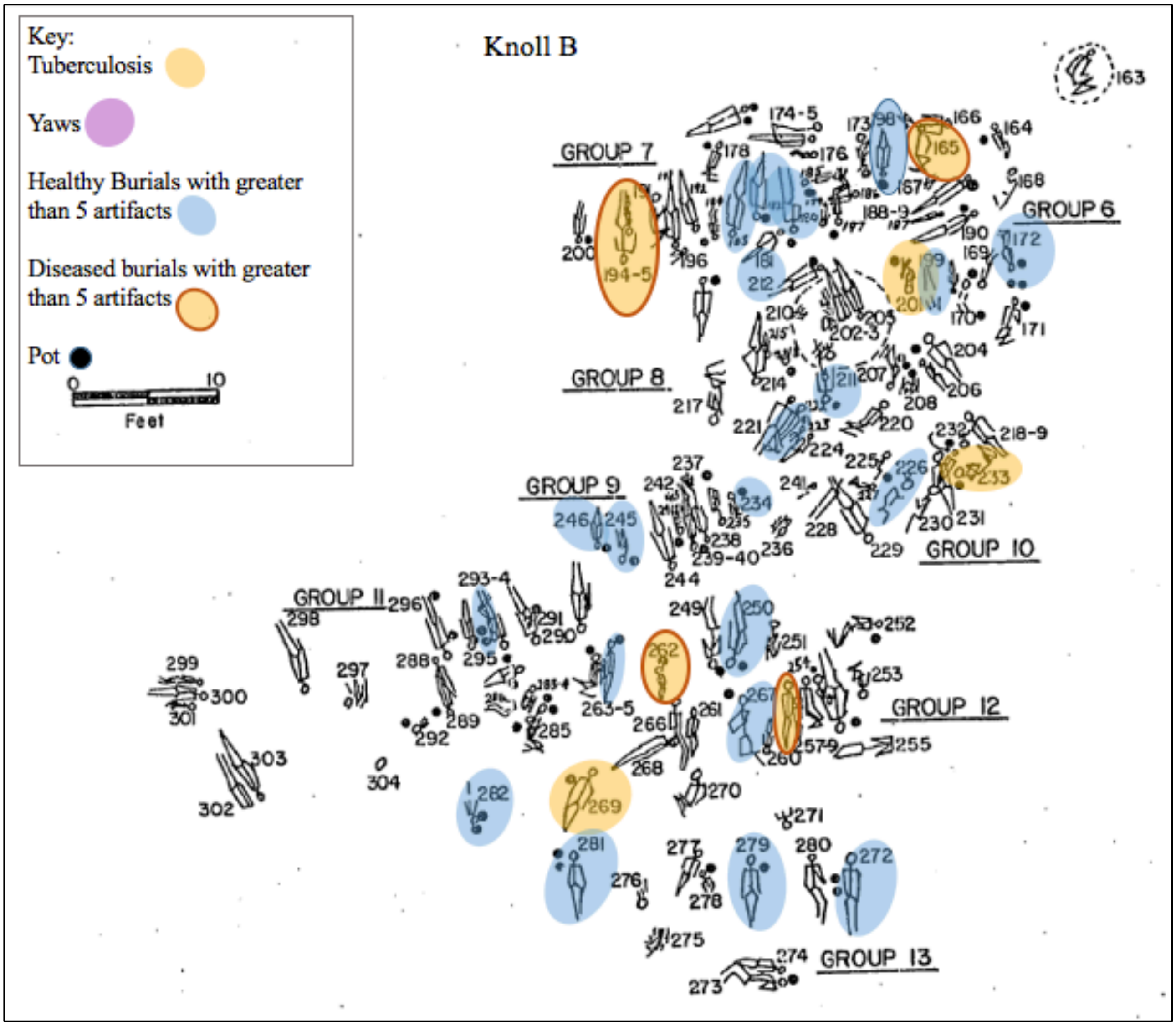

Figure 7. Map of Burials at Knoll B, reconstructed from Perino (1971).

