A Paleopathological Analysis of the Moran French Colonial Cemetery

Jennifer Lynn Funkhouser

University of Southern Mississippi

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A PALEOPATHOLOGICAL ANALYSIS OF
THE MORAN FRENCH COLONIAL CEMETERY

by

Jennifer Lynn Funkhouser

A Thesis
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
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Approved:

Marie E. Danforth
Director

H. Edwin Jackson

Amy Young

Maureen A. Ryan
Dean of the Graduate School

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ABSTRACT

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This research examines the health experiences of early eighteenth-century European immigrants to the Mississippi Gulf Coast. Most were low-status individuals forcibly expelled from France and brought to Biloxi to colonize Louisiana. Historical records report the immigration effort was poorly provisioned and that large numbers died from malnutrition and disease soon after arrival. The remains of 30 adults, presumably colonists from this period based on collagen dating and grave goods, have been recovered at the Moran site (22HR511). DNA analysis (n = 8) suggests all are European. Most are males, and only one lived past age 40. Estimated mean height is 165.1cm for males (n = 15) and 155.49cm for females (n = 3), which is several centimeters shorter than contemporary European populations. Hypoplasias were found on 13 of 20 individuals scored with nine showing multiple episodes. Most lesions were of moderate severity, and ages at formation ranged broadly between two and five. Porotic hyperostosis was seen in several individuals, but all cases were slight. Frequencies for caries and antemortem tooth loss were relatively low, and periosteal lesions suggestive of infectious disease were rare. Arthritis is uncommon, as would be expected given the young age at death for most. Trauma also is infrequent, but two crania do display possible healed blunt force trauma. The population as a whole fits the expected demographic profile of a colonial settlement. The health patterns revealed also accord with individuals who endured harsh
childhoods and died from acute rather than chronic causes as they sought new lives in the New World.
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CHAPTER I
INTRODUCTION

This study examines the health experiences of early eighteenth-century European immigrants to the Mississippi Gulf Coast, an era of history in the state that is often overlooked by historians and archaeologists alike. The colonization of any area is not homogenous across time and space, and this is certainly true for the colonial efforts, being primarily Spanish and French, of the Gulf South. The Mississippi Gulf Coast had many foreign visitors to that shore, some of whom were the colonists, French, Acadian, German, Swiss, and African, sent by the French crown to build the colony of La Louisiane (Conrad 1970; Giraud 1995).

The history of the French colonization of the Mississippi Gulf Coast is one of forced immigration, personal ambition, altered landscapes, economic collapse, and nails. The French presence in the whole of North America spanned from the North Atlantic seaboard, through the mid-continent, and ended in the Gulf Coast. The French first settled on the Gulf Coast in what is today Ocean Springs, Mississippi, in 1699 with the construction of Fort Maurepas. Its residents were mostly sailors, soldiers, and artisans (Conrad 1970). The colony was transferred to Old Mobile three years later. However, in 1719, amidst an apparent economic boom in France, the decision was made to move the capital back to Mississippi (Conrad 1970; Giraud 1993).

While the initial population was largely composed of those individuals helping to build the colony, such as soldiers, artisans, and clergymen, and those who initially bought land plots, the second immigration wave was decidedly different, and the Biloxi settlement became, in many ways, a rural colony populated by an urban proletariat
Historical records report that most colonists were low-status individuals forcibly expelled from France and brought to Biloxi to colonize Louisiana (Conrad 1970; Dawdy 2008; Eccles 1998:183; Norton 2007; Sublette 2008). This included an assortment of convicts, prostitutes, and the poor as France sought to fulfill contractual obligations that had been set concerning the number of colonists scheduled to arrive on the Gulf’s shore annually. The French crown also envisioned the forcible removal of the poor and criminal populace from the cities to the New World as a scenario in which these individuals are both removed from the temptations of urban areas and employed in endeavors that would provide an income for the treasury through agriculture (Hardy 1995). Records reveal that the immigration effort was poorly provisioned and that large numbers died from malnutrition and disease soon after arrival (Conrad 1970; Eccles 1998). For many prospective colonists, nutritional stress began long before they reached the docks let alone the colony.

Varying reports from or concerning the short lived Biloxi habitation all describe a settlement plagued with “fevers, exhaustion, and privation,” though for various reasons (Allian 1995: 98; Conrad 1970; French and Shea 1853). In the two years that the colony remained in Biloxi, the French economy collapsed. An investment scheme referred to as the “Mississippi Bubble,” a kind of fiscal Pequod helmed by a fugitive Scotsman, had bust by 1720; investors panicked with those who could pulling their backing, the lofty ambitions of the colonial administrators were forsaken (Giraud 1966). Biloxi proved to be a poor choice as a capital in its second tenure as well, both for all the reasons that existed 17 years prior and because the barrier islands (Ship and Dauphin) kept the Gulf between the islands and the shore shallow, making it impossible for ships to create a port.
near land, so the decision was made to move the colonial capital to New Orleans (Eccles 1998). The settlement at New Orleans, initially begun in 1718, then became the official colonial seat in 1722.

The Moran French Colonial Cemetery (22HR511) on the Mississippi Gulf Coast represents an outpost of this early French presence in coastal Mississippi. The site was found in 2005 in the aftermath of Hurricane Katrina. The modern city of Biloxi took a direct hit by the storm, which completely destroyed the Moran Art Studio and adjacent family home, exposing additional interments. The University of Southern Mississippi assisted with the initial recovery of exposed bone, and then began a full excavation of the entire property, including areas previously covered by modern concrete slab house foundations. Research conducted on the history of the area in tandem with recent archaeological investigations appears to support the idea that the site was originally designated as a formal cemetery and that it was active in the early years of the French colony, particularly the early eighteenth century (Hester 2011).

This research examines the health experiences of early eighteenth century European immigrants to the Mississippi Gulf Coast. The evaluation of pathognomonic conditions that, harbored within the body for a sufficient period of time, may result in skeletal lesions can assist in the reconstruction of both the nutrition (or lack thereof) and disease frequencies within a population. The analysis of this series is guided by the data generated by stature, hypoplasias, anemia, dental pathologies, infections, degenerative joint disease, and trauma in an effort to best understand the general health of the individual at death (Steckel and Rose 2002). Few human remains from the eighteenth-
century French colonial sites have ever been recovered in the New World, and the Moran population represents the oldest known cemetery from this period in the Southeast.

The history of the French colonization of the Mississippi Gulf Coast is, ultimately, one of the people who attempted to make a life for themselves on that shore. The French presence in the whole of North America spans from the North Atlantic seaboard, through the mid-continent, and ends in the Gulf Coast. As a region, the Gulf Coast is a place full of those very aware and proud of their past. For those living outside those borders, however, precious little is commonly known about European colonization in this area. For many, the French in the New World is synonymous with New Orleans (or for the truly savvy Mobile, Alabama, as the home of the first Mardi Gras festival in North America). Relatively few people are aware that there was ever a French colonial presence in Mississippi. This research attempts to contribute to a better understanding of the unique circumstances surrounding the rise and fall of the Biloxi capital through the unique lens of the pathological analysis of those unable to survive the effort.
CHAPTER II
LITERATURE REVIEW: HISTORICAL BACKGROUND

The political atmosphere in France had a huge influence on both the birth and survival of its New World colonies. Two major events coincided at the turn of the eighteenth-century that would forever alter the Gulf Coastal landscape: the settling of a military encampment in 1699 on the east side of the Mississippi River and the onset of the War of Spanish Succession in 1701 (Eccles 1998; Sublette 2008). In 1698 the French received intelligence that the British were intent on establishing a Gulf Coastal presence in the New World at the mouth of the Mississippi River (Sublette 2008). The French sought to circumvent this by way of erecting an encampment, Fort Maurepas, on the Biloxi Bay (McWilliams, 1981). Originally engineered by some 80 men, most of them Canadian, the fort became home to more than 120 in the following two years (Eccles 1998). Unfortunately, the sandy Biloxi soils proved unsuitable for intensive agriculture, the weather was unpredictable, and the area was prone to flooding and hurricanes (Conrad 1995; Sublette 2008). Then in 1701 the king of Spain died without an heir and, in his will, left the kingdom to his half-sister’s son, Philip - who also happened to be the grandson of King Louis XIV, known in history as the Sun King, of France (Mitford 1995). France, through King Louis, had been trying to build its empire with growing colonies in Asia, Africa, and the Americas, and the idea of having such a stranglehold on European commerce held enormous appeal. Of course, others had huge objections to this, most notably Britain, the Holy Roman Empire (Austria), and the Dutch Republic (Netherlands) (Mitford 1995). War was waged, and the fledgling colony was moved to Mobile in 1702 (Eccles 1998; Conrad 1995).
The move to Mobile was prompted by a number of factors, chief among them the belief that it would be easier to trade with the Spanish in Pensacola and the Native Americans (Apalachee) that lived along the Mobile River (Eccles 1998; Conrad 1995). In 1706 the colonial governor, Canadian-born Pierre Le Moyne d’Iberville, died and the position was succeeded by his younger brother, Jean-Baptiste Le Moyne de Bienville, who was well acquainted with the colony having assisted his brother, at age 18, in the founding of Fort Maurepas (Rule 1995). Allegations of brashness, nepotism, and public misconduct resulted in the demotion, in 1710, of Bienville to second in command and the appointment of a new governor, Antoine de le Mothe, Sieur de Cadillac, founder and former governor of Fort Pontchartrain d’Etroit (Detroit) (Rule 1995; Sublette 2008).

Unfortunately, the southern colony was not producing anything but reports of sickness, mutiny, and desertion and, with the crown engaged in a costly war that spanned two continents, the ambitious Cadillac became overseer of little more than a hellacious situation (Lemann 1995). In an attempt to remedy this, Cadillac briefly returned to France and sought an audience with Antoine Crozat, a wealthy businessman, to advocate for the colony as a business investment (Sublette 2008). Operating under orders from the Minister of the Navy, Cadillac portrayed the colony to Crozat as a virgin landscape of untapped wealth teeming with gemstones, precious metals, and pearl fisheries (Allain 1995; Sublette 2008). Crozat agreed to privately finance the colony and, in 1712, was appointed La Louisiana’s financial administrator (Sublette 2008). For the next five years, with proprietary control of the colony in the hands of a Parisian entrepreneur, Crozat, and a reformed pirate, Cadillac, Louisiana would be run as a commercial enterprise rather than as a colonial effort (Rule 1995; Sublette 2008).
The War of Spanish Succession was fought in both Europe and in the Americas and when King Louis finally ceded control of Spain in 1714, he also lost his northern colonies in America (Acadia, New Foundland, and the Hudson Bay) to the British (Mitford 1995). In American history this period is Queen Anne’s War, the second of five campaigns that comprise the French and Indian Wars, lasting from 1702-1713. In 1715 Louis XIV died and left the country to his five year old great-grandson, Louis XV (Dawdy 2008). While the new king was in his minority the country was ruled by his uncle, Philippe duc d’Orleans, who was appointed by parliament as regent (Sublette 2008).

In 1716 the Duke of Orleans met Scotsman John Law and was persuaded to try a revolutionary banking scheme in an attempt to alleviate France from some of the rising debt (Thiers 2010). Debt was increasing for a couple of reasons – the opulent spending of the monarchy, the cost of maintaining a standing army (for both wars and colonial efforts), and the exemption of nobility from taxes (the only way to reverse this was by order of parliament and parliament was comprised almost entirely of nobles) (Mitford 1995). Law’s multifaceted plan included the establishment of a national bank that utilized the national estate as collateral for issued bank notes instead of gold or silver specie, the creation of a corporation to control estate properties abroad, and the assumption of the national debt by this corporation (Thiers 2010). In 1717 the decision was made to take the currency off gold and silver standard, and a state run bank, the Bank Generale, was launched (Thiers 2010).

That same year Crozat relinquished his claim on the colony and Law’s Company of the West was given proprietary control of all French controlled North American
territories (Sublette 2008). Immediate plans for the southern territory were the exportation of buffalo hides, with long-term plans to invest in agriculture, especially tobacco, and usurp the British colonies as the primary supplier of growing domestic markets (Sublette 2008). The Company, as it came it be called, intended to recruit colonists for the Louisiana venture, a vitally necessary component for the colony to fulfill its intended purpose as an agricultural goldmine, via paid concessions (land grants bought buy the gentry) (Thiers 2010). Original efforts to facilitate this involved the decimation of bogus propaganda that detailed the enormous financial potential of the concessions, located along the Mississippi and Arkansas Rivers, the charmingly rugged splendor of the burgeoning settlement at New Orleans, and the discovery of silver mines and an emerald boulder in Mississippi (Arnold 1995; Sublette 2008:52). Unfortunately for John Law and The Company, too few believed these portrayals of a seemingly utopian paradise and voluntary immigration efforts failed (Allain 1995; Sublette 2008). Between the winter of 1718 and the spring of 1719, John Law’s bank became the Banque Royale, The Company of the West became The Company of the Indies and was given a monopoly on all French colonial commerce, and the two entities merged into one monstrous conglomerate and together assumed the national debt (Hardy 1995; Sublette 2008). This level of fiscal manipulation did not allow time for anything but immediate returns on the Louisiana investment (Hardy 1995).

As voluntary recruitment was failing to adequately populate the colonies, and produce the kind of profits projected by Law, a forced immigration policy was put in place (Hardy 1995; Sublette, 2008). Instead of a colony populated by gentry, what investors got instead were boats of some 6,000 of France’s best vagrants (Conrad 1970
and 1995; Hardy 1995). The jails, hospitals, and workhouses were emptied in the major cities of Lyon, Orleans, and Paris (Hardy 1995). Individuals were encouraged to marry (having been promised dowries by way of compensation), shackled together (literally) as a newly sanctioned couple, and boarded onto the ships (Hardy 1995). Guards often mistreated those in their care by stealing food and even clothing from the prisoners (Hardy 1995). In his memoirs, the Duke of Saint-Simon wrote of witnessing the treatment of those meant for transportation, noting that food was regularly denied to those awaiting deportation and that, as a result, people died in large numbers and arrived at the colony already in varying states of illness and/or nutritional distress (Norton 2008).

After the 1719 merger of the royal bank and The Company of the Indies, The (new and improved) Company set about the onerous task of relocating the colonial capital to Biloxi (Figure 1) (Conrad 1970, 1995; Eccles 1998; Sublette 2008). The reasons for this were many, varied, and tended to correlate with the personal ambitions of colonial administrators (Conrad 1995; Eccles 1998; Giraud 1993; Lemann 1995; Sublette 2008). The first blow to the Mobile was the closing of the Dauphin Island harbor in 1717, as Dauphin Island had long been utilized as an outpost of Mobile, after a series of storms clogged it with sand and mud (Conrad 1970; Giraud 1993). The accumulation of sediment, and increased shallowness of the water, created the additional problem of exposing the ships to more of the force of hurricanes, and strong winds in general, making it an undesirable location to attempt to offload cargo (Conrad 1970; Giraud 1993).
This undesirable location was rapidly becoming unsafe and tensions with the nearby Spanish continued to increase (Conrad 1970; Giraud 1993). Rates of desertion, which had plagued the Mobile settlement during the war years, continued to rise in 1717 and climaxed in September 1719 when deserters from Mobile traveled to Fort Toulouse and successfully inspired a revolt by the garrison stationed there (Lemann 1995). The Alabama tribe assisted in capturing the rebels, and the leader of the rebellion was sentenced to death by tomahawk with the remaining soldiers sentenced to life imprisonment (Lemann 1995). During the capture of Pensacola earlier that same year the French found 37 deserters living with, and fighting for, the Spanish (Lemann 1995: 365). Plans to reduce the rate of desertion included building new forts engineered in a way that limited escape routes, closing island forts completely, and imposing curfews that were punishable by death (Lemann 1995).
Another problem afflicting the Mobile settlement was its size (Giraud 1993). For the majority of its tenure as the colonial capital, Mobile was an incredibly small settlement (in 1713 only 60 men served in Louisiana) with a physical infrastructure that reflected its low population density (Giraud 1993; Lemann 1995). As The Company began to take the colony in hand, it became clear to officials that any location chosen as the base of operations for Louisiana would have to be constructed wholesale (Giraud 1993; Lemann 1995). Finally, in the later months of 1719, inflation hit and investors in John Law’s financial scheme began to panic. The Mobile settlement was floundering and The Company, desperate to manifest the appearance of control and progress in the southern territories, moved to take its operations westward (Conrad 1970).

New Biloxi, 1719-1722

Transferring the colonial capital began in the winter of 1719-1720 when some 200 soldiers were sent to the site selected for the new post, this time on the opposite side of the Biloxi Bay, to begin clearing land and building shelters (Conrad 1970; French and Shea 1883). Rather than pack up and relocate Mobile, a settlement, the military installations at Dauphin Island, which included a battery of a dozen cannons and army barracks, were disassembled and those munitions, officers, and soldiers stationed at Dauphin Island transferred to Biloxi in February 1720 (Conrad 1970). Interestingly, however, while the structures were transferred from Dauphin Island to Biloxi they were never erected (Conrad 1970). Bienville, well acquainted with the trouble posed by the Biloxi location, felt certain the settlement would have to be relocated and, initially, intended to invest as little in it as possible (Conrad 1970). Additionally, no investment was made toward permanent agricultural fields at Biloxi (Conrad 1970), and even if there
had been, this was hardly a colony populated by agriculturalists. Those immigrants not forced onto Biloxi’s shores were soldiers and tradesmen (masons, blacksmiths, brick makers, and carpenters), not farmers (Kilman 1995).

This spectacular lack of foresight set the stage for a perfect storm of complete ridiculousness that began immediately taking place for the new colonists. The year began with the resolute death of John Law’s financial scheme (Thiers 2010). Though the bank was destroyed and The Company, once again The Company of the Indies, was deprived of much of its former glory it was permitted to remain operational – and continued to send ships teeming with immigrants but without the necessary assistance to keep them alive (Theirs 2010; Usner 1992). Originally, in the early months, The Company’s offices in Biloxi functioned as a layover, briefly hosting new immigrants recently disembarked from their ships, and then assisting them on their way into the territory by transport boat (Conrad 1970). A ship, at this time, typically had passengers numbering somewhere between one and 200 (Conrad 1970). Unfortunately, the Biloxi offices were equipped to successfully handle exactly that volume of traffic (Conrad 1970).

In August a ship arrived with some 400 passengers, and in early September only 150 of these new colonists were able to be transported elsewhere, either to Mobile or New Orleans, with the remainder forced to wait at Biloxi (Conrad 1970). Not only did the administrators at Biloxi not have enough boats to handle the increased traffic, without replenished supplies from France, ranging from nails to carpenters, they had no way to supplement the number of craft in use (Conrad 1970). The end of August brought food rations from The Company, 80 more people, and no supplies or workmen to build the boats (Conrad 1970). Also, an illness was sweeping through the colony from Dauphin
Island to New Orleans, overcrowding the impotent Company hospitals that lacked both adequate food and medicine, and resulting in the deaths of 30 individuals at Biloxi alone (Conrad 1970, 1995).

During this time Old Biloxi continued to functionally operate and was employed as a location to house soldiers, prisoners, Company employees, and was the location of the company store (Conrad 1970). On the first of October a drunken soldier, attempting to flick a lit twig out of his barracks without rising from bed, successfully set fire to several huts including the store (Conrad 1970). This complete loss of what few rations that settlement boasted was followed by a winter that brought six ships carrying approximately 1,500 people, their effects, little food, and “above all, no nails” (Conrad 1970: 47). The new capital had become a holding tank that was entirely dependent upon rations provided by the Crown, and they were not coming in sufficient numbers (French and Shea 1853; Conrad 1995). In his memoirs French engineer Dumont de Montigny detailed the hardship experienced by colonists because of this shortage, chronicling stories of those who, in desperation, consumed unknown local vegetation and beached mussels which, he explains, resulted in their deaths (French and Shea 1853: 21).

Similarly, the memoirs of Charles Le Gac, a military official at the settlement, focus on the lack of goods being brought into the area and, as a result, his near constant dilemma of always having too many people and never enough supplies (Conrad 1970). And while both publications contain accounts of parties being sent to trade for supplies with local Native American groups (first the Biloxi and Pascagoula tribes and later the Natchez), these administrative measures came either prematurely or far too late (Conrad 1970; French and Shea 1853). That winter proved difficult for the stranded colonists, as many
of them were not only without food but shelter as well, and between December 1720 and January 1721 53 perished from a combination of inadequate nutrition, exposure, and illness (Conrad 1970, 1995).

Reports on the spring of 1721 vary, though Deiler (1969) cites the French civil codes as recording an epidemic that was so destructive “the priests at the place, having so many other functions to perform, were no longer able to keep the death register” and Giraud (1966) cites the number at being somewhere around five 500 (Deiler 1969: 23; Giraud 1966). However it occurred, and a mortality rate capable of completely reconfiguring the social fabric of the colony would do it, it gradually became clear to administrators that the majority of the colonists would never be sent to their lands, causing the emphasis to switch from boats to the construction of Fort Louis in the summer of 1721 (Conrad 1970; Wilson 1995). Unfortunately, and again, food and construction materials were in short supply and, in tandem with the misery of the summer heat, progress was slow (Wilson 1995). By the year’s end, however, Biloxi laid claim to huts, forages, sheds, a chapel, and a functioning hospital (Wilson 1995). Then, on December 23, The Company officially designated the transfer of the capital, just as Bienville had predicted, to New Orleans (Campanella 2008). Word of the decision arrived to the colonies in the early spring of 1722 and the transfer was complete by the following year (Campanella 2008).