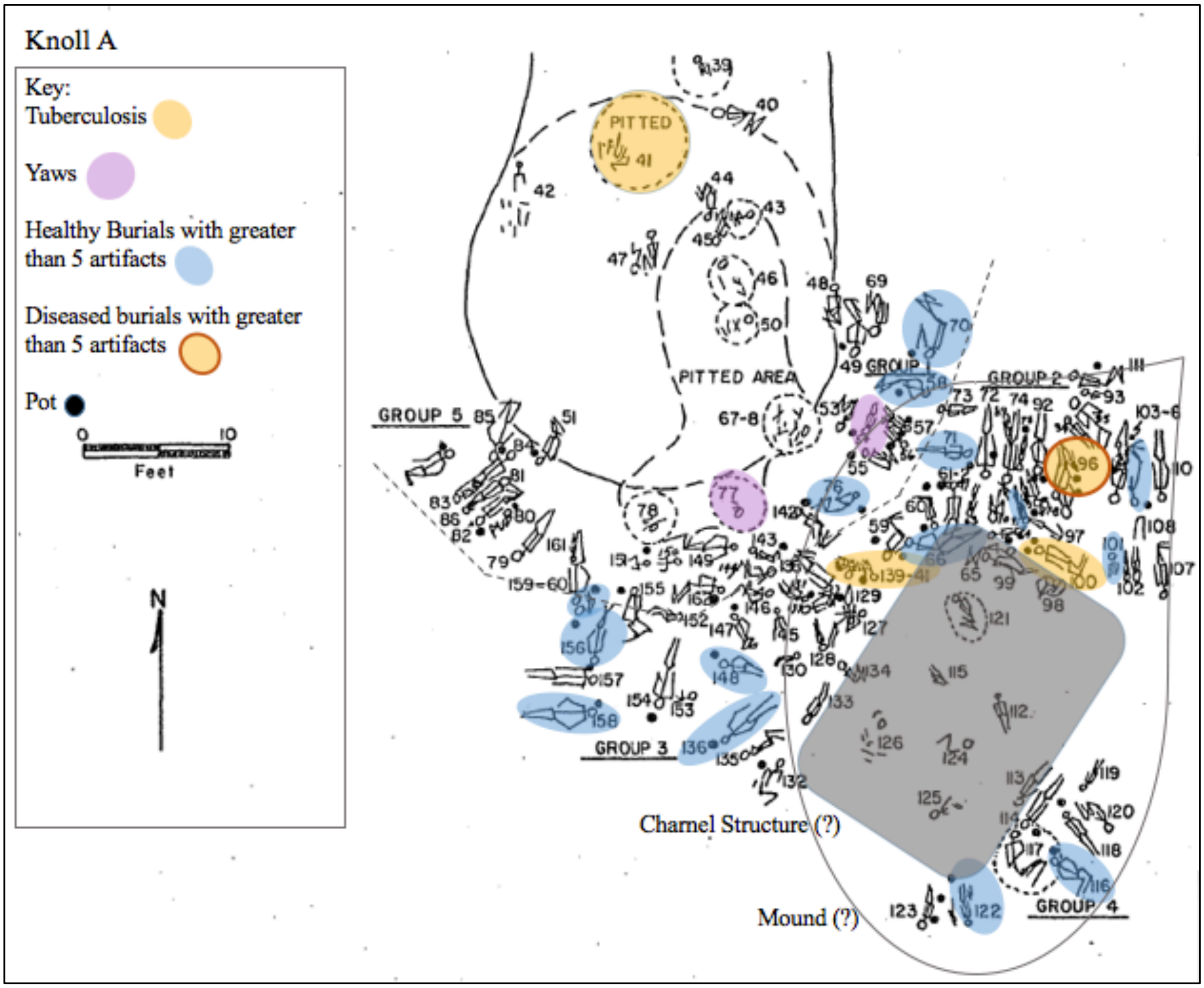

Figure 8. Map of Burials at Knoll A, reconstructed from Perino (1971).

Discussion

Treatment of Diseased Individuals

The emergence of infectious disease in the Mississippian allows for the development of differing social standing between diseased and healthy individuals. The previous interpretation of Schild as an egalitarian population is a proper identification of the overall social structure at the site. Nevertheless, there may be differing social standing at the site. This difference is not necessarily characteristic of a social hierarchy, but rather suggests that some individuals at the site were treated in an unusual way or played a diverse role in the population. My research aims to provide provisional analysis of the understudied treatment of diseased burials at the Schild Site to understand the role infected individuals occupied in their society.

The quantity of artifacts associated with individuals is the first matter of burial treatment that needs to be taken into consideration. In the site's entirety, there are not many artifacts present and there is a large portion of individuals buried with a few artifacts or none at all. Nearly all individuals who are not buried with artifacts are healthy individuals. Individuals who are buried with artifacts are typically only buried with few. These burials are expected of a relatively egalitarian site. Nevertheless, there are individuals in the healthy population who exceed the site's standard quantity of artifact association. There is a small group of healthy individuals, most of which are male, who exceed the average artifact quantity. Since there are so many males in association with a greater quantity of artifacts, I question Goldstein's original claim that there was not much difference in burial treatment based on sex. Nevertheless, the analysis of social status based on sex could be a thesis in itself, so in the meantime, my analysis will adhere to infectious disease. The most outstanding individual in the healthy population is a male greater than 50 years of age who has significantly more artifacts associated with his burial than any others at the site. The presence of individuals with such great differences in quantity of grave goods suggests that there is some difference in social standing at Schild, with heightened quantities of artifacts being associated with individuals of importance.

The possibility of there being variation in social standing at the site makes it interesting to focus in on the social standing of individuals afflicted by infectious disease. Almost all of the disease-ridden individuals were associated with some kind of artifact. There was one TB individual and one yaws individual who did not have any artifacts associated with their burials. Based solely on artifact association, it appears that social status did not decrease because an individual had TB or yaws. Corresponding to healthy individuals, the vast majority of diseased individuals were buried with the standard amount of artifacts. This too is expected of an egalitarian society, which, based solely off artifact quantity, suggests that most diseased individuals were treated in a similar way to healthy individuals.

Nevertheless, there are multiple diseased individuals who were associated with more than the expected quantity of artifacts. In fact, there was an overall greater quantity of artifacts associated with diseased individuals than with healthy individuals. The most outstanding diseased individual, also a male of greater than 50 years of age, did not have as many artifacts as the most outstanding healthy individual. This diseased individual had a significantly greater number of artifacts than the normal distribution. Since the vast majority of diseased individuals were associated with some quantity of artifacts, it does not seem that any diseased individuals were being scrutinized based off the presence of artifacts alone. It more so appears that diseased individuals were receiving a similar amount of burial artifacts as healthy individuals, and that artifact quantity was not used to alienate the diseased. While neither of the yaws individuals were buried with a significant quantity of pottery, over half of the TB individuals had a high quantity of artifact association. Of the TB burials, two individuals in particular had at least twice as many artifacts than the standard expected amount. These two burials will be revisited in correlation with burial location. The healthy and diseased individuals with the greatest quantity of artifacts are both male aged greater than 50 years. The similarity in sex and old age of these individuals, in combination with quantity of artifacts, suggests that these men were possible elders in the population.

Adding another layer to the identification of social quantity of artifacts, pottery is the next factor of burial treatment that varies amongst individuals. While about half of the healthy individuals were buried with pottery, the vast majority of diseased individuals were buried with some form of pottery. As the presence and type of pottery is a main attribute to determine status in Mississippian populations, it is interesting to consider what the presence of pottery means for the social standing of individuals in a fairly egalitarian population. Most all healthy individuals with greater artifact quantity are associated with pottery. For the most part, all the diseased individuals with a greater number of artifacts are also associated with pottery. With this, these individuals are typically accompanied by decorated pottery and an associated spoon. There are two instances where an effigy vessel is present with diseased individuals who have greater artifact association, as well as there is an effigy vessel present in the burial of an infected individual that has the standard number of artifacts. This is interesting especially when comparing the presence of effigy vessels with healthy individuals. The only healthy individuals that are associated with effigy vessels are those with greater artifact quantity, but not all individuals with greater artifact quantity have an effigy vessel. Effigy vessels are characteristic of a ceremonial artifact. Having effigy vessels buried with multiple diseased individuals suggests a sacred ceremony of some sort for that particular individual. The association provides a clear distinction of who received a specific kind of pottery amongst healthy individuals, and diseased individuals except for the one burial that is not classified as having greater artifact association. The trend in pottery will receive further attention when burial location is taken into consideration.