Eighteenth-Century Disease and a Colonial Connection

It is important here to remember the context in which much of the written documents concerning the area fall and that the truth of the matter was that Biloxi was meant to be a money making venture for the French crown. Advertising a colony rife
with systemic infection and endemic disease would have been a financial disaster. Additionally, many diseases at this time are either not specifically recognized or have been recorded by multiple authors under different “common” names. So while few diseases are mentioned as being present at the Biloxi colony specifically, by focusing, instead, on those infectious diseases and recorded maladies that plagued the Louisiana colony one may be able to infer what individuals were likely living with (or dying from).

Yellow Fever

Due to its unique symptoms, yellow fever was one illness easily recognized at the time. Le Page du Pratz, writing of his 1719 passage from France to Louisiana, recorded that upon reaching the West Indies 800 individuals, of the 1,500 aboard the ship, succumbed to yellow fever (Sublette 2008). Yellow fever, also called Yellow Jacket and The Black Vomit, is a viral infection transmitted by mosquitoes that focuses in the lymphatic system and is so named because sufferers often take on a jaundiced appearance (Barnes 2005). Symptoms of the illness include fevers and chills that seem to pass only to reoccur with an even greater fervor days later. The kidneys shut down and the stomach fills with blood which is then vomited up, hence the name Black Vomit. Two-thirds of those who contract the disease eventually recover, but those that do not will typically pass away within two weeks of contracting the virus. Inhabitants of port cities were the most likely to become infected, and usually only during the summer months, which makes sense given that the disease is transmitted by mosquitoes (Sherman 2007).

Gastrointestinal Diseases

Dysentery, along with scurvy and venereal disease, appears to be of the triad of ailments ever present among military encampments, and the eighteenth-century French
colonial encampments were no different (Dawdy 2008). Dysentery is typically a catch-all term for diarrhea caused by contaminated water, either by bacteria or parasitic worms. Typhoid fever is another of the major “flux” diseases. A bacterial infection, typhoid is most commonly transmitted in an oral-fecal fashion courtesy of contaminated water or food (Barnes 2005).

**Malaria**

Dumont de Montigny, in his autobiography, wrote of the restorative properties of the new capital of New Orleans, where he was able to rid himself of a terrible fever that had plagued him for some months in the early 1720s; speculation by historians is that this fever may have been malaria (Dawdy 2008). Malaria is a vector borne disease, mosquitoes in this case, that directly affects the liver and often proves fatal to the human host (Sherman 2007). While some pathologies are specifically mentioned in the literature related to this colonial effort, others that are not may be speculated on with a fair amount of confidence given their mode of transmission and the specific environmental conditions that would have proved conducive for these pathogens to flourish.

**Venereal Disease**

Syphilis, a bacterial infection often referred to as the Great Pox, enters the body through open wounds or intact mucus, travels through the blood stream, and afflicts sufferers with fever, joint pain, scars, paralysis, and insanity. Speaking of the condition, Joseph Grunbeck of Germany, wrote in the late fifteenth-century, “In recent times I have seen scourges, horrible sickances and many infirmities affect mankind from all corners of the earth . . . a disease which is so cruel, so horrifying, nothing more terrible or disgusting, has ever been known on this earth” (Sherman 2007: 84). Other complications
of syphilis arose from the long preferred method of treatment of directly applying liquid
mercury to the infection site, leading some to die not from the disease itself but from the
presumed cure (Porter 2002).

Smallpox

Smallpox, too, while no little matter, is another easily recognizable disease that, by this time, had become something fairly commonplace. As an illness associated with childhood, though present at New Biloxi it may not have been considered worth
documenting. Smallpox is a viral disease, most commonly transmitted by inhalation,
which breeds in the mucus of the nose and mouth and spreads to the blood stream
(Sherman 2007). Initial symptoms are fever-like but are soon accompanied by a rash of
small raised bumps. Of those afflicted with the virus, some 25% would succumb to it, and
the remaining survivors would be immune to future outbreaks (Sherman 2007).

Lice

Typhus is a bacterial infection most commonly spread by lice. The bacterium
resides in the intestinal tract of the louse, eventually killing its host, and is transmitted to
humans through the contact of lice excrement and open wounds or abraded skin (often
caused by simply scratching a bite) (Barnes 2005). Lice operate opportunistically and
will leave their current host when a “better” one becomes available. Close living
conditions and poor hygiene are the two major contributors to typhus, and, historically,
epidemics have occurred in populations in prisons, aboard ships, in city slums, and in
military encampments (Barnes 2005). The condition of the human host at infection often
determined the likelihood that one would survive the infection. Typhus is transmitted
though the bloodstream, with the small blood vessels of the heart, liver, gastrointestinal
tract, and lungs being first affected. A fever also quickly afflicts the affected, as well as a telltale rash that covers the majority of the body and lasts the duration of the fever. Disease fatalities often ranged from 10% to 60%, depending almost completely upon the nutritional and physical condition of the host (Barnes 2005).

Conclusions

Infectious disease, malnutrition, infection, trauma, high infant mortality, and low life expectancy are often the price city residents, in the Old World and New, payed for their cosmopolitan dwellings, particularly among city dwellers in the colonies. In the Biloxi settlement, colonists were likely living with any number of diseases, especially given the haphazard and unstable conditions. While the historical record is relatively silent on specific cases of disease at the colony, what is clear is that this settlement on the banks of the Gulf Coast, in the winter and summer months, had attempted to support a population beyond the carrying capacity of the resources available to them. Humans from all walks of life living cheek-by-jowl in what few structures, of unknown quality, that would have been available could have provided a perfect storm for illness and swift death.
CHAPTER III

ANALYSIS OF PALEOPATHOLOGICAL INDICATORS

When analyzing health, diet and disease are inextricably intertwined. Diet and disease typically interact in two principle ways (Roberts and Manchester 2007; Steckel and Rose 2002). Either dietary resources are insufficient and an individual’s immune system is compromised because of it, or dietary stress leads to specific dietary deficiencies (Roberts and Manchester 2007). Genetic predisposition (or susceptibility) is also an active agent in skeletal patterns of health, though one that is rarely able to be identified in the course of osteological analysis (Roberts and Manchester 2007). Skeletal manifestations of malnutrition and disease tend to be a reflection of both time and severity as both are necessary for observable pathologies to occur (Roberts and Manchester 2007; Steckel and Rose 2002).

In any paleopathologic analysis of interest to the researchers are rates of morbidity (incidence of disease) and mortality as seen by skeletal lesion frequencies and average age at death (among others) (Wood 1992). In identifying the presence of lesions, analysts will also attempt to determine their status as active or inactive (a possible indicator of cause of death or something in the process of healing) (Wood 1992). Interestingly, those individuals with any kind of lesion may be representative of the least frail within the mortuary population because, by evidencing observable pathologies, they had to have been able to survive with it for a prolonged period of time; this is referred to as the “Osteological Paradox” (Wood 1992). More general themes that relate to or directly affect disease frequency include migration, environment, economics, occupation, and methods of treatment (Roberts and Manchester 2007).
The following section is a combination of potential deficiencies and diseases affecting the Moran colonials. Each will be discussed in terms of clinical definition and literary reference to either the colony or comparative populations that prompt investigation. Skeletal manifestations, scoring systems, and differential diagnosis will all be discussed in materials and methods. In selecting comparative populations for this research, an attempt was made to focus on those French settlements in North America during the seventeenth and eighteenth centuries that provided both site background and a full paleopathological analysis of the assemblage. They include the St. Croix Island cemetery in Maine, 1604 (Crist 2005); St. Peter’s cemetery in New Orleans, 1725-1788 (Owsley and Orser 1984); and the Quebec City Fortification burials in Quebec, 1746-1747 (Cybulski 1988).

Indicators of Childhood Health

Malnutrition and disease exist, often synergistically, with those experiencing malnutrition more susceptible to disease (courtesy of a now weakened immune system) and those who have contracted disease potentially becoming malnourished because they cannot themselves access proper nutrients in their current state or, if able to access them, cannot properly absorb them (Larsen 1997; Roberts and Manchester 2007). When malnutrition and disease affect subadults they may also negatively affect patterns of growth (Larsen 1997; Roberts and Manchester 2007). In the course of paleopathological analysis, the examination of physiological disruption, or stress, is a centerpiece in the study of the general health of any population (Larsen 1997). Indicators of childhood stress may be observed as lesions on the bones and teeth, caused by disruption in growth, and assist in the evaluation of the adaptive success of a population (Carter 2004). An
effort is made to be aware of the limits of a single venue of data collection and analysis and supplement that information with additional osteological indicators such as, in this instance, the recording of Harris lines and hypoplastic defects (Danforth 1999; Shuler 2011). The following health conditions will be evaluated.

*Stature*

Metric measurements have been used in the description and analysis of human skeletal material since the earliest osteological studies (Buikstra and Ubelaker 1994: 69). Postcranial measurements, especially those derived for studies on stature, represent a significant portion of that research because they provide information on sex, age, nutrition, and behavior (Buikstra and Ubelaker 1994: 69). Derived stature estimates for a population assist in assessing the overall health of a group by comparing them to temporally and geographically concurrent assemblages (Roberts and Manchester 2007; Steckel and Rose 2002). Stature also serves as a measure of childhood health because individuals go through primary growth phases during infancy and adolescence (Larsen 1997; Steckel 1995). While the terminal height an individual may reach in adulthood is a combination of their genetics and environmental factors, studies conducted on stature indicate that while genes are certainly an active factor in the average height of a population, it is the environmental factors (especially access to nutrition) that allow individuals to reach that genetic potential (Steckel 1995). Additionally, sensitivity to negative determinates, such as malnutrition and disease, is influenced by age at occurrence (Steckel 1995: 1911). If these negative conditions are chronic they will eventually lead to stunted growth, though if restricted to early age an individual may, in adolescence, experience a period of catch-up growth (Steckel 1995). Stature can then
often additionally act as a measure of social status for groups of individuals, as socioeconomic status often correlates to availability of resources and quality of living conditions (Larsen 1997; Roberts and Manchester 2007; Steckel 1995).

Recent research into the variability of height estimates for an individual utilizing formulae drawn from the same reference population can vary markedly depending on the specific long bone used. For example, in an examination of prehistoric populations from the southeastern U.S., Shuler (2011) observed that the ulna consistently generated the greatest height estimate and the femur the lowest. Therefore the most reliable comparisons are made when the same element is used for all individuals. The femur is commonly utilized in stature estimates both because it displays the lowest SSE in regression formulae for long bones and because, being both large and dense, it is one of the most commonly recovered elements in archaeological settings (Shuler 2011; White and Folkens 2005). The femur is also incredibly prone to the effects of environmental stressors in terms of both stunting and catch-up growth (Shuler 2011).

**Linear Enamel Hypoplasias**

Tooth formation occurs within the maxilla and mandible with eruption occurring once formation is nearly complete (White and Folkens 2005). Enamel hypoplasias are the result of physiological stress induced disruptions in amelogenesis which produces visible defects in the dental enamel that typically manifest as either pits or horizontal lines on the anterior portion of the tooth, usually the incisors and canines (Goodman and Rose 1990; Roberts and Manchester 2007). Teeth, unlike other skeletal elements, are both more genetically stable in development (meaning there is less environmental influence), and once formed can only be altered by wear, fracture, or demineralization (Hillson 2009;
White and Folkens 2005). Enamel formation, or amelogenesis, begins at the occlusal apex and extends toward the cervicoenamel line (where the crown meets the root) (White and Folkens 2005). Because dental enamel is unable to remodel, these marks become a permanent feature of the tooth crown (Goodman and Rose 1990).

Linear enamel hypoplasias serve as an indicator of childhood stress precisely because they are formed in childhood (from birth to seven years for permanent dentition) (Steckel and Rose 2002: 23). Enamel hypoplasias are non-specific markers, meaning stresses ranging from chronic illness to weaning to a highly emotional event that affected the individual enough to manifest physically, could cause such marks (Goodman and Rose 1990; Roberts and Manchester 2007; Steckel and Rose 2002). It should be noted that enamel defects can also be genetic, non-systematic defects are easily identifiable (Goodman and Rose 1990).

Last, and additionally under consideration, within the scope of indicators of childhood health, is the knowledge that even in utero the environment may dictate an individual’s risk for disease as an adult. Occasionally, for example, enamel hypoplasias are observed on deciduous dentition, which begins formation in utero at about five months (Buikstra and Ubelaker 1994). In these instances it is believed that the child may have undergone prenatal physiological stress, potentially stemming from the mother being malnourished or from “abnormal events during gestation” (Goodman and Rose 1990: 85). A hypothesis by Barker (1994) suggests that stress undergone during gestation may correlate to adult health problems especially diabetes, cardiovascular disease, hypertension, and breast cancer (Barker 1994; Rich-Edwards and Gillman 1997). In clinical cases this stress tends to most clearly manifest in a high infant mortality rate
and low birth weight in living births and correlates, in some measure, to socioeconomic status (Barker 1994; McCance 1994; Rich-Edwards and Gillman 1997).

Dental Disease

Human dentition provides a wealth of information about the diet, health, occupation, and culture of the population under analysis (Larsen 1997; Roberts and Manchester 2007). The teeth are also the part of the skeleton most likely to survive in archaeological contexts courtesy of the strength of the dental enamel matrix (Larsen 1997; Roberts and Manchester 2007). As a result, diseases of the teeth and surrounding bone are among the most commonly recorded pathologies in archaeological assemblages (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Many dental diseases occur in tandem with one another, as one disease will typically serve as a vector though which others arise (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Dental diseases are categorized, more specifically, as being either infectious or degenerative in nature (Roberts and Manchester 2007).

Infectious Disease of Dentition

Dental problems observed in archeological assemblages tend to reflect subsistence strategy and/or food preparation/processing (Roberts and Manchester 2007). The most common dental disease is dental caries (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Dental caries are infections of the tooth that, left untreated, can lead to the complete destruction and loss of the tooth (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Caries can occur as opacities on the tooth surface or as cavities, ranging from slight to extreme, sometimes resulting in the complete destruction of the tooth crown (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Caries are
directly related to diets high in sugar and/or carbohydrates (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). As bacteria occurs on and around the teeth in the form of plaque, acids are produced that affect the enamel matrix creating opacities and/or porosities that may vary in size (Hillson 2008; Larsen, 1997; Roberts and Manchester 2007). Additionally, periodontal disease can result in resorption of the gum line, leaving the dentition open to the development of plaque where the crown of the tooth meets the root (the cement-enamel junction) (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Dental wear (attrition) can also lead to the formation of carious lesions if severe enough (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). The areas most affected by caries are those that allow for this accumulation of bacteria: the crown of the tooth (especially molars were food residue may get trapped between cusps), between teeth, and along the gum line (especially if the individual is already host to a periodontal disease such as gingivitis) (Roberts and Manchester 2007).

Sex and social status can also be determining factors in the rate of caries observed on both the level of the individual and population (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Both are bound by implications for differential access to certain types of subsistence (Roberts and Manchester 2007). Socially, arguments for both a higher caries rate (courtesy of better access to high sucrose foods) and lower caries rates (courtesy of better access to protein) may be made for those of higher status (Roberts and Manchester 2007). Research focusing on European populations in the modern era seems to indicate, however, that here a lower caries rate is more likely to be observed among those of higher socioeconomic status due to higher protein consumption (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). As with all paleopathological research, an
atypical rate (either high or low) observed within the population would need to be considered with other associated osteological indicators before a difference in status was speculated.

A major limitation in caries recording is its association with antemortem tooth loss attributable to dental abscesses (Roberts and Manchester 2007). Abscesses are pockets of pus and bacteria that collect and eventually lead to a drainage hole in the surrounding bone (Roberts and Manchester 2007). They typically result from a cavity that has gotten near the tooth root (or from rapid tooth wear) which opens up the pulp cavity and exposes the individual to infectious bacteria from the outside (Hillson 2008; Larsen 1997; Roberts and Manchester 2007).

Periodontal disease begins with inflammation of the soft-tissue gum line and can lead to resorption of the alveolar bone (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). In the course of a soft-tissue infection transferring to the underlying bone, the lining of the tooth socket is reduced in “a trench-like removal of bone [from] around the cervix of a tooth” (Hillson 2008: 321). Signs of pitting, loss of bone density, and evidence of new bone growth may all assist in the accurate identification of periodontal disease (Larsen 1997; Roberts and Manchester 2007). Periodontal disease is intrinsically tied to the presences of dental calculus and where calculus rates are high periodontal disease follows in tandem (Roberts and Manchester 2007). As the surrounding bone is lost so is the periodontal ligament keeping local dentition in place, and as the bone and connective tissues continue to diminish (exposing more of the tooth root) the dentition can be lost antemortem (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Unfortunately, the observation and scoring of periodontal disease is
made difficult by the fragile nature of the surrounding alveolar bone, which can be easily fragmented by both taphonomic damage in-situ and by the excavation process (Larsen 1997).

**Degenerative Disease**

Among the degenerative dental diseases antemortem tooth loss and resorption maxillary and mandibular alveolar processes are the most frequent manifestations and correspond with increased prevalence to age (Roberts and Manchester 2007). While the primary contributors to antemortem tooth loss are periodontal disease, caries, and abscesses, the mouth, and teeth more specifically, are often additionally utilized for functions outside of food processing (including pipe holding and as a third hand in the course of occupational activities), and as an individual ages the likelihood that dentition will be loss courtesy of one or more of the factors increases (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). The only way to diagnose tooth loss as antemortem is to observe it in tandem with healing (resorption) of the tooth socket (Roberts and Manchester 2007).

Though periodontal disease that has become transmitted to the bone can result in alveolar bone loss, age alone can result in this as well (Hillson 2008). Bone is constantly remodeling throughout the life of an individual and the bones of the mouth are no exception to this. As the alveolar processes remodel, they force the teeth sockets upward, causing them to become more shallow (Hillson 2008). This process appears to occur in rate to the severity of tooth wear that an individual has attained, with more worn teeth associated with more bone remodeling (Hillson 2008). Interestingly, this does not result in antemortem tooth loss without a source of infection (caries or periodontal disease)
acting in tandem, thereby allowing observations of degenerative dental disease to serve as an indicator of dental health (Hillson 2008).

Metabolic Disorders

Metabolic disorders, generally any atypical skeletal manifestation owing to dietary deficiency or excess, are an indicator of stress (Roberts and Manchester 2007: 221-222). Given that the historical record is brimming with references to the spartan subsistence at the colony, indicators of dietary excess such as gout, the crystallization of uric acid around the joints causing inflammation and related to excess, and diffuse idiopathic skeletal hyperostosis, or DISH, the calcification along the sides of the vertebrae visually reminiscent of dripping candle wax and related to prolonged periods of inactivity/immobility, will not be included in this analysis (Miles 2008; Roberts and Manchester 2007). Dietary deficiency, or nutritional stress, like any infectious disease, needs a period of existence to manifest skeletally. Those who succumbed to the famine at New Biloxi, depending on the duration of time they were malnourished but still alive, may exhibit nutritional stress skeletally. Those colonists, soldiers, and sailors who found themselves in a state of dietary distress and managed to survive likely found themselves both vitamin and protein deficient.

Scurvy and Rickets

Deficiencies in Vitamin C primarily occur when individuals are deprived of nutrient rich fresh fruits and uncooked vegetables (Barnes 2005; Roberts and Manchester 2007). Vitamin C is necessary for the synthesis of collagen and the absorption of iron, the lack of which can lead to joint aches, a compromised immune system, and anemia (Barnes 2005). If treated, symptoms of this nutrient privation will begin to abate almost
immediately. If left unchecked, however, it will develop into scurvy (Barnes 2005). In individuals with scurvy, the continued disruption in the synthesis of collagen weakens the body’s connective tissues, manifesting in the form of bleeding gums, loss of teeth, and the loss of bone minerals, resulting in fragility particularly in the spine (Barnes 2005: 324). Skeletal manifestations that may be observed in the course of a paleopathological analysis include bone growth (as a response to subperiostial bleeding), periodontal disease and premature (or atypical antemortem) tooth loss, and lesions (reactive bone growth) on the crania manifesting in the eye orbits, on the cranial vault, and on the greater wing of the sphenoid bone, though it should be noted that the validity of these cranial indicators is currently in contestation (Roberts and Manchester 2007: 237).

Additionally, Crist (2005) presents the possibility that an osseous response to Vitamin C deficiency may manifest on the transverse processes of the cervical vertebrae (Crist 2005). As the case becomes more severe, eventually the sub-periosteal surfaces of long bones will become affected and result in ossified hematomas where this has occurred (Mays 2008). Bony changes indicative of hemorrhage are also evidenced in infantile scurvy, though in the form of porosities on both the cranial and postcranial skeleton courtesy, it is supposed, of a localized inflammatory response (Mays 2008).

There is debate among paleopathologists as to whether or not these non-documented conditions be used as diagnostic criteria to report cases of infantile scurvy; however, this will not be discussed in detail here, as the only evidence of an infant within the Moran population is from recovered juvenile dentition (Mays 2008). Scurvy that continues unabated will usually result in death (Barnes 2005). And scurvy was indeed present at the Louisiana colony, at least among the soldiers, as seen in the correspondence
between administrative officials Cadillac and Pontchartrain who, in 1713, detailed the circumstances of a midwife being fined for refusing to care for those afflicted as she believed the disease to be contagious (Baker 1995). In 1713 the colonial military presence, and therefore this particular incident, would have been centralized in Mobile. However, given how poorly supplied the military remained, even after relocation to Biloxi, recent historical precedents may be treated as potentially reoccurring themes.

Vitamin D deficiencies, most commonly caused by a lack of access to sunlight, is a possibility for this population given the length of time many of them were confined indoors awaiting transportation and then in the cargo area of the ships in the process of transportation. Additionally, many potentially lived in cities with shadowed areas outside and worked long hours inside of buildings. Colloquially referred to as rickets, this is a disease that typically affects children during periods of rapid growth (Barnes 2005).

Rickets, defined by Roberts and Manchester (2007: 237) as “the interruption in development and mineralization in the growth plates,” occurs, then, only during periods of bone growth and is, therefore, only a childhood disease. Manifestations of Vitamin D deficiency in adults are clinically referred to as osteomalacia and are the result of interrupted bone mineralization (Roberts and Manchester 2007).

Osseous responses to Vitamin D deficiencies can be classified as being either the result of direct metabolic insult or the result of mechanically induced deformation caused by inadequately mineralized bone (Mays 2008). Those bony changes caused by metabolic disturbance manifest from poor mineralization during growth (Mays 2008). Deficiently mineralized bone is laid down at the epiphyseal ends and results in porosity of the bone cortex because it contains unmineralized osteoids (Mays 2008). These porosities, and
evidence of any healing, can be observed by radiograph (Mays 2008). In the case of rickets (Vitamin D deficiency during childhood growth), mechanical stressors acting upon these softened bones can result in bending of the diaphysis of the lower long bones, as they are not structurally stable enough to bear the weight of the upper body, and the condition may be diagnosed from this characteristic “bowing” (Mays 2008). In the course of recovery the bone will remodel, with any evidence of a remnant deformity depending entirely on the severity of the nutritional insult, with most cases resulting in observable residual deformity (Mays 2008). Typical locations include the scapular spine and neck of the femur (Mays 2008).

Both rickets and osteomalacia are caused by an insufficient intake in Vitamin D, which is necessary for the absorption of calcium and phosphorus and the mineralization of the organic matrix of bone and cartilage (Barnes 2005; Roberts and Manchester 2007). Because adult bone tissue is constantly remodeling in life, with new cells regularly being created and older ones destroyed, the body is constantly in demand for this tripartite of calcium, phosphorus, and Vitamin D. When deficiencies in the latter occur, this typically results in the bowing of the leg bones, as they can no longer adequately bear the weight of the upper body, and the skeletal structure becomes extremely susceptible to fractures (Barnes 2005). There is a noted lack of any mention of either rickets, in the case of children born in or brought to La Louisiane, or of a temporally equivalent colloquialism for osteomalacia in the literature pertaining to disease within the Louisiana colony. However, given the large number of forced immigrants, the French government’s preferred means of capture, followed by imprisonment in France and an Atlantic
crossing, it is entirely possible that some found themselves confined indoors (essentially)
for such a period of time as to facilitate a Vitamin D deficiency.

Anemia

Anemia is “a deficiency in red blood cells or the hemoglobin they contain” and is
either genetic (as with thalassemia and sickle cell anemia) or acquired (Walker 2009:
110). Typically acquired anemia manifests from vitamin deficiency, blood loss, and/or
malabsorption of nutrients and takes more specific types as being iron-deficiency,
hemolytic, or megaloblastic (Walker 2009). Studies of iron-deficiency anemia, thought to
be the most prevalent type of anemia, have tended to focus on both the bioavailability of
iron, to speculate on cultural and dietary factors potentially contributing to a positive
diagnosis, and on skeletal manifestations of the deficiency, particularly porotic
hyperostosis (Larsen 1997; Roberts and Manchester 2007; Stuart-Macadam 1989).

Iron is necessary for the production of red blood cells, as it is a vital component of
the hemoglobin within those cells (Larsen 1997; Stuart-Macadam 1989; Walker 2009).
Because hemoglobin transports oxygen from the respiratory system to the body tissues,
adequate iron absorption is necessary for many body functions (Larsen 1997; Stuart-
Macadam 1989). Iron deficiency typically manifests from nutritional inadequacy and/or
malabsorption, though Stuart-Macadam (1992) has speculated that iron-deficiency
anemia may additionally manifest as an adaptive response to pathogens, as an iron
deficient, or hypoferremic, host would be unable to support the iron needs of the invading
pathogen resulting, ultimately, in the survival of the individual (Larsen 1997; Stuart-
Macadam 1989; Walker et al. 2009). The association of iron-deficiency anemia and a
skeletal response was firmly established in the 1950s and later dubbed porotic hyperostosis by Angel in 1966 (Stuart-Macadam 1989).

Porotic hyperostosis (PH) are skeletal lesions of the cranial vault that are “spongy” in appearance and tend to focus on the frontal, parietal, and occipital bones (Larsen 1997; Roberts and Manchester 2007; Walker 2009). These lesions form when the body becomes anemic, and those areas that produce red blood cells, such as the diploe of the crania, expand in an effort to increase red blood cell production to adequate levels (Roberts and Manchester 2007). As the diploe (the area between the inner and outer tables of the cranial vault) increases, it does so at the expense of the cranial vault, which will begin to resorb, and results in a porous (or “spongy”) appearance (Walker 2009: 109; Walker 1986). Active lesions of PH are typically observed in juveniles younger than age five, with remodeled or healed lesions commonly observed in adults, and is observed in greatest frequency among highly sedentary, or urban, populations (Larsen 1997).

Unfortunately, the clinical literature is without a clearly established connection between iron-deficiency anemia and manifest symptoms, as many individuals who are iron deficient are also asymptomatic (Stuart-Macadam 1989). Recently Walker (2009) has argued for a different interpretation of anemia based skeletal response, maintaining that anemia based in iron deficiency is incapable of producing an osseous response, that is itself reflective of increased red blood cell production, because the body first needs iron to create red blood cells, making any mass production impossible. Instead, nutritional megaloblastic anemia, caused by inadequate meat consumption (where vitamin B12 is typically found), and megaloblastic anemia courtesy of parasitic infection are argued by Walker (2009) to be the primary causes of PH in the New World.
Iron-deficiency anemia results from an inadequate supply of iron to bone marrow, where red blood cells are created (Uthman 1998). Red blood cells are then unable to synthesize the hemoglobin molecules they carry, which results in a decrease in the amount of hemoglobin in each red blood cell, causing them to diminish in both color and size (Uthman 1998). Because mature red blood cells have no DNA or mitochondria, they cannot reproduce and lack a major energy source, making their sole purpose the transportation of hemoglobin (Uthman 1998). The synthesis of hemoglobin begins early in the development of the cell, and without it the cell cannot exist (Uthman 1998). In time, hemoglobin production is reduced, red blood cell count diminishes in concert, and plasma levels increase in an attempt to compensate for the deficit (Uthman 1998). At this stage, an osseous response to iron-deficiency is not possible.

Megaloblastic anemia, a severe form of vitamin deficient anemia, is typically caused by a deficiency, through intake and/or absorption, of vitamins B12 and/or B6, C, E, folic acid, riboflavin, pantothenic acid, and thiamin (Uthman 1998). Both vitamin B12 and folic acid are just as vitally necessary for the production of healthy red blood cells as iron, as they directly affect the development of the nuclei through DNA synthesis (Uthman 1998). Despite the fact that cells are struggling with a slowly maturing nuclei, they are continuing RNA synthesis normally, which allows the cell to grow abnormally large before mitosis and increases the likelihood that it will die before leaving the bone marrow (Uthman 1998). Macrocytes, abnormally large mature red blood cells, are diagnostic of megaloblastic anemia, can result in marrow hypertrophy of the cranial diploe as the spongy bone expands in an effort to accommodate the production of the unusually large cells (Uthman 1998).
Hemolytic anemia is the premature destruction of red blood cells and can be inherited, as with thalassemia and sickle cell anemia, or acquired (Uthman 1998). The onset of the condition is marked by an increase in the production of red blood cells, and corresponding bone marrow expansion, as the body attempts to compensate for the premature destruction of red blood cells (Uthman 1998). Hemolytic anemia differs from both iron-deficiency and megaloblastic anemia in that there is no disruption in the production of healthy red blood cells (Uthman 1998). Factors leading to acquired hemolytic anemia include exposure to toxins, such as lead; infections, such as *M. pneumonia*; trauma, especially repetitive low-level trauma such as distance running; and cancers of the blood, such as leukemia (Uthman 1998).

While Walker (2009: 112) are quick to note that the osseous response for megaloblastic and hemolytic anemia would be visually identical despite their different etiologies, and speculate at length on the possibility that New World PH is a manifestation of megaloblastic anemia, no mention is made of the possibility of hemolytic expression or theories offered concerning manifestations of PH in the Old World. Courtesy of an imperfect understanding of how iron is rationed to red blood cells to allow for hemoglobin synthesis, I remain unconvinced that chronic low-grade anemia, in which hemoglobin levels remain just slightly below normal for an extended period of time, could not result in an osseous response of the diploe as the body attempts to compensate for red blood cells with below average hemoglobin levels by simply creating more of them. Additionally, if megaloblastic anemia is responsible for the majority of New World PH, then perhaps hemolytic anemia, by way of pneumonia and trauma, is responsible for observations of PH in the Old World. Ultimately, until a specific
understanding of the etiology of this response is forthcoming, any PH attributable to anemia can only be done in the vaguest way possible. In the course of this research, manifestations of PH, discussed in more detail in the materials and methods chapter, will be attributed only to anemia and not to a more specific typology.

Infectious Disease

Infections are the result of bacteria, viruses, fungi, and / or parasites with an individual’s chance of contraction being variable by age, sex, genetic inheritance, current health status, and nutrition (Roberts and Manchester 2007: 167). Diseases, the resulting effect of an organism impairing bodily functions, are commonly classified in a variety of ways depending on transmission. Zoonotic (transfer from an animal to human host), water-borne, air-borne, and oral-fecal diseases all increased in prevalence as human groups became more sedentary, often living in closer proximity to animals, and in correspondingly less sanitary conditions as systematic regulation of human and animal waste did not occur until the last century (Cohen 1989). Infection does not always result in disease, as this progression is contingent on a host of variables such as transmission route, health of the host, and strength of the pathogen (Larsen 1997: 64). Typically, if an infection escalates to a disease, the result is the death of the host, which usually occurs soon after contraction (Larsen 1997). If, however, a disease becomes chronic, it can then transfer to the bone in a manifest osseous response that is either non-specific (or general) or specific in nature (Larsen 1997; Roberts and Manchester 2007).

Nonspecific Infection

The bony lesions produced by bacterial infections are non-specific in that there is really no way to differentiate between them by observation and/or analysis of the skeletal
response, though pathogenic DNA testing does offer one option (Roberts and Manchester 2007). In modern populations the bacteria most likely to infect human hosts and generate a pathological response in the bone are streptococci and pneumococci (Roberts and Manchester 2007: 168). Skeletal responses to this infection first affect the periosteum but may progress to the cortical bone and, ultimately, the medullary cavity (Larsen 1997). Existing on a continuum, among manifestations of nonspecific infection periostitis (infection of the periosteum) is the least severe and osteomyelitis (infection of the medullary cavity) is the most, with other nonspecific osseous responses to infection including sinusitis and middle ear and mastoid infection (Larsen 1997; Roberts and Manchester 2007).

Periostitis is, broadly, inflammation of the bone surface (Larsen 1997; Roberts and Manchester 2007). This can occur by both infection and traumatic injury as both will “elicit bone production by stimulating the osteoblasts lining the subperiosteum” (Larsen 1997: 83). This response manifests as lesions characterized by light pitting and striated (or woven) new bone deposition on the original surface (Roberts and Manchester 2007: 172). As an observed paleopathology, periostitis is a rather common occurrence, rarely resulting in death as it is often localized to a specific area on a single bone, though prevalence does vary according to temporal context and culture (Larsen 1997; Roberts and Manchester 2007). Periostitis typically manifests in the form of “fine pitting, longitudinal striations, and, eventually, plaque-like new bone formation” (Roberts and Manchester 2007: 172; Larsen 1997). This bone formation is produced by stimulation of the osteoblasts lining the subperiosteum that surrounds the bone cortex and resulting
lesions are visibly delineated by observation of both characteristic attributes, distinguishable boundaries, and/or irregularly elevated cortical surface (Larsen 1997: 83).

The most commonly affected bone by far is the tibia, with suggested reasons ranging from a cooler surface area, courtesy of its proximity to the skin surface; inactivity at the area, leading to bacterial colonization; and from the ability of blood to stagnate in the lower leg, also allowing for the accumulation of bacteria (Roberts and Manchester 2007: 172). Additionally, males have a tendency to display periostitis more than their female counterparts, largely regardless of culture and temporal context, which is believed to be due, at least in part, to the female ability to withstand vectors of infection better (Roberts and Manchester 2007: 173). That being said, males are also generally more likely to be involved in activities that could produce injury (Larsen 1997). While evidence of infection can be, and often is, localized, it can also be widespread if the infection is systemic in nature (Larsen 1997). Healed infection can be visually distinguished from active in that it appears as an irregular mass and, though incorporated into the bone cortex, with a somewhat raised surface (Larsen 1997). While infection from periostitis is rarely fatal, osteomyelitis, while still being nonspecific in nature, is often systemic and can cause death if the infection spreads to the organs (Larsen 1997).

Osteomyelitis, as an infection that penetrates the medullary cavity, is an osseous response characterized by both bone repair and destruction (Roberts and Manchester 2007). Because the infection affects the bone surface, the same osteoblastic “repair” response occurring with periostitis is seen here as well (Roberts and Manchester 2007). This process is progressed by the development of mature compact bone (from the original deposition of striated bone) that successfully encases the original bone surface (Roberts
and Manchester 2007: 169). Destruction of the bone occurs to both the bone surface and in the form of a sinus, called a cloaca, that penetrates all layers of the compact bone and allows pus to drain from the middle cavity (Roberts and Manchester 2007). The result of both these repair and destruction processes occurring simultaneously is that the affected bone often becomes enlarged and deformed in the process (Larsen 1997; Roberts and Manchester 2007). Methods of infection include blood-borne bacterial transmission (probably from throat, ear, sinuses, or chest) and through generalized trauma (Roberts and Manchester 2007: 169-172). Those bones most likely to become infected include the knee, distal tibia, and proximal femur (Roberts and Manchester 2007: 172).

Osteomyelitis manifests on an element with both periosteal and endosteal bone production (Larsen 1997). Typically diagnosed by the presence of one, or more, cloaca, a sinus that forms as a way for pus to exit the medullary cavity, osteomyelitis is most commonly caused by the microorganism, *Staphylococcus aureus* (Larsen 1997; Roberts and Manchester 2007). Surface destruction of the cortex is often seen as pitting and irregularity of bony growth, though the affected section, or whole bone, tends to seem swollen in appearance courtesy of both the restriction of the medullary cavity though the endosteal bone production that takes place and through bone formation processes (Roberts and Manchester 2007). In the course of infection osteoblastic activity produces new, woven, bone that is laid down beneath the periosteum (Roberts and Manchester 2007). As the woven bone becomes mature, compact bone the original cortical surface becomes encased in this new bone layer, called the involucrum (Roberts and Manchester 2007). In extreme circumstance the original bone may die and this tissue, called sequestrum, may pass through the cloaca leaving the new layer the only true structural
support of that element (Roberts and Manchester 2007). The infection is transmitted via the circulatory system and often those elements, and/or specific areas of a given element, with numerous blood vessels are found to be the most likely to bear evidence of inflammation (Roberts and Manchester 2007).

Sinusitis, an osseous response to infection of the nasal sinuses, has no discernable etiology (Miles 2008). Because the nasal sinuses are hollow cavities in the bones of the face, they are capable of harboring mucus induced bacterial infections brought about by atmospheric pollutants as well as bearing the infectious brunt of upper respiratory infections (Roberts and Manchester 2007). Infections can occur directly from abscesses or be a chronic condition that manifests in the form of bony lesions (Miles 2008). In urban areas the rate of sinusitis increases, and this is correlated to an increase in exposure to both internal (e.g., wood fueled fires and house dust) and external (e.g., allergens and/or fumes and contaminants from various task labors) pollutants (Roberts and Manchester 2007). Sinusitis typically manifests as small to large pitting within the cavity, potentially indicative of an infection active at death, as well as evidence of healed infection in the form of new bone formation (Roberts and Manchester 2007). Lesions tend to be bilateral and can be designated as active or healing/healed given the presence, or absence, of new bone growth (Roberts and Manchester 2007).

Lastly, middle ear and mastoid infections are localized responses to infection that begins in the middle ear (Roberts and Manchester 2007). Unfortunately, the bones of the inner ear are both incredibly small and situated by soft tissue, and so are prone to postmortem loss or destruction in archaeological contexts (Roberts and Manchester 2007). If an abscess forms in the course of a severe middle ear infection and penetrates
the surrounding bone it is capable of producing a mastoid infection (this may be done by something as simple as a vigorous nose blow) (Roberts and Manchester 2007). Mastoiditis, left unchecked, will also lead to the production of an abscess through which pus drains (Roberts and Manchester 2007). If this abscess drains externally, it will often heal (while cases of drainage into the skull likely proved fatal) (Roberts and Manchester 2007). Intrinsic and extrinsic factors such as heredity, environment, and poor sanitation are assumed to be the causative factors in infection rate (Roberts and Manchester 2007).

Specific Infections

Specific infections are signaled by bony lesions for which, by distribution or physical attribute, the causative micro-organism is known (Mays 1998; Roberts and Manchester 2007). Because it is necessary for infection to become a chronic condition within the host, only a handful of diseases are known to produce skeletal manifestations (essentially, those in which the individual neither immediately dies nor recovers) (Roberts and Manchester 2007). It is therefore critical for researchers to take the form and distribution of bony lesions into account in the course of their analysis (Roberts and Manchester 2007). Infections known to generate an osseous response over time, and of applicable interest to an eighteenth-century French colonial settlement, include treponemal disease, tuberculosis, and smallpox osteomyelitis (Ortner 2008; Roberts and Manchester 2007).

Treponemal disease is recognized in the four forms of venereal syphilis, endemic syphilis, yaws and pinta with all but pinta resulting in skeletal lesions (Larsen 1997). The pathogens responsible are Treponema pallidum pallidum, T. pallidum endemicum, T. pallidum pertenue, and T. careteum respectively (Larsen 1997; Ortner 2008; Roberts and
Manchester 2007). Infection is introduced into the body via skin or mucus membranes (Larsen 1997: 94). The venereal form is transmitted during contact with lesions that form on the genitals (Larsen 1997). Endemic syphilis and yaws are typically acquired during childhood by open wound exposure and contact with an infected individual (Ortner 2008). While all three forms can be congenital conditions, this is typically seen only with the venereal variant (Ortner 2008). Syphilis (both venereal and endemic) and yaws begin with inflammation of the soft tissue that is then transmitted to the bones, and typically those bones with the least overlying soft tissue are the most severely affected (Roberts and Manchester 2007: 207). Venereal syphilis becomes the most severe in its final stages, involving both the circulatory and central nervous systems (Roberts and Manchester 2007). Due to the considerable similarity in skeletal manifestations between the three forms, and because pathogens are capable of mutating between forms, it is not possible to distinguish between them in the course of diagnosis, even with the use of pathogenic DNA (Larsen 1997; Ortner 2008; Roberts and Manchester 2007).

Skeletal indicators of venereal syphilis, one of the three forms of treponemal disease that affect the skeleton, will be the focus of the analysis for this specific infection because of the nature, including both the temporal and cultural context, of the Moran assemblage. Venereal syphilis typically manifests on those bone surfaces nearest the skin including the cranial vault, forearm, and lower leg (Larsen 1997; Ortner 2008; Roberts and Manchester 2007). Lesions on the skull, commonly affecting the frontal and parietal bones, appear as “crater-like” with a central foci and reactive bone growth on the lesion margins (Ortner 2008: 205). These lesions, *caries sicca*, are also characteristically described as being “worm-eaten” in appearance and often serve as the criteria by which a
positive diagnosis is reached (Roberts and Manchester 2007:210). Reactive bone formation, evidenced by inflammation from either periostitis or, if severe enough, osteomyelitis, is commonly observed on long bone diaphyseal surfaces, especially of the forearm, and occurs in tandem with, and surrounding, destructive lesions (Ortner 2008). The type of bone in evidence around these lesions, either woven or compact, can reflect the nature of the disease as being either onset, if woven, or chronic, if compact (Ortner 2008).

Venereal syphilis can also severely affect the joints, especially the knee (Ortner 2008). Because syphilis affects the central nervous system in its final stages, the resulting loss of sensation to some of the extremities can cause infections of the joints to become particularly severe (Ortner 2008). Congenital syphilis, venereal syphilis that passes from an infected mother to her child, also has a possibility of existing within the Moran population. While many of the clinical features in evidence with typical manifestations of treponemal disease are also characteristic of congenital cases, the latter involves specific defects of the dentition as a result of the bacteria influencing the developmental processes of the fetus (Ortner 2008). Distinctive features of the dentition include notched incisors, called Hutchinson’s incisors, and mulberry and moon molars (Ortner 2008). Episodes of bone formation and remodeling also readily affect the lower leg and characteristically manifest as hypertrophy of the anterior tibia, a phenomenon referred to as “saber-shinning” (Larsen 1997: 94).