While the quantity and type of artifacts are a feature of different standing at Schild, the factor of burial location provides the final layer of analysis necessary to contextualize social standing. The location of individuals in Knoll B does not provide much insight of patterning that would illustrate differing social standing. Overall, healthy and diseased individuals were located in various places around the knoll. There is one small cluster of healthy burials with greater artifact association but there is no significant patterning within this cluster. The healthy individual with the greatest quantity of artifacts among all individuals is located at the southern end of the knoll. While this does not say much about the possibility of diseased individuals being of a higher social standing, it demonstrates that infected individuals were not seen as a lower social standing. A lower social standing individual would be a person who was buried in isolation from all other burials without any grave associations. The lack of difference in burial location at Knoll B supports the differential patterning seen in Knoll A.

There are two main features in Knoll A that are used as the reference point for the proximity of burials. First is the Late Woodland Mound 9. There is one TB individual located on top of the mound. The age and sex of this individual could not be determined. This person is buried in a pit without any immediate neighboring burials. Further investigation found that the individual was buried with only a ground stone tool, and no pottery. The nature of TB as an aerial infection would disable the disease from spreading after the death of its host individual. This poses the question as to why this burial isolated from all other infected burials, and distanced from other standard healthy burials. There are only three other individuals associated with ground stone tools, all of which are individuals with greater artifact association, with one of these three being a TB individual. Two of these individuals have multiple ground stones buried with them. A ground stone tool is not necessarily a tool of particular prestige, but more so a functional tool for making other things. As a functional tool, it is possible that the individual isolated on the mound was a craftsman of some sort. While an egalitarian society suggests little specialization at the site, it is possible that this individual was in charge of manufacturing stone tools, or possibly preparing food. For the latter possibility, the pit could be representative of a hearth used to cook and prepare food. TB infection would not have been easily identified or visible on the human body, so the rest of the population could have been oblivious to the diseased person's illness. Without any knowledge of the infection, disease would not have been a reason for isolation. The diseased individual could have been designated as the main person in charge of preparing and distributing food to others without being scrutinized for their illness.

Bordering the southern edge of Mound 9 was a group of individuals in purposeful placement around the mound. The significance of the placement of these individuals was originally unknown. Nevertheless, looking at the mound with a specific focus on diseased individuals shows an interesting pattern. There are two diseased individual located around the mound. These just so happen to be the only two yaws infected individuals. One of the individuals does not have any associated artifacts, and is buried in a pit. In consideration of yaws as a disease spread through contact, this disease would have left visible marks on the skin of a body. It is possible that, after seeing the lesions on the person's body, the person was isolated in the pit. Isolation could have been done in hopes to possibly prevent the spread of infection to other individuals, or it could have been done out of disgust of the diseased individual. The other yaws individual who surrounds the mound is not buried in a pit, and has a decorated pot and associated spoon. This individual might not have had as sever of lesions or the lesions may not have been visible. Less distinct lesions could have made him less of a perceived hazard in the population.

The level of knowledge of infectious diseases at this time is unknown. While I highly doubt this population had any knowledge of Germ Theory, I am curious if they had any knowledge of the transmission of disease. Since there are so few cases of yaws at the site, it is possible that these two yaws burials were placed around the mound in a form of isolation as to not spread infection. This also eludes to the possible perception of individuals with a visible disease. Stigmatization of yaws infected individuals could be another reason for their placement of isolation. Nevertheless, there are also healthy burials placed around the mound, one of which is buried in a pit, and a few of which are associated with a greater quantity of artifacts. The healthy individual buried in the pit is neighboring the pit that contains the yaws individual. The presence of these healthy individuals around the mound contradicts my previous conclusion of the isolation of yaws individuals. It poses the question of the social standing of the healthy individuals who received similar burial treatment to diseased people.