Tuberculosis (TB) is caused by the bacilli *Mycobacterium tuberculosis* and *M. bovis* (Larsen 1997). Transmission is typically airborne with an infected host expunging tubercle bacilli into the air onto a surface; bacilli are capable of surviving outside a host
for an extended period of time (Roberts and Manchester 2007). The manner of
transmission lends to children being the most frequently infected and to TB being a
disease of urban populations (Larsen 1997; Roberts and Manchester 2007). Soft tissue
changes that initially result from infection are largely related to how the bacillus enters
the body (Roberts and Manchester 2007). Because *M. tuberculosis* is often an airborne
illness, most cases begin though the respiratory tract with the primary infection occurring
in the lungs (Larsen 1997). Alternatively, *M. bovis*, a strain affecting other mammals as
well as humans, tends to begin in the stomach and intestinal tract, believed to result, in
large part, from the consumption of contaminated milk (Roberts and Manchester
2007:187). Tuberculosis begins as a primary infection that, over time, can become
secondary if the infection was latent and was then reactivated; at this point the bacterium
can spread to the skeletal system via the circulatory system (Larsen 1997; Roberts and
Manchester 2007).

Manifestations on the skeletal system, with the advent of the condition becoming
chronic, tends to be focused in the blood producing marrow and cancellous bone in the
form of osteomyelitis (Larsen 1997: 100; Roberts and Manchester 2007). This
osteomyelitic activity, focused at the epiphyseal ends of the long bones, lends to the
transmission of the infection to the joints and “producing septic arthritis” where the joint
surfaces are destroyed to the point of being fixed in placed (Roberts and Manchester
2007: 187). Any joint in the body may be affected, with the knee and hip being the most
commonly affected though this may also be produced by severe cases of arthritis or
osteomyelitis and presence of a fixed joint, or ankylosis, is not enough to make a
diagnosis (Larsen 1997; Ortner 2008; Roberts and Manchester 2007). Typical sites of
secondary infection include the bones of the thoracic cavity including the ribs, vertebrae, and sternum (Larsen 1997). Lesions on the inferior aspect of the rib are often associated with tuberculosis, but as their exact etiology is unknown they are not enough to prompt a positive diagnosis (Larsen 1997).

Vertebral involvement is considered the diagnostic pathological feature of tuberculosis, with most manifestations occurring in the upper thoracic and lower lumbar vertebrae (Roberts and Manchester 2007). Involvement usually includes abscess formation from within the vertebral body which then drains into the chest cavity and weakens the structural integrity of the vertebral body mass (Roberts and Manchester 2007). Because cancellous bone is so disturbed, vertebral bodies severely affected by the loss of bone mass can collapse, resulting in a condition called “Pott’s disease” (Larsen 1997: 100). Additionally, tuberculosis can manifest in the rhinomaxillary region in the form of bone destruction and on the inner table of the cranial vault (Ortner 2008: 199). These skeletal lesions, evidenced either in tandem or, in the case of sufficiently numerous vertebral lesions or pathologies, being diagnostic in nature will be used to identify the presence of tuberculosis in the Moran population through differential diagnosis.

Smallpox is one of the few viral infections that can result in skeletal lesions (Ortner 2008). Transmission is airborne, and infection will progress from soft tissue to bone only if an individual contracts the disease during a childhood growth period and survives the infection (Ortner 2008). However, as with tuberculosis, because of the manner of transfer children are the most often affected (Miles 2008: 133). Termed smallpox osteomyelitis, the condition, appearing to directly affect the growth plates, is marked by a periosteal reaction of the long bones epiphyses (Miles 2008; Waldron 2009).
Smallpox osteomyelitis tends to be localized in the elbow joint (Ortner 2008). The distal humerus typically evidences bilateral osteomyelitis and is usually visibly enlarged as a result (Miles 2008). The infection travels into the joint from the pus draining cloacae, then affecting the proximal ends of the radius and ulna (Miles 2008). The elbow being affected in this way, especially bilaterally, is in fact diagnostic of the condition (Ortner 2008). This particular patterning of lesions, occurring at this joint specifically, are so rare in non-smallpox infections that an accurate diagnosis is likely (Ortner 2008).

Unfortunately, this is the only known evidence of this disease existing archaeologically (Miles 2008).

Degenerative Joint Disease

The human skeleton contains three types of joints, classified by joint movement and anatomy: synarthrosis (fixed joint), amphiarthrosis (minor movement), and diarthroses (free movement) (Roberts and Manchester 2007: 134). Amphiarthrodial and diarthrodial joints are most affected by degenerative joint disease, a phenomenon that may occur due to age, wear, immune deficiency, and metabolic insult, and it increases exponentially in statistical likelihood after age 45 (Larsen 1997; Roberts and Manchester 2007: 133). Specific degenerative disorders affecting these joint types include osteophytosis and osteoarthritis, respectively, with osteoarthritis (OA) being the most common and subsuming spinal joint disease induced by stress (age and/or wear) (Larsen 1997; Roberts and Manchester 2007).

Osteoarthritis

Osteoarthritis is a non-inflammatory disease involving the degeneration of bone at the synovial joints (Larsen 1997; Roberts and Manchester 2007). The prevalence and
severity of OA appear to be dependent on factors such as age, genetic predisposition, climate, weight, and sex (Larsen 1997; Roberts and Manchester 2007). The single most contributive factor to the development of OA, however, is mechanical stress and physical activity (Larsen 1997: 163). While the likelihood of OA increases around the mid-40s, because it is ultimately a stress-induced phenomenon, there is considerable variation in age at onset among populations, with some young adults showing manifestations of the degenerative disease (Larsen 1997). Skeletal manifestations of osteoarthritis are the result of processes by which bone may be gained, lost, or both (Roberts and Manchester 2007).

Bone formation occurs in the form of osteophytes, spurs, found on the joint surface or around its borders, and as bone newly deposited in the periosteum (Roberts and Manchester, 2007). Bone formation is typically characteristic of the body attempting to compensate for the amount of stress being placed on the joint (Roberts and Manchester 2007). The destruction of cartilage in the synovial joints allows for bone on bone friction, which can result in an ivory-like shine to the area of contact known as eburnation and the destruction of the original articular surface (Larsen 1997; Roberts and Manchester 2007). Vertebral osteoarthritis is the result of stress-induced rupture of the intervertebral discs, which prompts bony growth around the borders of the vertebral bodies, a condition called osteophytosis (Larsen 1997; Roberts and Manchester 2007). The greater the stress, and more serious the subsequent rupture, the more severe the osseous response (Roberts and Manchester 2007). In the most severe cases the osteophytes will lengthen toward one another to the point of fusion, effectively fusing the vertebral bodies together as well (Roberts and Manchester 2007).
Osteoarthritis has a characteristic patterning that arises from the destruction of articular cartilage of the synovial joints (Bridges 1992). Skeletal transformations occurring from osteoarthritis take a diagnostic form as bony growth around a joint surface and/or bone erosion on a joint surface (Larsen 1997: 165). Bony projections localized around a joint surface, called osteophytes, vary in shape and density from being “tuft-like, barely perceptible protrusions to large projections of spiculated bone” (Larsen 1997: 165-166). Osteophytes occurring on the spine can sometimes fuse the vertebral bodies together, diminishing the intervertebral disk space between vertebral bodies and affecting spinal mobility (Larsen 1997). If the cartilaginous joint separating the bodies begins to deteriorate, a condition called spondylosis, the superior and inferior aspects of the bodies will evidence porosities (Roberts and Manchester 2007). Some joint surfaces are marked by pitting or reduction, a sign that the cartilage typically acting as a barrier between the two surfaces has been compromised in some way (Larsen 1997).

Trauma

Trauma, an injury or wound to bodily tissue, is one of the most frequently occurring recorded pathologies within archaeological assemblages (Bennike 2008; Larsen 1997; Lovell 2008; Roberts and Manchester 2007; Walker 2001). Information on forms of trauma evident within and between populations lends to our understanding of both how people are interacting with one another and their environment (Lovell 2008). Additionally, changes in patterns of trauma over time and across geographic boundaries assist in better understanding human everyday activities such as trade, recreational pursuits, and even clothing fashions and how they may affect the body (Miles et al. 2008; Roberts and Manchester 2007). Types of trauma may be subdivided into anywhere from
Fractures

Fractures are identified as a break, either complete or partial, in the skeletal tissue and constitute the vast majority of traumatic injuries to the skeleton (Bennike 2008: 310; Roberts and Manchester 2007). Fractures present in archaeological collections are often initially classified in terms of when they occurred in relation to time of death (Larsen 1997; Lovell 2008; Roberts and Manchester 2007; Walker 2001). Antemortem fractures are injuries that took place before death and are identified as such because they show evidence of healing in the form of new bone growth (Larsen 1997; Lovell 2008; Roberts and Manchester 2007; Walker 2001). Fractures that show no sign of healing are deemed perimortem, or occurring around time of death (Larsen 1997; Lovell 2008; Roberts and Manchester 2007; Walker 2001). Finally, postmortem fractures are those that resulted from taphonomic processes and, potentially, recovery methods and are normally diagnosed by the lighter coloring of the bone at the break site (Larsen 1997; Lovell 2008; Roberts and Manchester 2007; Walker 2001). By focusing on the type, location, and patterning of fractures, paleopathologists are able to make inferences about human behavior (Larsen 1997; Lovell 2008; Roberts and Manchester 2007; Walker 2001).

All fractures may be classified as being either simple (open) or compound (closed) (Lovell 2008; Roberts and Manchester 2007). The distinction between the two is a connection between the fracture and the external skin, either by a fracture end piercing
the skin in the course of breaking or by the manner of trauma piercing the skin before causing damage to the bone (Roberts and Manchester 2007). This connection allows bacteria to enter the fracture site and cause infection (Roberts and Manchester 2007). Skeletal evidence of this may be found when osteomyelitis occurs in tandem with the healed break (Roberts and Manchester 2007). Further classification of fracture type varies by both discipline and author, so those types that most occur with violent and accidental injury will be discussed in the sections below.

**Violent Trauma**

The designation “violent” is applied to trauma that displays evidence, by location and patterning, of malevolent intent (Walker 2001: 576). The majority of the paleopathological literature concerning violent trauma is dominated by cases studies of atypical manifestations including projectile wounds (both arrow and gunshot), decapitation, scalping, and cranial injury (Larsen 1997: 119). More recent shifts to population-oriented approaches allow for a better understanding of both inter- and intra-site violence and indicate trends such as violence tending to be influenced by environmental stressors, such as resource scarcity (Larsen 1997: 118). Violent trauma seen archaeologically can be categorized into projectile, sharp, and blunt trauma (Larsen 1997; Lovell 2008; Roberts and Manchester 2007). And the majority of identifiable violent trauma, identified both in the course of paleopathological analysis and observed as a global trend, is focused on the head and face (Larsen 1997; Lovell 2008; Roberts and Manchester 2007; Walker 2001).

Traumatic injury to the skull is generally thought to represent, more so than any other skeletal element, evidence of interpersonal aggression or violent trauma because the
most common fractures affecting the cranium are caused by direct trauma (Lovell 2008; Roberts and Manchester 2007). Injuries to the skull are both common in archaeological assemblages and tend to result from hand-to-hand combat (Roberts and Manchester 2007). Cranial injuries are typically focused on the frontal, parietal, zygomatic, nasal bones, and mandible with the last two likely indicative of fist-fighting (Lovell 2008; Roberts and Manchester 2007). Facial fractures of the mandible tend to focus at the mandibular angle, sometimes resulting in ankylosis of the temporomandibular joint (Lovell 2008). Injury to the jaw includes the possibility of damage, and a resulting infection, to the teeth (Lovell 2008). The bones of the cranial vault tend to display more evidence of violent conflict, potentially because the aggressor was attempting to inflict maximum damage (Roberts and Manchester 2007: 109).

Fracture patterns observed on the skull are subjected to such variables as implementation of a weapon, location on the skull of the injury, the force and direction of the object of impact, physical characteristics of the scalp and hair, and even if the individual was stationary or in motion at the time the trauma occurred (Lovell 2008; Roberts and Manchester 2007). The most common fracture pattern observed is one caused by “low-velocity” injuries that are characteristically described as being linear, usually caused by blunt force trauma; depressed, typically caused by accidental falls on a raised surface or blunt force trauma; penetrating, caused by sharp and/or projectile trauma; or a combination of these types of injuries (Lovell 2008; Roberts and Manchester 2007: 109-110). Sharp trauma, the result of an edged weapon, typically manifests as a kind of “cutting” mark (Roberts and Manchester 2007: 111).
Blunt force trauma can be identified by the presence of concentric fractures, a fracture pattern that radiates outward from a common center (Roberts and Manchester 2007). Projectile trauma is rarely observed in the archaeological record (Roberts and Manchester 2007). In instances of projectile trauma, manifestations of injury may allow for accurate speculation of the type of weapon used to produce it (Roberts and Manchester 2007). Cranial injuries resulting from indirect impact are uncommon and tend to be accidental in nature, such as falling from a height (Lovell 2008). Successfully attributing trauma to interpersonal violence on the post-cranial skeleton is made difficult because of the many and varied ways humans accidentally hurt themselves (Lovell 2008). The ribs and, potentially, proximal ulnar diaphysis are the two post-cranial areas/elements where injury may be the result of deliberate violence (Lovell 2008). Fracture of the proximal ulna, usually occurring with dislocation of the radial head, may be sustained in the course of using the arms to protect the head in an attempt to deflect blows (Lovell 2008). Other, more general, post-cranial fracture patterns as evidence of trauma are interpreted based on location and fracture type as resulting from accidental activities including falling and crushing injuries. Additional fracture patterns commonly associated with violent trauma are linear (or transverse) fractures appearing as a horizontal break across the bone, comminuted fractures in which the cortex is fractured into multiple pieces, and compound fractures in which a fracture correlates with open skin (Lovell 2008; Roberts and Manchester 2007).

**Accidental Trauma**

Accidental, or unplanned, trauma is believed to be generally indicative of living conditions and daily hazards faced by a population (Larsen 1997; Walker 2001). In
observing and ultimately categorizing trauma as accidental, injuries must be considered within the context of the population with which they are associated (Walker 2001: 578). Patterns and frequencies of accidental injury tend to reflect subsistence strategy, sex, and age (Larsen 1997). Global patterns of sedentism, often occurring in tandem with agriculture, reflect trends of lower leg accidental trauma (Larsen 1997). Postmenopausal adult females tend to exhibit higher frequencies of unintentional trauma, especially to the femoral neck, as a result of age-related bone loss, while adult males tend to sustain more injuries than their female counterparts because of cultural norms that involve males participating in activities more likely to result in trauma than their female counterparts (Larsen 1997; Walker 2001). Paleopathologists and clinicians have identified repeated patterns of unintentional trauma, including fracture, muscle tear, and dislocation, as most commonly occurring to the clavicle, upper arm, wrist, hip, and lower leg (Larsen 1997; Lovell 2008; Walker 2001).

Repeated or regularly observed fracture patterns have undergone attempted reconstruction in an effort to delineate their causes; for example, fractures of the distal radius which are believed to most commonly occur when an individual is attempting to break a fall (Colles’ fractures) (Larsen 1997: 110). Parry fractures of the middle/distal ulna, once believed to be exclusively obtained in the act of self-defense, are now generally considered accidental unless they coincide with some of evidence of violent injury, especially to the head (Larsen 1997; Walker 2001). Lytic (or destructive) lesions associated with muscle tear or strain are alternative forms of accidental injury (Roberts and Manchester 2007). Additionally, common observations of cortical defects resulting from mechanically induced muscle stress include stress produced by tears of the deltoid
and adductor muscles (Roberts and Manchester 2007). More specific patterns of muscle stimulated stress are typically categorized as Markers of Occupational Stress and will be discussed in more detail below (Capasso 1999; Hawkey and Merbs 1995; Larsen 1997; Roberts and Manchester 2007). A third type of traumatic lesion is dislocation and involves “loss of contact between two osseous surfaces which are normally a joint” (Roberts and Manchester 2007: 120). Dislocations may be full or partial and commonly occur in conjunction with a fracture, especially when the causative factor of trauma is falling (Roberts and Manchester 2007). Because the only way to diagnose a dislocation in an archaeological context is to observe the skeletal effects that result from the lack of alignment, such as the formation of a new joint surface, dislocations are not commonly identified (Roberts and Manchester 2007).

**Markers of Occupational Stress**

Markers of Occupational Stress (MOS) are alterations to the skeleton that can be traced to patterns of activity (Capasso 1999). These changes can occur as either distinctive morphologies or true pathologies, and their observation and analysis lends to the ability to deduce, potentially, occupation (Capasso 1999). Often, however, MOS occur as a suite of morphologies that, taken wholesale, suggest a range of potential behaviors rather than a specific work-related bony response (Capasso 1999). That these non-metric traits exist is explained by a theory on bone adaptation called “Wolff’s Law” (1892) that posits bone is adaptive, either increasing or decreasing in mass, to the stress put upon it (Roberts and Manchester 2007: 144; Larsen 1997). Markers of Occupational Stress range from changes observed to a complete element, especially in relation to its opposite side if a paired bone, to more specific bony changes believed to be indicative of
a specific repetitive activity or suite of activities associated with a specific occupation and/or occupation type, such as manual labor (Capasso 1999; Kennedy 1989; Roberts and Manchester 2007).

These markers tend to occur within a characteristic patterning, resulting from repetitive extrinsic stressors, which are indicative of a type of labor, such as manual (Roberts and Manchester 2007). This patterning includes “non-metric traits,” such as squatting facets of the anterior distal tibia, where the osseous response is one of accommodation to repetitive movement; reconstructions of osteoarthritic patterning, where the arthritic activity is manifest in such a way that it is deemed labor, rather than age, related; unilateral bone hypertrophy, where the length, width, circumference, and/or density of a bone seems indicative of disproportionate mechanical stress; and instances of accidental trauma where the fractures type and location have been interpreted being occupation related (Roberts and Manchester 2007: 144).

Research on the patterning of functional adaptive changes, or non-metric markers of occupational stress, is rooted in the ethnographic and clinical literature and includes modifications attributable to lifestyle, culture, and temporal context (Kennedy 1989). Corsetry, for example, can result in the inward curvature of the distal sternum and flattened and twisted ribs resulting from stress and imposed immobility on the thoracic cavity (Kennedy 1989). Occupational markers evidenced by osteoarthritis of the joints and spine are often correlated to ethnographic accounts in an effort to reconstruct what activities are responsible for the observed arthritis at the site (Roberts and Manchester 2007).
The dominant activities affecting the joints of the upper body tend to focus on the shoulder and are attributed to heavy lifting and repetitive movement, such as paddling (Kennedy 1989). Occupational osteoarthritis on the lower body tends to focus on the knee and is thought to result from keeping the knees flexed in a stooping position, this is referred to as “miner’s knee” (Kennedy 1989: 156). Research on the asymmetry of limb bone size has focused on assessing the arm bones in general and the frequency of right-hand dominance in prehistory more specifically (Roberts and Manchester 2007). The upper limbs are more readily accepted for this analysis because there is less variation in activity and because lower limb asymmetry is more variable (Roberts and Manchester 2007). Traumatic markers are typically fractures attributable to sudden or reoccurring stress (Kennedy 1989). Schmorl’s nodes, defects ranging from slight indentions to sizable holes found in the center of the vertebral body, most typically in the lower thoracic and lumbar regions, and are usually associated with disc herniation; they are thought to be the result of “flexion and lateral bending” and are commonly found in paleopathological analyses among both hunter-gatherer groups and soldiers (Kennedy 1989: 139). Markers of Occupational Stress utilize differential diagnosis, rather than a scoring system, to identify pathologies. Skeletal manifestations of MOS that are deemed likely candidates for the population, given the age, presumed occupation, and cultural context of the individuals will be discussed in the section on materials and methods.

Musculoskeletal Stress Markers

Musculoskeletal stress markers (MSM) are stress-induced changes that occur at the muscle, tendon, and ligament attachment sites to the periosteum and bone (Capasso 1999; Hawkey and Merbs 1995; Wilczak 2004). As stress is put on a muscle, usually by
repetitive activity, the blood supply to the periosteum intensifies and creates an osseous response of hypertrophy, or atypical robusticity, at the muscle attachment site (Hawkey and Merbs 1995). This phenomenon is another explained by Wolff’s Law, justifying how bone formation and resorption will follow use (Hawkey and Merbs 1995; Wilczak 2004). The size and robusticity of the muscle attachment sites is also affected by age, sex, and body size with older males and larger bodied individuals (of both sexes) typically having larger MSMs (Lieverse 2009: 495). When demographic information is properly taken into account, however, it is possible to not only ascertain level or degree of activity but also, potentially, to delineate the specific repetitive movements responsible for the visible robusticity at particular sites (Capasso 1999; Hawkey and Merbs 1995; Lieverse 2009; Wilczak 2004). At present two methods of scoring MSM are available for implementation in the course of analysis: the methods outlined by Hawkey and Merbs (1995) in the course of their work on the Northwest Hudson Bay Thule Project and the methods outlined by Villotte (2006) in an attempt to make MSM scoring more comparable to clinical literature.

The Hawkey and Merbs (1995) scoring system differentiates between four different types of osseous response that may result from activity-induced stress including robusticity of muscle attachment sites, robusticity of tendon attachment sites, stress lesions, and ossification exostosis (Hawkey and Merbs 1995). Robusticity of muscle and tendinous attachment sites is detailing the severity of bone formation and/or resorption as a response to mechanical loading, while noting that attachment site type will affect response, as muscles “require a more substantial attachment area to prevent rupture” (Hawkey and Merbs 1995: 329). Stress lesions manifest as depressions into the bone as a
result of recurrent low-level trauma, while ossification exostosis is the formation of new bone at a site as a result of a major traumatic injury to the site, such as a muscle rupture (Hawkey and Merb, 1995:329). The emphasis in their study was the upper extremities and the subsequent analysis focused on the 46 musculoskeletal stress markers found on the bones of the arm (humerus, radius, and ulna) and shoulder girdle (scapula and clavicle) (Hawkey and Merbs 1995). The primary criticisms of the Hawkey and Merbs (1995) method are that it makes no attempt to differentiate between healthy and pathological markers, is too simplistic in its approach, and underutilizes the clinical literature (Villotte 2006).

The Villotte (2006) scoring system focuses on four groups of stress markers, with the first three (and the thrust of the research) being fibrocartilaginous insertions and the last being fibrous insertions that are little understood and/or poorly documented (Villotte 2006). Villotte justifies the concentration on fibrocartilaginous insertions, only numbering 18 total and covering the entire postcranial skeleton, by arguing that with the majority of the available clinical literature focusing on this particular type of skeletal attachment site paleopathologists must follow suit because it is from the clinicians that we develop an understanding of the distinctions between healthy and pathological sites (Villotte 2006). Furthermore, without this distinction any subsequent analysis is both arbitrary and, in lacking a solid standardization, impairs an interpretation of activity based on those markers (Villotte 2006). Criticisms of the Villotte (2006) method come from both the limited number of sites recorded and the confusion that may result from employing a more complex method than is utilized in the now traditional Hawkey and Merbs (1995) method.
Criticisms of attempting to interpret activity patterns, and especially specific activities, center on the lack of clinical evidence available to support these theories (Jurmain 1999). In his review of this phenomenon within the discipline, Jurmain (1999: 150) cites Kennedy’s (1989) list of occupational markers as an example of contemporary research lacking evaluative rigor and scientific standards. Jurmain (1999: 183) continues by adamantly advocating for increased interaction between paleopathologists and clinicians, citing studies where this has proved successful. Trends do exist within paleopathology, as in any discipline, and attempting to employ osteological indicators to recreate past activities is certainly a major one right now. However, those with allegations of circular arguments and censure concerning the lack of clinical underpinnings in this line of research must also bear in mind the limits imposed when working within this discipline. Clinicians tending not to work in hypothetical situations and paleopathologists, out of shear necessity, needing to possess some degree of imagination are two that appear to be well met at the corner of musculoskeletal and stress-markers.

Neoplastic Conditions

Neoplastic conditions, or tumors, are traditionally classified as being either benign or malignant and are typed as such in accordance with the type of tissue of which they are composed and the ability to metastasize (Ortner 2003; White 2011). Benign tumors are typically asymptomatic and generally not harmful, being on average small and lacking the ability to spread, unless their size or position in the body proves deleterious to normal body functioning (Aufderheide and Rodríguez-Martín 1998; Waldron 2009). Malignant tumors, on the other hand, pose a dual threat to the body in their ability both to destroy
tissue in a localized area and to spread to others (Aufderheide and Rodríguez-Martín 1998; Waldron 2009). Neoplastic conditions in general result from oncogenes, or genes found in mammals that facilitate the malfunction of the proteins that control the division of cells, thus turning normal cells into ones with unregulated growth (Aufderheide and Rodríguez-Martín 1998; Waldron 2009). Disposition to tumors of any kind is influenced by heredity, environment, and lifestyle, as well as age and sex depending on the type of tumor (Ortner 2003; Waldron 2009).

The identification of tumor presence, type, and etiology in archaeological remains is extraordinarily difficult and for a number of reasons (Aufderheide and Rodríguez-Martín 1998; Ortner 2003). Firstly, while certain malignant neoplastic conditions will originate on bone, skeletal tumors generally originate from other areas of the body, leaving paleopathologists without a primary site for attempting diagnosis (Aufderheide and Rodríguez-Martín 1998; Ortner 2003). Additionally, secondary tumors are far more likely to affect older demographics, so populations without this age grade well represented are unlikely to be observed (Aufderheide and Rodríguez-Martín 1998; Ortner 2003). Benign tumors, however, are regularly identified in archaeological specimens and among them osteomas are fairly common (Ortner 2003; White 2011). Typically occurring on the outer cranial vault they appear as dense well defined bone growths and are often termed button osteomas for this reason (Ortner 2003). Ear exostoses is another common benign tumor found in archaeological material and results from growth in the lateral end of the external auditory meatus (Aufderheide and Rodríguez-Martín 1998). While the observation of neoplastic conditions in the Moran population is unlikely, given that factors involved in their presence is in part genetic, environmental, and/or lifestyle
choices, the presence of such a condition has the potential to compliment this analysis by offering another interesting glimpse into the lives of these colonists.

Congenital Disease

Congenital diseases or anomalies are abnormalities that develop beginning in utero and manifesting more noticeably at birth or in the following infant growth phase, and affect the soft tissues and/or the skeletal system (Roberts and Manchester 2007). These defects may range from slight to severe and can sometimes result in natural miscarriages if the abnormality affects fetal development too severely (Barnes 2008; Roberts and Manchester 2007). The vast majority of congenital anomalies are caused by intrinsic genetic factors with mutation(s) occurring from genetic traits, being hereditary in nature, or being extrinsic environmental factors (Barnes 2008; Roberts and Manchester 2007). Influences on the mother that may result in developmental anomalies include prenatal viral infections (syphilis, measles, mumps, and rubella); self-medication, including alcohol and narcotics; and chemicals, such as mercury which was historically used in the treatment of smallpox (Barnes 2008; Porter 2002; Roberts and Manchester 2007). If more than one area of development is affected, the defects will be classified as associated and labeled a syndrome (Barnes 2008).

Typically congenital diseases occur during times of development of, what Barnes (2008: 330) refers to as, “critical threshold events” for the developing embryo, the delay or alteration of which then results in anomalous growth (Roberts and Manchester 2007). Skeletally some the most commonly observed congenital malformations include cleft palate, spina bifida occulta, achondroplasia, and club foot (Roberts and Manchester 2007: 55).
The following section will focus on congenital defects of the vertebral column and ribs with an emphasis on etiology by differential diagnosis. Possibilities for segmentation failure and resulting synostosis include Klippel-Feil Syndrome (KFS), Fetal Alcohol Syndrome (FAS), Juvenile Rheumatoid Arthritis (JRA), and spontaneous fusion as a result of trauma (Horlyck and Rahbek 1974; Lowery 1977; Nguyen and Tyrrel 1993; Oxenham 2009; Thomsen et al. 1997; Tredwell et al. 1982).

As the base of the skull, or chondrocranium, develops, it can be genetically affected to an upwards or downwards shift of the occipitocervical border, with fusion of the first cervical vertebra to the base of the skull occurring as an expression of downward shifting (Barnes 2008). The developing vertebral column goes through a series of tissue formations as the notochord becomes, during this process, flanked by somitomeres that form segmented blocks or somites (Barnes 2008: 340). In the final stages of vertebral formation the somites fuse with gaps forming between them, later becoming the space for intervertebral discs (Barnes 2008: 346). If these gaps should fail to form, the result is segmented vertebrae (Barnes 2008).

**Klippel-Feil Syndrome**

Klippel-Feil Syndrome (KFS) is a genetic defect of the axial skeleton that manifests as the fusion of the cervical vertebrae. It was first clinically documented in 1912 by Maurice Klippel and André Feil in the examination of a short-necked French tailor (Gunderson 1967). Working similar clinical cases for most of the following decade, Feil diagnosed the syndrome as occurring in three primary types. The first, Type I, consists of mass block fusion of the cervical and thoracic vertebrae and is usually associated with other various developmental defects of both the soft and skeletal tissue
Type II is characterized by fusion of only a few vertebral segments, though it also includes the phenomenon of hemi-vertebrae and/or occipito-atlantal fusion (fusion of the first cervical vertebra to the occipital base). Finally, Type III includes mass blocks of cervical fusion and segmented fusion of thoracic, and sometimes lumbar, vertebrae (Gunderson 1967; Pany and Teschler-Nicola 2006). Type II is the most common of the three, occurring in approximately 1:40,000 to 1:42,000 births, and manifests genetically as an autosomal dominant trait in the fusion of the second and third cervical vertebrae and as an autosomal recessive trait in the fusion of the fifth and sixth vertebrae (Barnes 1994; Funkhouser 2011; Tracy 2004).

**Fetal Alcohol Syndrome**

Fetal Alcohol Syndrome (FAS) was recognized by English physicians in the seventeenth and eighteenth centuries as they began to recognize a correlation between alcoholic mothers and infants who displayed a low birth weight and/or developmental retardation (Tredwell 1982). Children who suffer from FAS all appear to be the result of alcohol abuse in at least the first trimester (and potentially between the 24th and 28th day of development more specifically) (Tredwell 1982: 334). Individuals with FAS tend toward a characteristic suite of traits including a delay in motor milestones, atypically small body size, and some degree of mental retardation (Tredwell 1982: 332). It is assumed by clinicians that many of the reported cases of Fetal Alcohol Syndrome are also often the most severe, leaving the true rate of occurrence speculative (Tredwell 1982). Literature focusing on the similarities between Klippel-Feil Syndrome and Fetal Alcohol Syndrome maintain that while the focalization of the synostosis tends to affect the cervical vertebrae more regularly, and often C2-C3 specifically, the disorders are separate
entities and by focusing on the associated anomalies of the two, an accurate diagnosis is possible (Lowry 1977; Tredwell 1982).

Numerous diseases are potentially present at Moran, and many of these have been studied in other fort and colonial populations. An effort was made to create the most appropriate context possible and, to this end, five comparative populations were used to better understand how observed rates of pathology relate to trends for the period. Ideally, a broad range of sites, occupations, living conditions, and access to resources will provide the best possible understanding of pathology within the Moran Cemetery.

Comparative Populations

*St. Croix Cemetery, 1604*

The site of St. Croix was initially documented in 1969 by researchers at Temple University and later revisited in 1992 and 2003 by the National Park Service. The 25 males interred at the site belonged to a French settlement that had been established on the island in 1604. The St. Croix Island cemetery, like the Moran cemetery, is primarily composed of young adult males, with most between ages 20-30. Also, the demographics of the two populations are extraordinarily similar, as the St. Croix expeditionary effort included laborers, clergymen, soldiers, and gentlemen. From the osteological and historical evidence available for the site, Crist (2005) concludes that the likely cause of

*St. Peter’s Cemetery, 1725-1788*

By contrast, St. Peter’s cemetery in the Vieux Carré, New Orleans, served as the city’s first official cemetery, active from 1725-1788. The site was rediscovered in 1984 and excavated by Douglas Owsley and Charles Orser that same year (Owsley and Orser 1984). A portion of the area had been disturbed over a decade earlier by construction,
leaving only 32 burials in the remaining area; the remains of 29 individuals were analyzed (Owsley and Orser 1984). Demographically, the skeletal sample is composed of 26 adults between the ages of 15 and 59 and three subadults (Owsley and Orser 1984). The population includes 14 males and 12 females (Owsley and Orser 1984). Ancestry was determined for 18 individuals, with 13 individuals identified as being of African descent, two of European, and three of mixed descent (Owsley and Orser 1984). The authors conclude that this assemblage is composed of individuals engaged in excessive physical labor and subsisting on a “highly cariogenic” diet (Owsley and Orser 1984: 165).

*Quebec City Fortifications, 1746-1747*

The Quebec City Fortifications’ series, discovered within the remaining fortification walls surrounding the city in the course of restoration efforts, was excavated in 1986-1987 by the Canadian Parks Service (Cybulski 1988). A total population of 50 individuals yielded 45 males, three to four females, and a single child, all believed to be English Protestant prisoners of war (Cybulski 1988). Ages ranged from late teens/early twenties to between 60 and 70 years for the males and late teens/early twenties to between 20 and 30 years for the females (Cybulski 1988). Research into the historical literature concerning the burials of these individuals into the Quebec City walls, by way of diaries written by the prisoners, revealed the presence of, specifically, fevers, consumption, dysentery, and scurvy among the incarcerated (Cybulski 1988: 81). Cybulski (1988) concludes that the deaths of these individuals are primarily attributable to their poor living conditions as prisoners.
St. Marylebone Cemetery, 1750-1854

St. Marylebone Cemetery, located in London, was excavated by the Archaeology Services of the London Museum first in 1992 and then again in 2003 (Miles 2008). The interment of the majority of the deceased in metal coffins allowed for relatively good preservation at the site (Miles 2008). In total the population numbers 301 individuals with, more specifically, 223 adults and 78 subadults (Miles 2008). The ratio of male to female interments displayed a slight male bias, with 105 males and 86 females among the 191 for whom sex could be determined, though as the report authors are quick to point out, given various cultural and biological factors this is not uncommon (Miles 2008: 104). Adult age at death rates indicate that the largest number of people died between 36 and 45 years old with a small number of young adults identified within the collection (Miles 2008). Conclusions concerning the population, reaffirmed when comparing it to other populations from London cemeteries, are that the assemblage is largely dominated by relatively high-status individuals (Miles 2008).

Conclusions

Paleopathological analysis is fraught with limitations (Roberts and Manchester 2007; Wood 1992). In their work on the Osteological Paradox, Wood and colleagues (1992) begin by stating that the only thing one can know for certain in researching a skeletal collection is that they are all dead (Wood 1992: 344). In the course of any analysis, the population under study may not be a representative sample of the living population, as at best the paleopathologist is working with a sample of a sample (Roberts and Manchester 2007: 12) especially in instances, like Moran, where it is possible that the entire burial ground has not yet been excavated. There are also potential issues with
selective mortality (Wood 1992). Paleopathologists analyze bony lesions that generally result from chronic conditions, which is potentially only a fraction of the number of actual cases present within the population (Wood 1992). Most individuals who contract severe infections die from them quickly, leaving an absence of osteological indicators (Larsen 1997; Roberts and Manchester 2007; Wood 1992). In observing bony lesions it is rare to be able to exact an etiology or even cause/manner of death (Roberts and Manchester 2007). That some lesions, fractures, and/or porosities are the result of postmortem damage further complicates the enterprise (Larsen 1997; Roberts and Manchester 2007; Wood 1992). Finally, issues also exist in both our understanding of the pathologies observed; Musculoskeletal Stress Markers are an excellent example of this, which, understandably, then limits our ability to extract any meaningful information from them (Larsen 1997; Roberts and Manchester 2007; Wood 1992).

These limitations aside, paleopathological analysis, the epitome of an interdisciplinary endeavor, effectually allows for the better understanding of human behavior, diet, and disease (especially over time) (Larsen 1997; Roberts and Manchester 2007). There are, in fact, instances where paleopathology, even with its limitations, not only best illustrates how humans interact with each other and their environment, but also provides the only direct evidence of those interactions (Roberts and Manchester 2007). Documentation of violence, for example, may be found in both in the historical literature and as a type of iconography, but the skeletal analysis of violent trauma is the only actual evidence of a physical conflict having happened (Roberts and Manchester 2007). Recent advances in technology are also allowing researchers to meet and overcome some of the disadvantages inherent in the discipline (Roberts and Manchester 2007). Because modern
media allows for the easy and expedient documentation and dissemination of data, analysts are able to seek second opinions, collaborate, and comment on work in a way that allows for more accurate diagnoses (Roberts and Manchester 2007). As long as researchers remain aware of the limitations of their work, the data generated by paleopathological analysis may remain a tool that allows for the best understanding possible of the biological nature of disease in human contexts (Roberts and Manchester 2007).
CHAPTER IV

THE MORAN FRENCH COLONIAL CEMETERY

Historical documents, archaeological investigation, and scientific analysis support the theory that the property now known as the Moran Site was clearly designated as a formal cemetery in the early years of the French colony, particularly the early eighteenth-century. The site (22HR511) is located on Porter Avenue in Biloxi, Mississippi, approximately 100 meters north of the modern shoreline of the Mississippi Sound and about 500 meters east of the city’s nineteenth-century “Old French Cemetery” (Figure 2). Freshwater springs feed a small stream that runs about 50 meters west of the Moran cemetery, which would account for the attractiveness of the site not only to colonial settlers but also to an earlier prehistoric Woodland Period occupation into which the burials intrude. Also, in the mid-nineteenth-century, the landmark Biloxi Lighthouse and lighthouse keeper’s house, the Dantzler residence, and the Biloxi Chamber of Commerce were located in the immediate environs of the site.

Figure 2. Approximate location of the Moran French Colonial Cemetery.
Site Background

The first record of the discovery of human skeletal remains in the area was a 1914 newspaper article reporting bones that were found on the property immediately to the south of the site during land grading (Biloxi Daily Herald, May 7, 1914; Carter 2004). The Biloxi Daily Herald additionally chronicled workmen discovering four skulls, and corresponding postcranial material, from individuals speculated by the media to be Native Americans, African slaves, or Portuguese pirates (The Biloxi Daily Herald, May 7, 1914; Carter 2004). The remains were reinterred and promptly forgotten.

Fifty-five years later, on August 17, 1969, Hurricane Camille hit the Mississippi Gulf Coast, and in the wake of its devastation, 12 to 13 burials were discovered beneath the art studio then situated on the property. After an investigation was conducted by anthropologists Richard Marshall and Dale Greenwell, the individual burials were left exposed so that they could be viewed through plexiglass panels in the floor of the art studio. For purposes of preservation, the bones were covered in shellac.

In 2003 faculty and graduate students from The University of Southern Mississippi were given permission to conduct an osteological analysis of the burials in situ. Eight burials were confirmed (four had been lost in the construction activity on the property), and findings generally corroborated those of the 1969 report, which were additionally supported by C-14 dating that yielded dates of 1450-1600 A.D. In 2005 Hurricane Katrina hit Biloxi, completely destroying the Moran Art Studio and adjacent family home, exposing additional interments. The University of Southern Mississippi assisted with the initial recovery of exposed bone, and then began a full excavation of the
entire property, including areas previously covered by modern concrete slab house foundations.

The excavation strategy implemented at the site was ultimately an effort intended to best facilitate the location and documentation of burials. A grid was established extending from the southwest corner of the site and meter wide trenches were excavated in an effort to effectively expose as much as possible. The location of trenches was determined by previously located burials and early investigation immediately following Hurricane Katrina utilized the original burials reported by Greenwell (2008) as a focal point from which to radiate out. Probing was not conducted in the course of trying to locate additional burials, as it was feared it would damage the remains. Once excavated, burials were pedestaled and measurements and a preliminary analysis conducted in situ. The delicate nature of the bones necessitated a stylized recovery method with the long bones and pelvis removed in the field and the cranium and thoracic cavity removed in blocks and excavated in the laboratory.

Mortuary Practices

Mortuary practices tend to be a broad amalgamation of philosophical-religious, social organization, circumstantial, and physical factors that may be more generally described as being either social or environmental in nature (Carr 1995). Burial customs differ in terms of internment style/type, body adornment, orientation, position of appendages, and accoutrements. These observable phenomena have the potential to assist our understanding of the social customs and, potentially, offers some sense of their world view both how that world is shaped and how they see themselves in it (Binford 1971).
Understanding normative social practices for the period provides a baseline for which to attempt to interpret atypical patterning and their potential etiology.

The principal and only state sanctioned religion of the period in the Southern Territories was Catholicism and generally the colonial burials reflected this (Puckle 1926). Interments are typically shroud burials, with either a cross laid over the chest or arms positioned to mimic a cross, and head oriented to the west (Puckle 1926). The Moran burials all displayed an interment style similar to this and were interred with arms crossed over the pelvis or thoracic cavity. Orientation, however, was frustratingly less uniform with three individuals placed head to the southeast, six with head to the north, and twelve with head to the south. A single individual, Burial 25, was interred extended and prone while all others were interred extended and supine. Only two individuals, Burials 26 and 30, were interred in coffins, with all others assumingly buried in simple shrouds. Burial 26 was, interestingly, also a stacked burial with two additional individuals located underneath the coffin of the first. Dubbed Burial 27A and B, the skull and lumbar vertebrae were missing from both poorly preserved individuals, possibly disturbed in the course of construction at the site (Cook 2011). In sum, the Moran mortuary program displays a demographic composition of primarily males and occurs in association with an apparent lack of systematic grid designation but with an evident regard for eighteenth-century stylistic tradition.

Artifacts

The few artifacts found in Moran Site burials are all typical eighteenth-century mortuary items: a brass crucifix and associated beads, copper shroud pins, a brass button, and hand-wrought coffin nails. The brass crucifix and associated beads, believed to
belong to a Catholic rosary, were found in the lumbar region of Burial 14. Comparable crucifixes were found at the Bloodhound site, a Tunica Indian site in Louisiana dating to circa 1700 to 1730 (Brain 1988), and Fort Michilimackinac, an 18th century French fort located on the straits connecting Lakes Huron and Michigan (Stone 1974). Forged iron nails whose depositional arrangement suggest a coffin configuration (though only two of the burials suggested a coffin) and brass straight pins with coiled-wire heads, probably used as shroud pins, are of typical eighteenth-century manufacture (Danforth 2013). A brass button with a plain convex crown and a flat-edge lip, concave back, and a U-shaped eye brazed to the back, also of typical eighteenth-century design, was found at the site (Danforth 2013).