The second feature in Knoll A is the possible charnel structure and its surrounding mound. The surrounding mound is characteristic of the soil placed on top of the foundation of a charnel structure after the structure is done being used. In accordance to social standing, the placement of the charnel structure is significant for the location of burials. Individuals buried north of the charnel structure are thought to be burials of higher standing. There are many individuals buried north of the charnel structure. Of these burials, there are five healthy individuals with greater artifact association. One of these healthy burials is of particular interest because of its vast quantity of artifacts. The individual is a middle-aged adult female. This burial is bordering the northwest corner of the charnel structure. Considering the quantity of artifacts associated with this individual and its position around the structure, it is plausible that this individual was of higher standing in some aspect of her life. Something to note is the absence of pottery in association with her burial. Since she is bordering the edge of the structure, it is possible that the structure was dismantled prior to completion of her burial, and a pot was not added to her burial. Other than this possibility, the reason for the individuals lack of pottery is unknown. The other healthy individuals with greater artifact association do not have nearly as many artifacts, but they are all associated with pottery. These include two child burials of indeterminate sex, a middle-aged adult male, and a young adult of indeterminate sex. There is one diseased individual located near the north-east corner of the charnel structure, in between the charnel structure and Mound 9. The individual is a child of indeterminate sex; it is buried with artifacts but there is no pottery present. There are also two diseased individuals located north of the charnel structure. Both individuals are middle-aged females and are associated with artifacts and pottery. One of the two burials is categorized as having greater artifact quantity. Considering the age and sex of these two individuals, the age and sex of the healthy female, and the presence of three children all located north or near north of the structure, it seems that these individuals are related in some way. It is possible that these are mothers who died in child birth and north of the charnel structure was allocated for their burials. In this case, quantity of artifact association would illustrate commemorating this unfortunate death with adornment and artifacts. This possibility still does not explain the lack of pottery associated with the healthy female, nor does it explain the healthy male and unknown healthy burial located north of the structure. It does, however, suggest the possibility that burial placement north of the charnel structure was purposed for something other than higher social standing.

Location of burials in Knoll A illustrates patterning for diseased individuals. While healthy individuals are located all over the site, including those with greater artifact association, diseased individuals are allocated to specific spots in the cemetery. All diseased burials located near the northern wall of the charnel structure, or in association with Mound 9. The purposeful placement of infected individuals in Knoll A suggests that there was consideration being put into the location of infected individuals at the site.

In sum, consideration of the artifact association, pottery, and location of diseased burials for a sense of the treatment of disease-ridden individuals makes for a complicated analysis. The general analysis of associated artifacts and pottery demonstrates that, on average, diseased individuals are accompanied with a greater quantity of artifacts, and a greater percent of these individuals are associated with pottery. This general analysis would suggest that there is higher social standing among diseased individuals. Nevertheless, this analysis is complicated by burial location being taken into consideration. While not much patterning could be gathered from Knoll B about differences in social standing, it provides information on the lack of differences between diseased and healthy individuals based on burial location. Knoll A provides patterning in burial location. The position of burials north of the charnel structure and around Mound 9 contain all diseased individuals from Knoll A. Patterning continues in the location of diseased burials based on disease. Yaws individuals were located together; similarly, all TB individuals were located together with the exception of one that was located on the mound. The placement of these burials may be reflective of the nature of the disease. This layered analysis indicates that there was some higher form of social standing for diseased individuals.

Perception of Infectious Disease

Identification of a difference in the social standing of individuals at death, allows for the consideration of the life of diseased individuals and the way they were perceived in society. The perception of disease in a society heavily depends on the nature of the disease. Historic Europe provides an optimal example for perceptions of infectious disease. TB and yaws received copious attention and were regularly featured in popular literature. Tuberculosis, despite its infectious and pathogenic nature, received positive attention throughout history. During the 18th

and 19th century in Europe, as epidemic TB plagued the continent, it gained admiration and honor amongst the very population it infected (Daniel, 2006). Well renown author Emily Bronte romanticized a victim of TB as having eyes that "sparkled as bright as diamonds." In addition, Charles Dickens described the death of a character infected by TB "[As] the mortal part wastes and withers away, so the spirit grows light and sanguine" (Daniel, 2006). As these example illustrate, death by TB was not considered a threat despite the devastation it posed to the population it infected.