The Skeletal Series

Excavations at the site in January and June of 2008 and January of 2009 increased the number of individuals associated with the Moran Cemetery to a total population of 31 burials. The preservation at the site is fair to poor (being, unfortunately, more poor than fair), due in large part to a combination of repeated flooding associated with the site’s proximity to the coast and considerable post-depositional damage from root growth, which has etched and bored into the bone. Reliable sex determination was possible for most individuals in the sample, but age determination was usually based only on tooth eruption, tooth wear, and suture closure.

As two of the burials contained additional internments, the Moran site has yielded a skeletal sample that consists of 29 adults, three adolescents, and one subadult. Demographically, the collection is composed of 25 males, two females, and six individuals of undetermined sex (including the subadult). Skeletal aging methods
employed both in the field and in the lab suggest that the ages of individuals (all but the subadult) appear between 15 and 50 years old.

In 2006 the stable isotope analysis was conducted for 23 individuals at the site (all burials that had been excavated to date). Page (2007) analyzed many samples recovered during surface collection as well as Burials 5, 6, and 14 and the Stable Isotope Laboratory at the University of Georgia evaluated Burials 16-23. The results of their work were used to reconstruct the colonial diet at the colony and, more specifically, attempt to determine the extent to which settlers were utilizing local resources to fulfill their dietary needs (Page 2007). Teeth and cortical bone were analyzed for various carbon and nitrogen signatures, with the results showing a C3 (non-maize) signature for all but one (Page 2007). Unfortunately, this may be more indicative of the speed with which colonists died upon arriving to the New World rather than a complete lack of maize consumption (Cook 2010; Page 2007). Results of the nitrogen testing were very similar, with only two outliers in the isotope study displaying high N15 values, which is indicative of protein obtained from a marine resource (Page 2007). This may be supported by literature that maintains the French immigrants rejected the marine resources available in the sound, although du Pratz (1975) notes that a number died from hypothermia gathering oysters in the water (Conrad 1970; Deiler 1969). Generally the immigrants favored deep sea fishes, such as cod, which again was a familiar part of their diet in France (Conrad 1970).

In addition to stable isotope analysis, selected individuals within the population who displayed morphological evidence of possible African or Native American ancestry were tested for ancestry using mtDNA (Cook 2011; Cook 2010). Determination of ancestry of those recovered from the site was of interest since health expectations would vary
enormously according to social division along racial lines (Cook 2011). Haplogroup findings suggested seven were European and one was indeterminate (likely European but the possibility of Native American could not be eliminated). Since mitochondrial cells are passed from mother to child (Ridley 2006), these results reveal these individuals had mothers of European ancestry (Cook 2011). Because the colonial social customs make it highly unlikely that a father would be non-European, it is inferred that the cemetery is composed entirely of Caucasians (Dawdy 2009).

Conclusions

The historical record offers numerous accounts of the limited resources, and disastrous consequences, of this overtaxing of the infrastructure at the New Biloxi settlement. Additionally, because the township of New Orleans was being built in tandem with the fortification efforts at Biloxi and because the engineered designs for Biloxi were, instead, implemented in New Orleans no legitimate effort was made to establish Biloxi as a secure settlement. Rather, Biloxi was the byproduct of a more organic process that arose out of sheer necessity rather than foresight and planning. Unfortunately, because there is a distinct possibility that only a portion of the original burial ground has been exhumed, this analysis reflects a random subsample of that population.
CHAPTER V
MATERIAL AND METHODS

The methodological suite of standards in analysis and reporting outlined in *The Backbone of History: Health and Nutrition in the Western Hemisphere* (Steckel and Rose 2002) was chosen for this research because of the recentness of the work, its comprehensive nature, and its broad acceptance in bioarchaeology. This compilation includes stature, hypoplasias, anemia, dental disease (including caries, or cavities, and abscesses), infection (localized and/or systemic), degenerative joint disease (arthritis), and trauma. Additional paleopathological markers used in this study were an evaluation of occupational stress, musculoskeletal stress markers, neoplastic conditions, and congenital disease for those individuals with adequate preservation. The analysis of the bone was conducted using measurements, observation of the bone surface, and radiographs. This research will compare the results of ancestrally similar and temporally concurrent assemblages.

Indicators of Childhood Health

*Stature*

Stature estimates obtained from skeletal collections utilized mathematical regression formulae that are, as much as possible, population-specific with measurements derived from long bones (Mays 1998; Shuler 2011). For the Moran Cemetery population, measurements were taken from the femur, tibia, and humerus, using an osteometric board and the methods found in *Standards for Data Collection from Human Skeletal Remains* (1994). Height was calculated using Trotter and Gleser’s (1958) stature formulae for White males and White females. Stature estimates derived from the Moran population
were then compared with contemporary populations from London (Angel 1976; Komlos and Francesco 2005; Miles 2008), France (Komlos and Francesco 2005), Quebec (Cybulski 1988), Ireland (Angel 1976), Maine (Crist 2005), and New Orleans (Owsley and Orser 1984).

Linear Enamel Hypoplasias

Growth defects in dental enamel serve as a permanent indicator of episodes of stress that an individual faced during childhood (Buikstra and Ubelaker 1994). Childhood health in the Moran series was assessed using the frequency and severity of hypoplastic defects with focus on the maxillary central incisors and mandibular canines, as they tend to be both the most vulnerable to hypoplasia formation (Goodman and Rose 1990). Criteria for presence is tactile, and severity was determined by measurement in width with anything less that 1mm designated slight to moderate and anything greater severe. A general notation of age at formation was made.

Dental Disease

The analysis of dentition within the sample will focus on the identification and analysis of carious lesions and antemortem tooth loss as infectious and degenerative dental diseases, respectively. Carious lesions, the most common type of dental disease, typically manifest as cavities that range in severity from slight to extreme (Hillson 2008; Larsen 1997; Roberts and Manchester 2007). Antemortem tooth loss is the most frequent manifestation of degenerative dental disease and can often be attributed to various lifestyle factors (Roberts and Manchester 2007).
Infectious Disease

Caries analysis requires observation of all available dentition for an individual, necessitating a detailed inventory first be created (Buikstra and Ubelaker 1994). In an effort to delineate the presence of the disease within the population, the number of total teeth observed must be reported in tandem with the number of caries and reporting be conducted in such a way as to differentiate between teeth lost pre- and postmortem (Buikstra and Ubelaker 1994: 54; Roberts and Manchester 2007).

Abscesses are identified by the presence of a drainage sinus running from the infected pulp chamber through the surrounding bone (Buikstra and Ubelaker 1994). Recording the occurrence of dental abscesses is made difficult by proximity of the alveolar bone to the tooth root, which lends to the ability of pseudosinuses to develop (Roberts and Manchester 2007). Healed (or rounded) edges may serve as evidence of a pre-mortem infection and, as such, assist in diagnosis (Roberts and Manchester 2007).

The scoring system outlined in Standards for Data Collection from Human Skeletal Remains (Buikstra and Ubelaker 1994) was utilized to identify and record the presence of dental abscesses within the Moran population. Reporting focused on teeth affected and location of the drainage as being either buccal or lingual.

Diagnosing periodontal disease in archaeological assemblages is made difficult by the multiple factors that may affect the distance between the surrounding bone and the cemento-enamel junction and so mimic periodontitis (Hillson 2008; Roberts and Manchester 2007). Periodontitis typically affects the molars, which are more prone to cavities and plaque accumulation, and commonly manifests in the loss of posterior dentition, resulting in a healed smooth surface where the tooth sockets were located and a
loss of height of the horizontal ramus (Hillson 2008). The appearance of these “irregular defects” (Hillson 2008: 321) indicative of active and/or episodic inflammation was used to suggest the presence of periodontal disease within the Moran population, and was scored in accordance with the grading classification put forth by Lukacas (1989) (Roberts and Manchester 2007).

**Degenerative Disease**

Antemortem tooth loss is thought to be primarily initiated by periodontal disease, though caries and abscesses may lead to tooth loss as well (Hillson 2009). Tooth loss can only be recognized as being antemortem by signs of healing around the edges of the surrounding alveolar bone or by complete resorption of the original tooth socket (Larsen 1997; Roberts and Manchester 2007). While this approach does exclude any dentition lost immediately before death, such losses are impossible to identify as being perimortem, rather than ante-, and so enable the possibility of an inflated rate of occurrence (Lukacas 1989). Rather than an implemented scoring system the dentition lost from those sockets that show signs of healing was counted as lost and rates of antemortem loss assessed and compared.

**Metabolic Disease**

Metabolic diseases was differentially diagnosed according to location and frequency of bony lesions known to be associated with the individual deficiencies.

Vitamin C deficiency was diagnosed by the presence of hematomas in the eye orbits, on the cranial vault, and on the greater wing of the sphenoid bone. Because hard palate and sub-gingival bone responses, as well as the cervical lesions, are undocumented in the clinical literature but do exist within archaeological case studies, when observed in
the course of analysis with the Moran population, their presence was documented; however, it did not serve as evidence of a positive diagnosis unless it occurred in tandem with the more widely accepted hematomas.

Vitamin D deficiency, manifest as either osteomalacia or healed rickets, was diagnosed by the observation of bowing deformities (Mays 2008). In adults the thoracic cavity is often affected by bending to the same extent as the lower long bones, especially the scapular spine (as buckling of the scapular body) and vertebrae (as compression of the vertebral bodies) and any observation of this was considered in the course of analysis (Mays 2008). Pseudofractures are defined here as “seams of unmineralized osteoid,” potentially arising from stress fractures unable to heal in the wake of the mineral deficiency, as defined by Mays (2008: 218).

Anemia was assessed within by the presence of porotic hyperostosis on only the frontal and parietals, as taphonomic damage disproportionately affecting the occipital makes differentiating between antemortem, perimortem, and postmortem porosity almost impossible. Degree of expression of the presence of porotic hyperostosis as well as thickening of the diploë on the frontal and parietal bones was scored in accordance with Standards (Buikstra and Ubelaker 1994). In the course of this analysis an effort was made to distinguish between active lesions, displaying “sharp edges and woven bone,” and healed ones, displaying “remodeled, sclerotic changes” (Buikstra and Ubelaker 1994: 121).
Infectious Disease

*Non-Specific Infection*

Currently, both the etiology of periosteal reactions and the validity of attempting to quantify such lesions in an attempt to make statements about general health is in contestation (Powell 1988; Rothschild and Rothschild 1996; Weston 2012). For this reason, periostitis was scored in this analysis but not in the complex coding manner recommended in *Standards of Data Collection for Human Remains* (Buikstra and Ubelaker 1994). Instead, bone formation location, status (active/healed), and level (slight, mild, severe) was noted.

Osteomyelitis observed within the Moran population was scored on all bones according to the suggestions in *Standards for Data Collection from Human Skeletal Remains* for abnormal bone formation and diagnosed by the presence of one or more cloacae (Buikstra and Ubelaker 1994).

Areas of the cranium were also examined for non-specific infection. A diagnosis of sinusitis was done by differential diagnosis, rather than using an ascribed scoring system. Observation of the paranasal sinuses was made on those individuals within the Moran population displaying fragmentation of the crania, which is common with the population given the low level of preservation. In tandem with observations of sinusitis was an investigation of signs of infection of the middle-ear and mastoids. Visual examinations of the presence of external physical manifestations including the enlargement of the external auditory meati, thinning of the anterior canal surface, and the presence of abscess that formed to allow for the discharge of pus was used to diagnose the presence of otitis media within the Moran population (Roberts and Manchester 2007).
Mastoiditis, caused by severe otitis media, was diagnosed differentially by the presence of a drainage sinus perforating either the external bone or internal vault (Roberts and Manchester 2007).

*Specific Infection*

Venereal and congenital syphilis were differentially diagnosed within the Moran population by observation of characteristic skeletal lesions. For venereal syphilis this includes affliction of the joints, especially the knee; episodes of bone formation and remodeling affecting the lower leg and characteristically manifest as hypertrophy of the anterior tibia, a phenomenon referred to as “saber-shinning”; and cranial lesions commonly affecting the frontal and parietal bones, referred to as “caries sicca” (Ortner 2008: 297; Roberts and Manchester 2007). Congenital syphilis was diagnosed by the presence of distinctive features of the dentition, including notched incisors, called Hutchinson’s incisors, and mulberry or Moon molars (Ortner 2008; Roberts and Manchester 2007).

Tuberculosis was diagnosed by the presence of septic arthritis, especially occurring in tandem with sites of secondary infection including the bones of the thoracic cavity, such as the ribs, vertebrae, and sternum; Pott’s Disease, a presentation of extrapulmonary tuberculosis that affects the spine; and manifestations in the rhinomaxillary region in the form of bone destruction and on the inner table of the cranial vault (Aufderheide and Rodríguez-Martín 1998).

Smallpox osteomyelitis was diagnosed in the population by the presence of bilateral osteomyelitis of the elbow joint, with the proximal ends of the radius and ulna affected (Jackes 1983).
Degenerative Joint Disease

Osteoarthritis

Analysis of degenerative joint disease within the Moran population focused on the six major appendicular joints (shoulder, elbow, hip, knee, wrist, and ankle) and vertebrae implementing recommendations from *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994) for both vertebral pathology and arthritis. While there is currently some discussion on the merits, or lack thereof, of traditional diagnosis, this research identified osteoarthritis through the presence of exophytic growth on the joint margins and erosion on joint surfaces (Larsen 1997; Waldron 2009). A positive diagnosis of osteoarthritis was given based on the presence of porosities, lipping, and eburnation.

Trauma

Traumatic injury was differentially diagnosed according to location and frequency of bony lesions known to be associated with the manifestation’s type.

Violent

Diagnoses of violent trauma included evidence of sharp or projectile trauma to the skull and postcranial elements and evidence of blunt force trauma to the skull.

Accidental

Accidental trauma was identified by the presence of those types of fracture most commonly associated with accidental trauma, especially falling, including comminuted fractures, compression fractures, impacted fractures, avulsion fractures, and transverse fractures (Roberts and Manchester 2007). Additionally, the observation of a dislocation,
though rarely identified in archaeological contexts, through the skeletal effects that result from a lack of alignment was considered a result of accidental trauma.

*Markers of Occupational Stress*

Markers of Occupational Stress were identified as patterning that includes non-metric traits, such as squatting facets of the anterior distal tibia, where the osseous response is one of accommodation to repetitive movement; reconstructions of osteoarthritic patterning, where the arthritic activity is manifest is such a way that it is deemed labor, rather than age, related; unilateral bone hypertrophy, where the length, width, circumference, and/or density of a bone seems indicative of disproportionate mechanical stress; and instances of accidental trauma where the fracture type and location have been interpreted as being occupation related (Kennedy 1989).

*Musculoskeletal Stress Markers*

The scoring system developed by Hawkey and Merbs (1995) was used to score muscle attachment sites of the upper extremities. Because the preservation is so variable within and between individuals in the Moran population, only the most prominent entheseal sites were selected for analysis. These include the costal tuberosity of the clavicle; the rotator cuff, deltoituberosity, and distal flexors/extensors of the humerus; the radial tuberosity, pronator teres, and supinator brevis of the radius; and the supinator crest, brachialis, and pronator quadratus of the ulna. Sites were first identified by type of response within a three aspect system scoring robusticity, osseous response, and stress lesion (Hawkey and Merbs 1995). Upon identifying which type of response was present at a site it was then scored as being without expression (0), faint (1), moderate (2), or strong (3) (Hawkey and Merbs 1995).
Neoplastic Conditions

Malignant Neoplastic Conditions

Long bone metaphyses were inspected for the presence of osteogenic sarcomas, diagnosed through the presence of lytic lesions of increased density which result in cortical penetration. Additionally, the presence of bone spiculation perpendicular to the bone surface, as a characteristic feature of lytic malignancy, was utilized to ascertain the presence of malignant tumors within the sample (Aufderheide and Rodríguez-Martín 1998).

Benign Tumors

Crania were inspected for benign tumors, which were identified by the presence of dense, well-defined bone growths or “button” osteomas. Auditory meati were also inspected for the presence of ear exostoses.

Congenital Disease

Klippel-Feil Syndrome

In attempting to diagnose Burial 23 as an example of Klippel-Feil Syndrome, the associated traits were compared to the compiled list of Type II traits developed by Pany and Teschler-Nicola (2007) and an attempt was made to ascertain both the presence of the “wasp-waist sign” as defined by Nguyen and Tyrrel (1993: 520) and the presence of atypically small intervertebral foramina (Funkhouser 2011).

Fetal Alcohol Syndrome

Physical manifestations of Fetal Alcohol Syndrome derived from clinical literature were compared to those that appear with KFS, and those associated anomalies that seem particular to FAS will be the focus of examination. Such anomalies include
syndactyly (fusion) of the fingers, hypertelorism (wide setting) of the eyes, hypoplasia of the facial bones, abnormal tapering of terminal phalanges, and microcephaly (abnormally small head) (Lowry 1977: 55; Tredwell 1982: 35). Additionally, single cervical fusion is a more common occurrence in cases of FAS than KFS (where segmentation tends to occur in at least two blocks) (Tredwell 1982: 331).

Summary

The analysis of this series is guided by the data generated by stature, dental pathology, metabolic disease, specific and nonspecific infection, degenerative joint disease, trauma, musculoskeletal stress markers, neoplastic conditions, and congenital defects in an effort to best understand the general health of the individual at death. Data from four skeletal series will be utilized as comparisons, with this data supplemented by other temporally equivalent samples when possible. The use of these outlined methods is intended to secure a better knowledge of the demographic composition of the sample, especially with regard to socioeconomic status through adequate access to proper nutrition, the presence, or absence, of specific and/or non-specific disease at Biloxi, and the rate of trauma as a potential indicator of interpersonal conflict and/or accidental injuries potentially indicative of group dynamics and/or occupation.
CHAPTER VI
RESULTS AND DISCUSSION

The results of this study show that while the skeletal population at the Moran French Colonial Cemetery was small and plagued by generally poor preservation, significant conclusions have still been reached in the reconstruction of health of those interred. Results will be presented in the same manner outlined in the Methodology section. The evaluation of the health indices employed in the analysis will be provided in the Discussion section.

Results

Stature

Stature estimates were able to be derived for 19 individuals, three females and 16 males (Table 1). Those individuals of ambiguous sex were not included in the stature analysis discussed here. Measurements were taken for the femur, tibia, and humerus, and height calculated using Trotter and Gleser’s (1958) stature formulae for White males and White females. Results for individuals from Moran were then compared with contemporary eighteenth-century populations from Ireland (Angel, 1976), urban London (Angel 1976; Miles et al. 2008), France (Komlos and Francesco 2005), and Quebec City (Cybulski 1988).
Table 1

Stature Estimations for Individuals Interred at Moran (cm)

<table>
<thead>
<tr>
<th>Burial #</th>
<th>Sex</th>
<th>Stature (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burial 1</td>
<td>Male</td>
<td>161.5</td>
</tr>
<tr>
<td>Burial 2</td>
<td>Male</td>
<td>163.0</td>
</tr>
<tr>
<td>Burial 3</td>
<td>Male</td>
<td>163.8</td>
</tr>
<tr>
<td>Burial 5</td>
<td>Male</td>
<td>171.3</td>
</tr>
<tr>
<td>Burial 6</td>
<td>Female</td>
<td>151.0</td>
</tr>
<tr>
<td>Burial 14</td>
<td>Male</td>
<td>171.3</td>
</tr>
<tr>
<td>Burial 16</td>
<td>Male</td>
<td>157.2</td>
</tr>
<tr>
<td>Burial 17</td>
<td>Male</td>
<td>159</td>
</tr>
<tr>
<td>Burial 18</td>
<td>Female?</td>
<td>152.3</td>
</tr>
<tr>
<td>Burial 19</td>
<td>Unknown</td>
<td>156</td>
</tr>
<tr>
<td>Burial 20</td>
<td>Female</td>
<td>148.7</td>
</tr>
<tr>
<td>Burial 21</td>
<td>Male</td>
<td>168.5</td>
</tr>
<tr>
<td>Burial 22</td>
<td>Male</td>
<td>160.7</td>
</tr>
<tr>
<td>Burial 24</td>
<td>Male</td>
<td>162.7</td>
</tr>
<tr>
<td>Burial 25</td>
<td>Male?</td>
<td>167.0</td>
</tr>
<tr>
<td>Burial 26</td>
<td>Male</td>
<td>168.5</td>
</tr>
<tr>
<td>Burial 27A</td>
<td>Unknown</td>
<td>163.3</td>
</tr>
<tr>
<td>Burial 27B</td>
<td>Male</td>
<td>159.6</td>
</tr>
<tr>
<td>Burial 28</td>
<td>Male</td>
<td>174.5</td>
</tr>
<tr>
<td>Burial 30</td>
<td>Male</td>
<td>170.5</td>
</tr>
<tr>
<td>Burial 31</td>
<td>Male</td>
<td>170.7</td>
</tr>
</tbody>
</table>

The males at Moran range in height between 157.2 and 174.5 cm, with an average (n = 16) height of 164.8 cm. The average male height at Moran is very similar to those of the male populations from France (164.52 cm) and Ireland (167.64 cm), whose samples were composed of soldiers and convicts, but shorter than the higher class populations from London, which averaged 173.74 cm. Female height at Moran ranged from 148.7 to 152.3 cm, with an average (n = 3) height of 150.7 cm, displaying the shortest mean height among the comparative groups. However, with only three individuals able to be measured, this may not accurately reflect the typical height and, consequently, resulting interpretations ranging from childhood health to social status of women at the Biloxi
settlement may be biased (Figure 6). Despite differences in age, among males, and status, as indicated by the presence of two coffin internments, there does not appear to be a great deal of correlation between age or status and stature (Figures 3-6). It is, therefore, likely that both males and females within this sample came from lower status backgrounds. Stature, as an indicator of the general health of a population, often acts as a measure of social status for groups of individuals within agricultural, industrial, and post-industrial societies as socioeconomic means often correlate with availability of food resources and quality of living conditions (Larsen 1997).

Figure 3. Stature estimates for males by burial at Moran.
Figure 4. Stature comparison with male burials, ascending by height. The black columns represent the two coffin interments. Graphic representations given black borders represent the youngest males within the sample.

Figure 5. Stature comparison with male burials, ascending by height. The black columns represent the two coffin interments. Graphic representations given black borders represent the oldest males within the sample.
Linear Enamel Hypoplasias

Hypoplastic defects were observed on the dentition of 10 of 13 observable individuals (77%), with four of those experiencing multiple lesions (31%). Of the 18 total hypoplasias observed, nine were slight in size and nine were moderate. Of the 15 canines evaluated, 27% had lesions, and of 33 incisors evaluated, 21% had lesions. Additional information on the hypoplastic patterns of the original eight burials can be found in Carter 2004. Further analysis in the laboratory of the remains of the original eight burials able to be recovered in the aftermath of Hurricane Katrina showed one individual, possibly Burial 1, displayed severe manifestations (Figure 7).
Figure 7. An example of hypoplasias in the Moran population. Burial 1, severe lesions.

Because there were multiple episodes for individuals the mean value per individual was 1.09 (Table 2). Those individuals evidencing multiple episodes suggest a greater degree of regularity in health disruption. Relative to other populations, the mean number of hypoplastic defects per individual falls between what is observed among the comparative populations at St. Croix (Crist 2005); Fort Rosalie, a later eighteenth-century French Fort located near Natchez, Mississippi (Manhein 2003); and Quebec City (Cybulski 1988). Among the 25 burials recovered from St. Croix, 20 were able to be analyzed for the defect, with five individuals (25%) evidencing manifestations, only one of which was multiple; episodes ranged from slight to severe in size (Crist 2005). At Fort Rosalie two of the three recovered adults (67%) displayed linear defects (Manhein 2003) with no notation of episode size, and at Quebec City defects were observed on 31 of 43
adults (72%) and ranged from slight to moderate in size (Cybulski 1988). Data concerning age at formation was not provided for any of the three comparative groups.

Table 2

_Distribution of Hypoplastic Episodes for Canines and Incisors by Individual Burial within the Moran Population_

<table>
<thead>
<tr>
<th>Burial #</th>
<th>Sex</th>
<th>Incisor</th>
<th>Canine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burial 14</td>
<td>M</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Burial 16</td>
<td>M</td>
<td>2 (slight)</td>
<td>0</td>
</tr>
<tr>
<td>Burial 17</td>
<td>M</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Burial 18</td>
<td>M</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Burial 19</td>
<td>M</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Burial 20</td>
<td>F</td>
<td>0</td>
<td>1 (slight)</td>
</tr>
<tr>
<td>Burial 21</td>
<td>M</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Burial 22</td>
<td>M</td>
<td>2 (moderate)</td>
<td>3 (moderate)</td>
</tr>
<tr>
<td>Burial 23</td>
<td>M</td>
<td>0</td>
<td>2 (slight)</td>
</tr>
<tr>
<td>Burial 24</td>
<td>M</td>
<td>3 (moderate)</td>
<td>0</td>
</tr>
<tr>
<td>Burial 25</td>
<td>M</td>
<td>1 (slight)</td>
<td>0</td>
</tr>
<tr>
<td>Burial 26</td>
<td>M</td>
<td>0</td>
<td>1 (moderate)</td>
</tr>
<tr>
<td>Burial 27</td>
<td>M</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Burial 28</td>
<td>M</td>
<td>1 (slight)</td>
<td>0</td>
</tr>
<tr>
<td>Burial 29</td>
<td>M</td>
<td>1 (slight)</td>
<td>0</td>
</tr>
<tr>
<td>Burial 30</td>
<td>M</td>
<td>1 (slight)</td>
<td>0</td>
</tr>
<tr>
<td>Burial 31</td>
<td>M</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Caries

Among the 22 individuals evaluated for carious lesions, 362 teeth were present and 302 were suitable for scoring. A total of 15 lesions were observed. Predictably, the majority of the teeth affected were molars and premolars with most lesions affecting the occlusal and interproximal surfaces. Caries averaged 0.68 per individual, which is somewhat low given that agricultural populations trend toward rates greater than 2.0 (Larsen 1995), but this may be attributed to a possible combination of poor preservation and, potentially, high antemortem tooth loss observed within the population. Pathologically, Burial 25, a male aged between 25-35 years, is somewhat of an outlier with the most dental caries (n = 5) in the series. Only a single female, Burial 20, was able to be observed for caries, which limits meaningful intra-site comparisons by sex.

In the comparative groups, the rate per individual at St. Croix was higher at 0.85 (Crist 2005), the more contemporaneous site of St. Peter’s cemetery in New Orleans reported rates of 7.25 (Owsley and Orser 1984), and the later Protestant prison population from Quebec averaged 6.3 per individual (Cybulski 1988) (Figure 8). Caries rate per individual was not reported for the population at St. Marylebone. In addition to the comparative populations utilized throughout this analysis, caries frequencies in the Moran population are also compared here with those seen at Fort Rosalie near Natchez, Mississippi with an average rate per individual reported as being 2.0 (Manheim 2003), a contemporaneous London population with a reported rate of 2.8 (Angel 1976), and a seventeenth-century Swiss population with the reported rate per individual being 4.7 (Lingstrom and Borrman 1999). Interestingly, the caries rate per individual at Moran falls exactly between the sailor population at St. Croix and the soldiering population at Fort
Rosalie, and is very distinct from either the population at St. Peter’s and the established urban center at Quebec.

Figure 8. Comparison of rate of caries per individual at Moran and contemporaneous populations.

Unfortunately, preservation issues prevented the analysis of the presence and severity of both abscesses and periodontal disease within the sample. Additionally, preservation is such within the population that antemortem tooth loss cannot be reported for socket, only by observed incidence of occurrence and rate per individual. Antemortem tooth loss is the second dental disease analyzed within the sample.
Table 3

*Distribution of Caries and Antemortem Tooth Loss by Tooth and Level of Severity for Individuals in the Moran Population.*

<table>
<thead>
<tr>
<th>Burial #</th>
<th>Sex</th>
<th>Number Teeth Scored</th>
<th>Dentition Affected by Caries</th>
<th>Number, Severity, and Location of Caries</th>
<th>Degree of Antemortem Tooth Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burial 3</td>
<td>M</td>
<td>N/A</td>
<td>N/A</td>
<td>2, N/A, N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Burial 5</td>
<td>M</td>
<td>N/A</td>
<td>N/A</td>
<td>1, N/A, N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Burial 6</td>
<td>F</td>
<td>N/A</td>
<td>N/A</td>
<td>1, N/A, N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Burial 14</td>
<td>M</td>
<td>10</td>
<td>None</td>
<td>None</td>
<td>Perimortem tooth loss observed</td>
</tr>
<tr>
<td>Burial 16</td>
<td>M</td>
<td>12</td>
<td>None</td>
<td>None</td>
<td>None observed</td>
</tr>
<tr>
<td>Burial 17</td>
<td>M</td>
<td>6</td>
<td>Maxillary canine (left)</td>
<td>1, slight, interproximal</td>
<td>Perimortem tooth loss observed</td>
</tr>
<tr>
<td>Burial 20</td>
<td>F</td>
<td>25</td>
<td>Maxillary 1(^{st}) molar (right)</td>
<td>1, moderate, interproximal</td>
<td>None observed</td>
</tr>
<tr>
<td>Burial 21</td>
<td>M</td>
<td>5</td>
<td>None</td>
<td>None</td>
<td>None observed</td>
</tr>
<tr>
<td>Burial 22</td>
<td>M</td>
<td>25</td>
<td>Mandibular 1(^{st}) premolar (right)</td>
<td>1, slight, occlusal 1, slight, occlusal</td>
<td>None observed</td>
</tr>
<tr>
<td>Burial 23</td>
<td>M</td>
<td>19</td>
<td>Maxillary lateral incisor (left)</td>
<td>1, slight, interproximal 1, severe, occlusal</td>
<td>None observed</td>
</tr>
<tr>
<td>Burial 24</td>
<td>M</td>
<td>11</td>
<td>Mandibular canine (left)</td>
<td>1, severe, interproximal at CEJ</td>
<td>None observed</td>
</tr>
<tr>
<td>Burial 25</td>
<td>M</td>
<td>16</td>
<td>Maxillary 1(^{st}) molar (left)</td>
<td>1, severe, interproximal at CEJ 2, both moderate, interproximal and occlusal</td>
<td>None observed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maxillary 2(^{nd}) molar (left)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mandibular 1(^{st}) molar (right)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3 (continued.)

*Reported Caries and Antemortem Tooth Loss within the Sample.*

<table>
<thead>
<tr>
<th>Burial</th>
<th>Sex</th>
<th>Age</th>
<th>Tooth</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>M</td>
<td>9</td>
<td>Mandibular canine (left)</td>
<td>1, moderate interproximal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mandibular 1st premolar (left)</td>
<td>1, moderate, interproximal at CEJ</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mandibular 1st molar (left)</td>
<td>1, severe, interproximal</td>
</tr>
<tr>
<td>28</td>
<td>M</td>
<td>5</td>
<td>Mandibular 1st premolar (right)</td>
<td>1, moderate, interproximal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mandibular 2nd premolar (right)</td>
<td>2, slight &amp; moderate, interproximal</td>
</tr>
<tr>
<td>29</td>
<td>M</td>
<td>10</td>
<td>Maxillary 3rd molar (right)</td>
<td>1, slight, occlusal surface</td>
</tr>
<tr>
<td>30</td>
<td>M</td>
<td>13</td>
<td>Mandibular 2nd molar (left)</td>
<td>1, very slight, CEJ</td>
</tr>
<tr>
<td>31</td>
<td>M</td>
<td>4</td>
<td>Mandibular 2nd molar (left)</td>
<td>1, moderate, interproximal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mandibular 1st premolar (left)</td>
<td>1, slight, interproximal</td>
</tr>
</tbody>
</table>

Of the burials recovered after 2005, 12 individuals were able to be analyzed for the prevalence of dentition lost before death, with nine individuals potentially evidencing antemortem loss, a rate of 75%. The rate per individual within the Moran sample is 1.6. Interestingly, those burials displaying the most severe socket resorption are burials 26, 29, and 30. Burial 26 is an older male and a coffin interment showing evidence of antemortem loss of almost all maxillary and mandibular molars. Burial 29 is another older male and a shroud interment, exhibiting antemortem loss of most of his mandibular molars. Lastly, Burial 30 is a young adult male buried in a coffin, displaying antemortem loss of all his left maxillary molars. Individuals interred in coffins may have had greater
access to sugary and/or carbohydrate-heavy foods that may have contributed to a higher incidence of antemortem tooth loss.

In comparing the rates of antemortem tooth loss observed in the comparative populations, Crist (2005) reports a rate of 1.6 per individual among the St. Croix population, Owsley and Orser (1984) report a rate of 3.9 for St. Peter’s, and Cybulski (1998) reports a rate per individual of 2.9 for Quebec City. Unfortunately, St. Marylebone also does not note the rate per individual for antemortem tooth loss and Manhein (2003) could not provide one for Fort Rosalie due to preservation issues. Among the additional comparative populations with available data, Angel (1976) reported a rate of 7.2 for metropolitan London. Therefore, the caries rate seen at Moran is identical to the St. Croix population and well below the rate reported for the settled populations of St. Peter’s, Quebec City, and London.

When both the number of carious lesions and antemortem tooth loss are collapsed into a count of infectious and degenerative dental diseases, the Moran population displays an observed rate of 2.28 total defects per individual. In comparing this measure to the other groups, the rate of general dental defects observed at St. Croix is 2.4 (Crist 2005), St. Peter is 11.16 (Owsley and Orser 1984), and Quebec City is 9.2 per individual (Cybulski 1988). Supplementing this with data from the additional sites, Fort Rosalie is 2.0 (Manhein 2003) and the London population is 10.0 (Angel 1976). What is, of course, immediately apparent is just how dissimilar the Moran population is from the settled groups in terms of dental pathology and its comfortable fit between the dental defects reported for St. Croix and Fort Rosalie. Of course, all populations must be taken in context, and one reason the settled groups do trend toward higher numbers is that they all
contain a number of individuals of more advanced age as well as those in young and middle adulthood, which will dramatically affect both observed antemortem tooth loss and caries, respectively. Moran, instead, is much more like the two military populations in terms of demography, with all being composed primarily of young and middle adult males.

Metabolic Disorders

The rate of positive diagnosis of metabolic disorders within the Biloxi colony was remarkably low. Unfortunately, the generally poor preservation at the site, obstructing the ability to either confirm or deny the presence of these lesions in many individuals, inhibits the ability to determine if observed rates are representative of the population. None of the post-Katrina burials evaluated for Vitamin C deficiency, in the form of cribra orbitalia, evidenced lesions associated with the disorder. One individual scored in the 2003 analysis, Burial 4, presented possible signs of scurvy in the form of mild cribra orbitalia in right orbital plate (Carter 2004).

This single incidence of healed cribra orbitalia is a departure from the data seen at the comparative sites, including the 13% reported for the Modern Period (1500-1950) in Europe (Papathanasiou 2009), 64% reported for St. Croix (Crist 2005), 24% for Quebec City (Cybulski 1988), 25% reported for New Orleans (Owsley and Orser 1984), and 31% for London (Miles 2008). It should be noted, however, that the very high incidence of cribra reported for St. Croix is the result widespread scurvy within the naval population. Interestingly, the single observed incidence at Moran is quite a departure from all the sedentary urban populations. Of course, sedentism aside, another possible distinguishing
factor between the two groups may be that one is civilian and the other military in composition.

Metabolic disease also manifested within the population in the form of well healed rickets in both femora and tibiae of Burial 17, a young adult male, which represents 5.8% of the population that could be scored. Among the comparative populations used in this study only St. Marylebone in London reported the positive diagnosis of any kind of Vitamin D deficiency with a similar 5% rate of occurrence for rickets. Courtesy of more recent history, the mental image associated with rickets is one of a child living in a random soot covered urban environment (Roberts and Manchester 2007). Unfortunately, the absence of additional testing necessary to determine Burial 17’s childhood environment leaves only speculation on his life as an adult in the wake of overcoming this disorder. While the individual is not the shortest male within the sample, he is on that end of the spectrum. Additionally, the deformity of his legs likely affected his gait and would, it seems, have made him a somewhat unlikely candidate for career soldiering.

Incidence of porotic hyperostosis for the Moran population is much higher than expected, with four of 22 individuals with observable crania displaying lesions at a rate of 18.18% for the sample. The first individual is Burial 4, for whom Carter (2004) report a healed episode of porotic hyperostosis on the right parietal. Among the burials excavated after 2005, Burial 24 exhibits slight porotic hyperostosis on both parietals but without evidence of a thickening of the diploë. This individual also evidences possible trauma and subsequent infection to the area, and the observed porosities may well be in association with that event rather than true porotic hyperostosis. Burial 29 displayed
diploic expansion of the right parietal, which was observable in cross section. Unfortunately, the preservation of the outer table was such that macroscopic analysis of the area was not possible. Finally, Burial 31 displayed slight porosities on both parietals but showed no evidence of diploic expansion.

The distribution of porotic hyperostosis observed within the Moran sample is well outside of the range of the 3% porotic hyperostosis reported by Papathanasiou (2000) for modern Europe and the 3.6% reported for St. Marylebone (Miles et al. 2008). It is, in fact, much closer to the 25% reported for St. Peter’s Cemetery (Owsley and Orser 1984) and the very high frequency reported for St. Croix, though the latter is likely, again, a condition corresponding to the observed rate of scurvy. No evidence of porotic hyperostosis was observed at Quebec City (Cybulski 1988).

Infection

Non-specific infection, as evidenced by periostitis, was observed in five of 27 individuals able to be scored (18.5%). In the only cranial incidence, Burial 24, an older adult male, evidenced a large area of well healed periosteal lesions on the central portion of the frontal bone. This is in association with a roughly circular depression approximately 1.0 cm in diameter coronally and 0.7 cm sagittally; it extends through the outer table to expose some of the diploë beneath. The edges of the defect are blunted in a way that suggests some degree of healing, and the matrix surrounding the area is manifest as more compact remodeled bone. This distinct region extends inferiorly from the right side margin of the defect, encompassing it and maintaining its trajectory inferiorly to the browridge then arches up at the midline of the left eye orbit terminating at the horizontal
middle of the frontal bone. The left side of the lamellar patch, just above the orbit, appears slightly depressed compared to the surrounding area.

Infection was seen in postcranial remains of other individuals as well. Burial 26, an older adult male, displayed moderate active periostitis of the anterior right tibia, although this may be related to dysplasia of the right acetabulum and subsequent remodeling of the right femur, which will be discussed later. Burial 27, an adult male of indeterminate age, exhibited slight active periostitis on the distal medial portion of both fibulae. Burial 28, an older adult male, evidenced healed periostitis on the left tibial anterior crest on the lateral side in association with healed trauma to the area. This individual also showed bilateral inflammation of the plantar surface of the calcanei. Burial 29, an older adult male, displays slight active infection of the right acetabulum in association with trauma to the area. Burial 30, an older adult male, displays slight active periostitis of both anterior tibiae. Though this pattern is evident within the suite of the stigmata for syphilis (Aufderheide and Rodríguez-Martín 1998), no additional indicators were present to support a diagnosis of treponemal infection. Osteomyelitis, however, was not observed within the Moran population.

Compared to the other populations, the rate of infection at Moran is a bit lower than the 27.2% reported for St. Peter’s Cemetery (Owsley and Orser 1984) and significantly lower than was observed at St. Croix, where more than half of the sample exhibited lesions, though much of this was related to the prevalence of scurvy within the sample (Crist 2005). Interestingly, however, the Moran rate is quite close to the 17% reported by St. Marylebone (Miles 2008).
No evidence of sinusitis or mastoiditis was observed within the sample. 

*Arthritis*

Arthritis is surprisingly frequent within this population. Of 16 individuals able to be scored for arthritic effects, seven displayed evidence of arthritis, most commonly seen in the knees and lower vertebrae. This high prevalence is made more interesting by the relative youth of the sample, with all adults falling between the ages of 20 and 50 years.

Burial 19, a male aged 30-40 years, evidences slight lipping of the lumbar vertebrae. Burial 23, a male aged 30-40 years, shows slight lipping of the cervical vertebrae in association with Klippel-Fiel Syndrome, as will be discussed later. Burial 24, a male aged 25-35 years, presented slight patchy porosities associated with both knee joints. Burial 25, a male aged 20-25 years, also displayed slight patchy porosities associated with both knee joints. Burial 26, a male coffin burial aged 30-40 years, exhibited a uniquely asymmetrical pattern of vertebral arthritis. This individual exhibited enlarged articular facets of the thoracic vertebrae, on the right side, and small patches of slight porosities. Burial 26 also exhibits moderate lipping of the lumbar vertebrae with several centra displaying Schmorl’s nodes. This may be related to observed dysplasia in the right hip and suggestive that both the hip and widespread asymmetry of the observed arthritic patterning of the vertebrae may be related to a traumatic event that occurred much earlier in the individual’s lifetime. The head of the right femur displays arthritic buildup in association with this trauma. Burial 28, a male aged 35-40 years, shows slight lipping on the anterior left side of lower thoracic vertebrae. The unusual patterning of this is also suggestive of a potential traumatic event. Burial 29, a male aged 25-35 years, displays
slight porosities associated with the right knee and right ankle joints. Burial 31, a male aged 30-40 years, exhibits slight lipping of the lumbar vertebrae.

**Trauma**

Trauma was also quite frequent within the population, with four incidences of accidental trauma, all in different individuals, and a single possible incidence of violent trauma. Burial 23, a middle-adult male, exhibits evidence of healed fractures to the spinous processes of two of the thoracic vertebrae (T3-4), a condition commonly referred to as a “clay shoveler’s fracture” which is believed to be a possible result of excessive manual labor (Roberts and Manchester 2007: 106). Burial 26, an older male, shows a possible muscle tear of the deltoid tuberosity of the right humerus. This individual also evidenced a healed traumatic injury to the right hip, which has resulted in a right acetabulum that is much wider and shallower than the left with subsequent remodeling of the right proximal femur. Burial 28, an older male, displays a traumatic lesion on the anterio-lateral diaphysis of the left tibia. Burial 29, an older male, exhibits a possible muscle tear in the acetabulum of the right innominate. This individual also displayed fusion of the right sacroiliac joint, though without associated complication to the right acetabulum and proximal femur. The single incidence of possible violent trauma within the population is observed with Burial 24, an older male, in the form of a slight depression on the frontal bone that may be the result of blunt force trauma to the area.