While tuberculosis is romanticized in European history, treponemal infections were not thought of as highly. Since yaws was an unknown disease to early European populations, syphilis, a related treponemal infection, represented the yaws bacteria in early European populations. Syphilis was an epidemic in Europe at the end of the 15th century (Emory, 2011). As a sexually transmitted disease, syphilis was highly stigmatized. The stigma behind syphilis is a main contributor to a lack of research behind the origin of treponemal infections.

Throughout history, much has changed in what is known about infectious diseases and the perception of these diseases has changed. Present day populations view infectious disease through the scope of the germ theory of disease. With the understanding of the germ theory, diseases can be treated with various vaccinations and antibiotics that target disease-causing microorganisms. Prior to understanding the germ theory, treatment of infectious diseases had to be performed in alternate measure, or the disease could note be treated at all. As a result of the unpredictable nature of an infection, past populations might have viewed these diseases differently. In turn, diseased individuals could have been seen in multiple different ways.

My goal of this study was to depict how the earliest populations inflicted by infectious disease perceived disease and most importantly, the human that hosted the disease. Having traced infectious diseases back to their initial emergence in the United States during the Mississippian, the Schild Site provides insight of the lives of individuals with disease infection and the way they were perceived in prehistoric populations. As seen in the treatment of infected individuals from Schild, two things are apparent. First, diseased individuals were not being treated any lesser than healthy individuals. Second, there was some form of higher social standing associated with some of the diseased individuals in the population. It is evident that the population represented at Schild did not view diseased individuals as people who needed to be separated from the rest of population or receive alternative burial treatment. Diseased individuals received similar treatment as most all other individuals in the population. The exception in the treatment of diseased individuals is the possibility of these individuals being members of more prominent groups or families.

An alternative explanation for a higher social standing of diseased individuals looks at the social status of these people prior to disease infection. Rather than concluding that people were of a higher social standing because they were diseased, it is possible that these people were of a higher social standing and then became infected by disease. In consideration to the location of the site, individuals of higher social standing could have been the people traveling to and from large urban centers. Their interaction with larger populations and procurement of trade items could have elevated them to a higher social standing than other individuals in the egalitarian population. As a result of travel and trade, these individuals would have been more exposed to disease pathogens and thus more susceptible to disease infection. The people who would have been traveling would most likely have been young adults who were capable of making the voyage. It makes sense that individuals with greater exposure to disease pathogens would be at greater risk of disease infection. Nevertheless, this line of conclusion is convoluted in consideration to the typical age of an individual when they become infected, and the severity of the infection.

The age of an individual at death, though not highlighted in the analysis, needs to be taken into consideration to understand who was infected by disease and the role of these people within society. All but one of the diseased individuals are older than 20 years of age. The one exception is the burial of a child with TB. A child infected by disease and dying at a young age would make sense when considering the age at which people are most susceptible to TB and yaws infection. Meanwhile, the adult individuals would have most likely contracted the disease at a young age, survived with the disease into adulthood, and then eventually either died from disease or from another cause. Both TB and yaws are diseases that a person can live with, but while a person may not be killed by the disease, the disease can have other negative impacts on human health. Long term infection by TB and yaws can result in serious deformities of the human body, and in order to have seen these diseases osteologically, it is assumed that the disease progressed to a debilitating state. As these deformities become increasingly more severe, the individual infected by the disease is going to become increasing less capable. The success of an older individual with the deformities caused by disease would rely heavily on the help and care the individual could receive from other members of the population. This line of analysis provides another example of the perception of diseased individuals. If other members of the population were willing to take care of and help diseased individuals, it is assumed that these diseased individuals' lives were intertwined with the rest of the population.

Limitations to Analysis

Having reported the critical components of my analysis, it is obvious that there are major aspects of mortuary treatment that have been overlooked. This is the result of multiple limitations posed by studying human burials. First off, there is not enough evidence of infectious disease at the Schild Site alone to make any drastic statements about the treatment of diseased burials during the Mississippian. As a result of the small sample size of infected burials at the site, it was difficult to show statistical significance in my data analysis. To increase my sample size and generate a more holistic view of burial treatment during the Mississippian, I originally planned to analyze multiple Mississippian sites. Nevertheless, these additional site reports were problematic. The site reports were either incomplete, unavailable, or nonexistent. The majority of Mississippian sites that are have been heavily studied were first excavated in the early to mid 1900s. I was able to learn a lot about the Schild Site from the burials, but since the time of the initial excavation at the site procedures in archaeology have changed drastically. A major change in archaeology in the United States occurred in 1990 with the passage of the Native American Grave Protection and Repatriation Act (NAGPRA) (NPS, 2016). Under protective regulations of NAGPRA, excavations of human burials were prohibited in the United States. As a result, the studies performed on Mississippian sites relies heavily on the excavations and documentation of previous archaeologists.