The 30% rate of combined traumatic injury at Moran exceeds the 25% reported for St. Peter’s Cemetery (Owsley and Orser 1984), the 20% reported for Quebec City (Cybulski 1988), and the 14% reported for St. Marylebone (Miles 2008). Interestingly, however, in delineating between accidental and violent trauma, as explained in the
Methods chapter, the 24% rate of accidental trauma observed at Moran is much higher than the 12.5% reported for St. Peter’s Cemetery (Owsley and Orser 1984), the 16% reported for Quebec City (Cybulski 1988) and the 11% reported for St. Marylebone (Miles 2008). Conversely, the 6% rate of violent trauma at Moran is much lower than the 13% reported for St. Peter’s Cemetery (Owsley and Orser 1984) but is very similar to the 4% reported for Quebec City (Cybulski 1988) and the 3% reported for St. Marylebone (Miles 2008) (figure 9).

![Figure 9](image.png)

*Figure 9. Comparison of percentage of population displaying violent and accidental trauma in the Moran and contemporaneous populations.*

The analysis of indicators of muscle stress revealed low levels of enthesis hypertrophy, through preservation was an issue. Musculoskeletal stress markers (MSMs) were scored, when able to be observed, using the system developed by Hawkey and Merbs (1995). Poor preservation limits the ability of specific sites to be regularly scored, so this is, again, presented in the form of rate of occurrence. Of the 16 burials analyzed for MSMs, five, even with taphonomic damage, manifest severe robusticity of at least one attachment site and three manifest moderate robusticity. Those sites primarily
affected include the attachments surrounding the elbow joint, deltoid tuberosity of the right humerus, and the attachment sites of the clavicles. Unfortunately, almost all attachment sites have been affected, to varying degrees, by detrimental taphonomic damage and many of those scored as moderate or only present were likely far more pronounced in life.

**Neoplastic Conditions**

No neoplastic conditions were observed within the sample.

**Genetic Conditions**

Also potentially present within the population is the presence of the genetic condition Klippel Feil Syndrome (KFS) in Burial 23. Perhaps the most well documented manifestation of the syndrome is fusion of the cervical vertebrae. A list of 22 known KFS skeletal manifestations has been compiled by Pany and Teschner-Nicola (2006). Of the listed specific features, six were unobservable (largely due to preservation and fragmentation) in Burial 23 and 10 were absent. The six features that were present include C2-C3 fusion, occipito-atlantal fusion, minor basilar impression and narrowing of the foramen magnum, constricted medullary cavity (of femoral diaphysis), vertically oriented (and asymmetrically positioned) acoustic meati, and asymmetrical articular facets of the cervical vertebrae (with the right being significantly larger than the left). Known complications of this syndrome include, but are not limited to, deafness or hearing deficiency, growth abnormalities of the kidneys and/or heart, and renal failure (Hensinger 1974). Initially it would seem, then, that this was a member of society that could have been dependent on the support of kin or social service groups. Analysis of the musculoskeletal attachment sites of this individual, however, reveal them to be among
some of the most robust leading us to conclude that despite the limitations imposed by this congenital disease, Burial 23 was an individual who was not made infirm by it.

Discussion

Infectious disease, malnutrition, infection, trauma, high infant mortality, and low life expectancy are often the price city residents, in the Old World and New, pay for their cosmopolitan lifestyle, particularly among those in the colonies (Larsen 1997). While the historical record is relatively silent on disease at New Biloxi, what is clear is that this settlement on the banks of the Gulf Coast had attempted to support a population beyond the carrying capacity of the resources available to them. Humans from all walks of life living cheek-by-jowl in what few structures, of unknown quality, would have been available could have provided a perfect storm for illness and swift death.

The results of the paleopathological analysis of the Moran series are both supportive and somewhat contrary to our expectations based on a combination of research done to date on the population and an applied knowledge of historical and comparative resources. Pathologically, the population paradoxically fits both military and urban models of episodic stress for the period. Childhood health indicators including stature and the presence of linear enamel hypoplasias are indicative of a sample culled from a lower socioeconomic status. Dental pathologies as indicators of health show that the Moran sample is far more similar to the soldiering groups from Fort Rosalie and St. Croix. Interestingly, this may be more indicative of a sample that, like Fort Rosalie and St. Croix, lived most of their lives in France rather than the new urban environs of North America. The demographic composition of the Moran sample must also be taken into
account, as the interred in Biloxi are also much closer in age to those present at both Fort Rosalie and St. Croix.

Rates of metabolic distress also present a confusing picture. While the rate of Vitamin C deficiency at Moran is quite low when compared to urban centers, the rate of Vitamin D deficiency is similar. The high prevalence of porotic hyperostosis observed within the sample is, conversely, much higher than is observed in Europe, but quite similar to rates seen at St. Peter’s Cemetery in New Orleans. Infection rates within the Moran sample are an incredible outlier, being far more similar to prevalence of the condition recorded for urban Europe than either St. Peter’s Cemetery or St. Croix.

Arthritis is surprisingly frequent within the generally young group, with most evidence manifesting in the knees and lower vertebrae. Trauma is quite high in the sample, with an overall rate that exceeds those of all the comparative populations. The rate of accidental trauma is extremely elevated when compared to other samples, but the rate of violent trauma is very similar to reported rates for Quebec City. When the results of the paleopathological analysis are put into the cultural and historic context, what emerges is a sample population that is neither wholly military nor urban in their physical setting or demographic segment.

This ambiguous middle ground of the Moran health patterns between the two contexts might be explained if one considers that the cemetery belonged not to Fort Louis, but to the Le Blanc Concession. One piece of supporting evidence for this may be found in the famous de La Tour 1721 map (Figure 1) of plans for the fort at Biloxi. The map indicates that the concession would have been placed to the east of a natural ravine and fresh water spring, a landmark now directly opposite the recovered cemetery on the
opposite side of Porter Ave. A second piece of supporting evidence comes from the recent work of the cultural resource management group Coastal Environments, Inc., who, in 2010, tested the areas immediately east and south of the Moran Cemetery and found nothing in the way of colonial mortuary practices (Hahn 2011). It should be mentioned, however, that the area to the south was highly disturbed by industrial land grading in the wake of area development and that reports from the time indicate that work crews did discover some number of burials to the south (Danforth 2013). This investigation was supported by later investigations, after Hurricane Camille in 1969, conducted by The University of Southern Mississippi, which focused on attempting to delineate the boundaries of the cemetery, finding no evidence that it extended north or west of the property lines (Danforth 2013). Previous work by local archaeologists in the 1980s as well as USM in 2008 suggested the cemetery also did not extend to the east (Young 2009). Given that Conrad’s (1971) interpretation of the events at New Biloxi resulted in the deaths of some 600 people, this rather small sample of 33 total individuals recovered from Moran, even including the unknown number of interments found to the south, falls far too short of the mark to make a case for affiliation with the fort cemetery but fits well with what might be expected from a concession. The cultural composition of this subsample reflects a population of individuals regularly involved in manual labor which might include, but is not limited to, soldiers, convicts, and the working poor.

Additionally, support for this argument may be found in the rates of porotic hyperostosis and non-specific infection within the sample, which suggest that some measure of the population did live with chronic illness for an indeterminate amount of time prior to death. Admittedly, what is not known is how long they survived on the
Biloxi shores with it. Still, many of the rates of illness and infection mirror those seen in urban Old World and New World environments (Crist 2005; Cybulski 1988; Dawdy 2008; Miles 2008; Owsley and Orser 1984), and it may be postulated that those observed at Moran are an accurate reflection of the rate of disease within the group. Interestingly, those individuals with lesions may be representative of the least frail within the mortuary population because, by evidencing observable pathologies, they had to have been able to survive for a prolonged period of time; this is referred to as the “Osteological Paradox” (Wood 1992:343). It may also be speculated that some measure of adequate nutrition would be necessary to support the amount of osteoblastic activity as is observed with these lesions (Weston 2012).

Lastly, there is a possibility that some of the individuals interred in coffins, who it is assumed were individuals of some measure of status sufficient to warrant a more elaborate mortuary context, were either officials within the colonial government, stationed military personnel, or, perhaps, leaders within the concession. All coffin interments were male and those men leading the concession efforts would have presumably been more privileged in terms of resources. Surprisingly, these men show no obvious signs of any kind of nutritional advantage to this social position.

Interestingly, the concession’s fate was to be inextricably intertwined with that of the settlement proper. The historical record offers numerous accounts of the limited resources, and disastrous consequences, of this overtaxing of the infrastructure at the New Biloxi settlement. Additionally, because the town of New Orleans was being built in tandem with the fortification efforts at Biloxi and because the engineered designs for Biloxi were, instead, implemented in New Orleans, no legitimate effort was made to
establish Biloxi, or the surrounding farmsteads, as a secure settlement. Rather, Biloxi was the byproduct of a more organic process that arose out of sheer necessity instead of from foresight and planning.
CHAPTER VII

CONCLUSIONS

Paleopathological analysis of human skeletal remains from the Moran French Colonial Cemetery gives insight into the social, economic, and environmental challenges met by some of the first French colonists who settled on the shores of the Gulf Coast of North America in the early eighteenth century. This information has become part of the canon of research that began in 1969 with the post-Camille work of Dale Greenwell (2008) and continued in earnest in 2003 when researchers from The University of Southern Mississippi undertook in situ evaluation of the visible remains from underneath the Moran Art Studio, largely confirming the 1969 findings (Carter 2004; Greenwell 2008). The analysis presented here concerns the pathological research of the population recovered from the Moran French Colonial Cemetery from 2003 through 2009 and is supplemented and assessed with a combination of historical documents and data from temporally and ancestrally similar comparative populations.

Possessing a command of the history of the site and this period as it pertains to larger French and North American colonial contexts proved vitally important to understanding the paleopathology of the population in question. Only by assessing the environmental, cultural, and historic processes in play could those available indicators and an understanding of potential causative explanations for the infrequency of occurrence be deemed complete. The Moran Site (22HR511) cemetery, located in Biloxi, Mississippi, intrudes, not surprisingly, on an earlier prehistoric (Woodland) component. A fresh water spring approximately 50 meters away is likely part of what made the location so attractive for both Native American and European settlements. Biloxi itself is
a peninsula bordered to the south by a shallow bay, created by the presence of barrier islands which segregate the bay and the gulf, and the Biloxi Back Bay to the north, on the other side of which is modern day Ocean Springs, Mississippi, and the location of Fort Maurepas in 1699 (Conrad 1970).

The French regency transferred proprietary control of the colony to John Law and the Company of the West in 1717, contractually binding him to send a total of 9,000 immigrants (6,000 Whites and 3,000 Blacks) over the course of 25 years (Giraud 1966). In the wake of this contractual agreement, and continuing problems with the Mobile outpost, the government chose to relocate the colonial seat to Biloxi. Unfortunately, this transition was largely in name only (Campanella 2008). The colonial governor, Sieur de Bienville, was well acquainted with the original settlement at Fort Maurepas, having been stationed there as a young man, and pitched re-habitation of the area because the original fort still stood (Conrad 1995). The government appears to have approved the venture in large part because so little capital would need to be invested in the renovation of a preexisting structure, supplemented with material dismantled and shipped from the garrison at Dauphin Island (Conrad 1970).

The old fort, however, was not the main focus of the new effort, and would not have been for long in any event, as it was shortly destroyed, so a small contingent of offices were erected on the gulf shores to facilitate the arrival of colonists and supplies to the main colonial seats of Mobile and the newly christened New Orleans (Conrad 1970). For all that this plan may have been sound in theory, ambition, poor communication, fraud, disease, piety, lust, and poverty all served as contributing factors that lead to the station becoming quickly overwhelmed and overrun with the poor souls who found
themselves literally stranded on its unfamiliar shores. No infrastructure was in place to support a populace of thousands and those who were able were instructed to build shelters (Conrad 1995, 1970; French and Shea 1853). Colonists, without supplies, shelter, or food, perished by the hundreds and were buried, many of them quietly and without ceremony, nearby in the sands (Conrad 1995; Conrad 1970; DuPratz 1975; French and Shea 1853).

According to burial records, those who died at New Biloxi in 1717 and 1718 were primarily soldiers and officials working for The Company (DuPratz 1774). Later influxes of colonists, being demographically composed of a combination of convicts and some families, occurred between 1719 and 1722, ending when the colonial seat was transferred to New Orleans (Conrad 1970). Demographically, the collection is composed of 33 individuals total; this includes 16 males, three females, and 14 individuals of undetermined sex (including the infant). Skeletal aging methods employed both in the field and in the lab suggest that the ages of individuals (all but the subadult) appear between 15 and 40 years old.

The population, on the whole, displays such a unique amalgamation of both military and urban patterns of pathology. Stature estimates derived from the Moran population saw an average height of males that is similar to populations composed of convicts. It is likely that both males and females within this sample came from lower status backgrounds. Hypoplastic defects of the teeth suggest that the population was composed of individuals who suffered harsh living conditions and possible malnourishment during childhood. Additional indicators of childhood health appear to confirm this assessment.
Adult indictors of health and illness suggest a population involved in labor. The rates of dentition at Moran fall exactly between the sailor population at St. Croix and the soldiering population at Fort Rosalie. The rate of positive diagnosis of metabolic disorders within the Biloxi colony was remarkably low, while the rate of porotic hyperostosis was quite high. The rate of infection at Moran is also high and resembles the affluent urban British cemetery at St. Marylebone (Miles 2008). Arthritis and trauma were also frequent within the population.

The results of the paleopathological analysis are both supportive and somewhat contrary to our expectations based on a combination of research done to date on the population and an applied knowledge of historical and comparative resources. The history of the French colonization of the Mississippi Gulf Coast is, ultimately, a history of the people who attempted to make a life for themselves on that shore. The French presence in the whole of North America spans from the North Atlantic seaboard, through the mid-continent, and ends in the Gulf Coast. As a region, the Gulf Coast is a place full of those very aware and proud of their past. For those living outside those borders, however, precious little is commonly known about European colonization in the area. For many, the French in the New World is synonymous with New Orleans (or for the truly savvy Mobile, Alabama, as the home of the first Mardi Gras festival in North America). Relatively few people are aware that there was ever a French colonial presence in Mississippi. It is hoped that this research assists in redressing this deficit and promotes the extraordinary story of early life in what would become the city of Biloxi, Mississippi.
And to be sure, life in the Biloxi concession would have been an adventure for only the most optimistic. For many, disembarking on this unfamiliar shore was the culmination of an experience that began with a forced expulsion from France. A motley array of individuals ranging from convicts to priests, from prostitutes to orphaned women escorted by nuns, filled the boats at the port cities of Calais and Marseille with their personal belongings, family trinkets, and keepsakes. A perilous journey across the Atlantic led, as we know, to a New World. Unfortunately, knowledge of what occurred between that first glimpse of an unfamiliar shore and being laid to rest in its sands is hard to come by in the historical record, but just as archaeology is the history of a place from the ground up, physical anthropology is a similar history of a people from the bones, and all the disinterred, saints and sinners alike, have a story to tell here. A favorite saying of those within this discipline is that dead men do tell tales. The data presented here concerning the health, disease, and nutrition of the colony is a part of the story to be told, a particular chapter gleaned from the bones of some of Biloxi’s first residents.
APPENDIX

Burial 14
Sex – Male
Age – 18-23 yrs
Stature – 170.2 cm
LEH – yes, single moderate episode
Caries – none
Antemortem Tooth Loss – none observed
Pathology – chipped left central incisor; possible pipe smoker
Direction of body – S/N
Artifacts – crucifix and beads

Burial 16
Sex – Male
Age – 15-18 yrs
Stature – 158.7 cm
LEH – yes, single slight episode
Caries – 0
Antemortem Tooth Loss – none observed
Pathology – robusticity to lower limbs; possible remodeling of the planter surface of both calcanei; possible pipe smoker
Direction of body – SW/NW
Artifacts – none

Burial 17
Sex – Male
Age – 15-21 yrs
Stature – 157.4 cm
LEH – Two slight episodes
Caries – 1
Antemortem Tooth Loss – none observed
Pathology – pipe stem wear; evidence of healed rickets; bilateral enthesal changes evident in attachments surrounding the elbow joint
Direction of body – SE/NW
Artifacts – none
Burial 18
Sex – ambiguous
Age – Adult
Stature – 156.5 cm
LEH – N/A
Caries – N/A
Antemortem Tooth Loss – N/A
Pathology – none observed
Direction of body – S/N
Artifacts – none

Burial 19
Sex – Male
Age – 30-40 yrs
Stature – N/A
LEH – N/A
Caries – N/A
Antemortem Tooth Loss – N/A
Pathology – slight arthritic lipping of the lumbar vertebrae
Direction of body – NW/SE
Artifacts – none

Burial 20
Sex – Female
Age – 17-20 yrs
Stature – 148.7 cm
LEH – one moderate episode
Caries – 2
Antemortem Tooth Loss – none observed
Pathology – chipped central right maxillary incisor; pipe stem wear
Direction of body – S/N
Artifacts – none

Burial 21
Sex – ambiguous
Age – Adult
Stature – 168.5 cm
LEH – none
Caries – 0
Antemortem Tooth Loss – none observed
Pathology – entheseal changes evident in attachments surrounding the elbow joint of right arm (preservation of left does not allow for analysis)
Direction of body – S/N
Artifacts – small copper pin
Burial 22
Sex – Male
Age – Adult
Stature – 162.1 cm
LEH – two moderate episodes
Caries – 0
Antemortem Tooth Loss – none observed
Pathology – pipe smoker; slight to moderate bilateral enthesal changes observed in the attachments of the arms and legs; possible bilateral remodeling of the planter surface of the calcanei
Direction of body – S/N
Artifacts – none

Burial 23
Sex – Male
Age – 30-40 yrs
Stature – 169.3 cm
LEH – two moderate episodes
Caries – 2
Antemortem Tooth Loss – N/A
Pathology – Klippel-feil observed fusion of second and third cervical vertebrae; slight arthritic lipping of the cervical vertebrae; healed fracture of the spinous processes of two thoracic vertebrae (T3-4); robust enthesal changes of the markers of the arms and legs
Direction of body – S/N
Artifacts – none

Burial 24
Sex – Male
Age – Older Adult
Stature – 165.2 cm
LEH – three moderate episodes
Caries – 0
Antemortem Tooth Loss – mandibular 2\textsuperscript{nd} and 3\textsuperscript{rd} molars on both left and right side, full alveolar absorption
Pathology – healed infection of the frontal bone; chipped left central maxillary incisor; slight porosity on the parietals but no evidence of a thickening of the dipole; possible pipe smoker; slight porosities on the knee joint
Direction of body – NE/SW
Artifacts – none
Burial 25
Sex – Male
Age – 25-35 yrs
Stature – 166.2 cm
LEH – single slight episode
Caries – 7
Antemortem Tooth Loss – none observed
Pathology – porosities observed on the right knee; pipe smoker
Direction of body – S/N
Artifacts – none

Burial 26
Sex – Male
Age – >50 yrs
Stature – 168.3 cm
LEH – two moderate episodes
Caries – 0
Antemortem Tooth Loss – Left maxillary lateral incisor with almost complete resorption.
Pathology – slight arthritic lipping of the lumbar vertebrae; active periostitis observed on the right tibia; possible muscle tear of the deltoid tuberosity of the right humerus; fusion of the right sacroiliac joint and associated complications to the right acetabulum and proximal femur; marked bilateral entheséal changes to the attachment sites of the clavicles
Direction of body – N/S
Artifacts – coffin nails

Burial 26 B
Sex – Male
Age – Adult
Stature – N/A
LEH – N/A
Caries – N/A
Antemortem Tooth Loss – N/A
Pathology – none observed
Direction of body – N/S
Artifacts – none
Burial 27
Sex – Male
Age – Adult
Stature – N/A
LEH – N/A
Caries – N/A
Antemortem Tooth Loss – N/A
Pathology – none observed
Direction of body – N/S
Artifacts – none

Burial 28
Sex – Male
Age – 39-42 yrs
Stature – 175 cm
LEH – single slight episode
Caries – 2
Antemortem Tooth Loss – none observed
Pathology – possible healed periostitis observed on the anterior left tibia; traumatic lesion on the antero-lateral diaphysis of the left tibia; chipped left central maxillary incisor; moderate bilateral entheseal changes to the attachments of the legs; possible bilateral inflammation of the planter surface of the calcanei
Direction of body – S/N
Artifacts – none

Burial 29
Sex – Male
Age – Older Adult
Stature – 156.1 cm
LEH – single slight episode
Caries – 0
Antemortem Tooth Loss – loss of all left mandibular molars and loss of first and second right mandibular molars with full to complete alveolar absorption
Pathology – porotic hyperostosis evidenced by dipole expansion of the right parietal (preservation was such that macroscopic analysis of the area was not possible); porosities of the right knee and ankle
Direction of body – N/S
Artifacts – possible buttons
Burial 30
Sex – Male
Age – 54-63 yrs
Stature – N/A
LEH – single slight episode
Caries – 0
Antemortem Tooth Loss – all left maxillary molars with nearly complete alveolar absorption for first and second molars
Pathology – possible healed periostitis observed on both anterior tibias; possible muscle tear in the acetabulum of the right innominate; chipped left central maxillary incisor
Direction of body – N/S
Artifacts – coffin nails

Burial 31
Sex – Male
Age – 27-31 yrs
Stature – 167.6 cm
LEH – none
Caries – 4
Antemortem Tooth Loss – N/A
Pathology – slight arthritic lipping of the lumbar vertebrae; porosities of both parietals but not in tandem with diploic expansion; extraordinarily robust entheseal changes of the attachment sites of the arms and legs
Direction of body – N/S
Artifacts – none
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