Questions for Future Study

The analysis performed in this study barely scratches the surface of what can be learned about infectious disease in prehistoric populations. A more comprehensive study of the treatment of diseased burials as a reflection of the perception of disease requires a larger sample size and the expansion of the study to encompass multiple sites. A large sample size is ideal when performing any form of analysis because it provides a more holistic view of the population of interest. While further excavations of human burials at the Schild Site will most likely not occur, the use of multiple sites would help to increase the population size of diseased individuals. Multiple sites would also allow for a broad scale analysis of infectious disease not only in the lower Illinois River Valley, but throughout the Mississippian. Using sites from various geographic locations of the Mississippian would allow analysis of how burial treatment might differ between sites, as well as the trade routes and possible ways in which infectious diseases may have been spread from population to population. With this, tracing the burial treatment though out a site's occupation and into later time periods would allow for analysis of how the treatment of diseased individuals changed over time. It would also be interesting to expand analysis outside of the United States to look at burial treatment of diseased individuals in other populations across the globe.

Since a contagious nature of a bacterial disease is necessary for the bacteria's survival, there would have had to be some form of treatment to prevent the disease from spreading. It would be interesting to see if there were any cultural aspects of a society that could have worked to prevent disease infection, or treat infected people. The territory of the Anishinaabe tribe of Native Americans occupies the northern portion of Illinois. The cedar tree is one of four sacred medicines that is greatly intertwined with Anishinaabek culture (Anishinaabemdaa, 2014). Cedar is used for multiple uses; it is included in most all ceremonies, used in human burials, and for medicinal uses. In addition, cedar has the potential to provide multiple forms of protection against and treatment of various pathologies (WIPO, 2016). Cedrene, the active chemical in cedar, is a common element found in modern medications (Pubchem, 2016). Cedrene is used as an antibiotic as well as an anti-infective (WIPO, 2016). Pollen analysis or botanical analysis of burials from the Schild Site would show if any people at the site were buried with cedar. The use of cedar could have been to keep diseases from spreading, or it could have been used in life to treat diseases.

To continue analysis on how infectious diseases impacted prehistoric populations and how these populations coped with disease, it would be interesting to look at the genetic components of the disease and of the human population. As human populations change with time, so do diseases. I am curious if any evolutionary adaptations occurred either in human populations as a form of resistance to infectious disease, or in the disease as a way to persist in human populations. A look at the adaptation of both diseases and human populations would allow further analysis of the impact of the same diseases in current human populations. These future studies could help elucidate who represents the population at the Schild Site, the role of diseased individuals, how infectious diseases were managed, and the impact infectious disease had on prehistoric populations.

Conclusion

There are multiple aspects of burial treatment that are configured to determine the structure and function of a society. The study of burial treatment of disease ridden individuals provides an atypical look at how the society functions and how the population persists. Tuberculosis and yaws are two major diseases that impacted Mississippian populations. While these diseases provide an adequate foundation to identify differences in burial treatment and perception of diseased individuals in prehistoric populations, this study is applicable to most all infectious diseases that have impacted human populations throughout history. Burial treatment infers how people with infectious diseases were perceived and how these diseases were managed in life. The way in which a culture treats their dead depicts the role this person played in life, the social perception of the person in life. Cultural practices have the potential to define the success of a disease in a population. From the aspect of infectious disease, this study proposes the possible way in which infectious disease spread throughout populations. Cultural practices and possible management of disease in prehistoric populations reflects on modern cultural practices and disease prevention efforts. It brings to the foreground the societal changes that could impact human health, and the way a population will compensate for societal changes. Furthermore, it indicates the extent to which the treatment of infected individuals and population organization shape the spread of infectious disease in society today.

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