Examination of Subadult Pathology in a 7,000-Year-Old Population from Florida

Rachel K. Wentz

Department of Anthropology, Florida State University, Tallahassee, FL 32306
E-mail: rksofd@hotmail.com

Introduction

Analysis of human skeletal remains affords a glimpse into prehistoric populations in an attempt to recreate their environmental, social, and subsistence regimes. Examination of traumatic injuries, infectious lesions, and indicators of stress, allows inference of the types of injuries they sustained, the pathologies they experienced, and the level of nutrition they achieved within their environmental contexts.

The study of paleopathology examines the evolution and progress of disease through long periods of time and examines how humans adapted to changes in their environment (Roberts and Manchester 1995). This paper focuses on a single population that utilized a small pond on the eastern coast of Florida approximately 7,000 years ago for the interment of their dead. The remains from Windover (8BR246) afford the analysis of skeletal remains from an Archaic population. Windover Pond is a small, ephemeral but persistent freshwater pond on the Atlantic coastal ridge in east central Florida near Cape Canaveral. Excavations took place over three field seasons beginning in 1984, producing the remains of 168 individuals, 91 of whom had preserved brain tissue (Doran 2002:75). Dated to over 7,000 years BP, the remains were buried within a peat matrix, allowing for exceptional preservation (Doran and Dickel 1988; Doran et al. 1986; Doran 2002). Excavations of Windover led to the recovery of a large number of subadult remains. This research examines the pathologies in subadult remains from Windover and the inferences they allow into the level of health of an Archaic population.

The recovery and identification of subadult human skeletal remains in the archaeological record can be problematic. Differential preservation of elements between individuals is dependent upon the density and porosity of bones (Stojanowski et al. 2002), and because of the fragility of subadult remains they are typically destroyed through diagenesis at a much greater rate than denser adult remains. Recovery of subadult remains also can be exceptionally challenging due to their small size and difficulty in identification. Another factor that may interfere in the recovery of subadult remains in archaeology is due to differential disposal of the dead. In some cases, subadults may be interred separately from adult remains and therefore be excluded at the time of excavation. Subadult remains also can be misidentified as faunal material. The recovery of pathological subadult remains can pose additional recovery problems, since bones affected by disease may be more fragile than healthy remains.

A total of 67 subadults representing varying degrees of completeness, were recovered from the Windover excavations, affording a glimpse into the health of children from an Archaic population. By utilizing the database created by David Dickel and Glen Doran following the initial recovery and analysis at the time of excavation, the remains exhibiting pathology were isolated ("pathos population") and a breakdown of the various disorders was compiled. The pathological conditions identified included traumatic injury, periostitis/ osteomyelitis, cribra orbitalia, linear enamel hypoplasia, and spinal disorders. These disorders will be defined and their incidence in the population examined.

The Windover Population

The term "subadult" refers to any individual below 18 years of age, as aged using standard aging methods from the dentition, long-bone lengths, post-cranial skeletal morphology, and population seriation. Subadults from Windover comprise approximately 40% of the total population recovered. Figure 1 provides age breakdowns for the subadult population (midpoint of age estimations). The "pathos population" was identified using examination notes from Dickel and Doran created at the time of excavation as well as re-examination by the author, and includes only those individuals demonstrating evidence of pathology (Figure 2).

Of the total subadult population from Windover, 27 individuals, or 38%, show evidence of pathology. Among the 27 individuals showing pathology, 50% (13 individuals) exhibit some form of bone inflammation, 50% (13) exhibit evidence of cribra orbitalia, 15% (4) exhibit some form of traumatic injury, and 23% (6) exhibit linear enamel hypoplasias. Eighteen of the 27 individuals, or 66%, exhibit evidence of multiple pathological conditions. Three individuals exhibit other forms of pathology, primarily spinal disorders.

Periostitis/Osteomyelitis

Periostitis is a surface inflammation of bone, manifested by fine pitting, longitudinal striation, and plaque-like new bone formation on the original cortical surface (Roberts and Manchester 1997:129). It is most often attributed to infectious disease but can also occur secondary to traumatic injury. Osteomyelitis is an infection of bone involving the marrow (Ortner and Putschar 1981:41). It results from introduction of

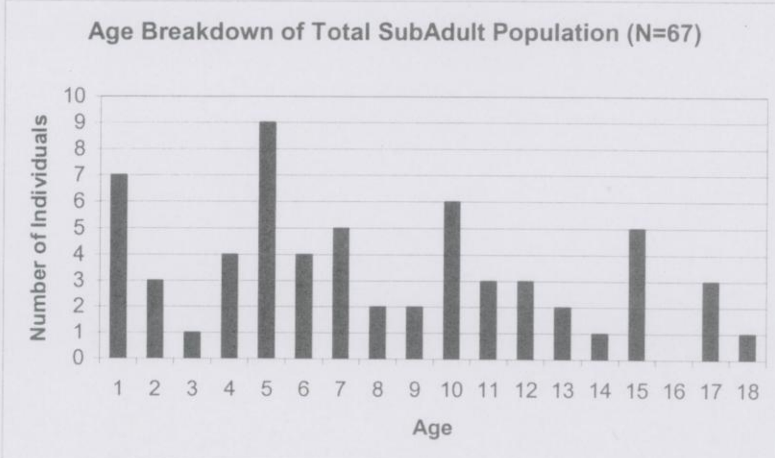

Figure 1. Age breakdown of subadults from the total Windover population. *One individual of 18 years of age is included due to immature skeletal morphology and the presence of extensive pathology.

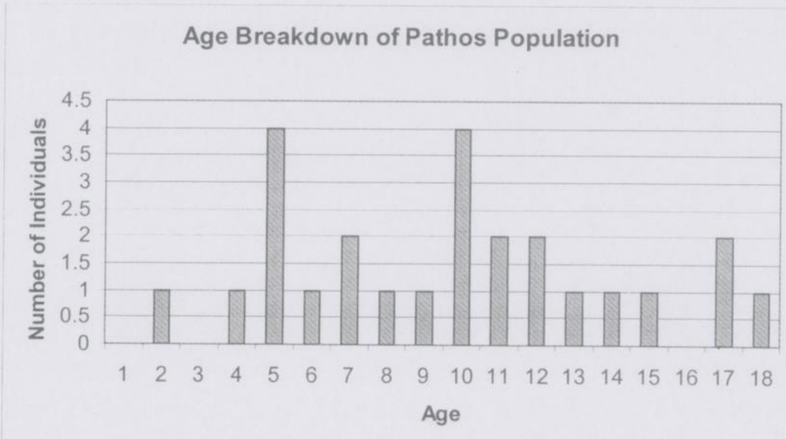

Figure 2. Age breakdown of subadults from the "Pathos" population (N=27).

pyogenic, or pus-producing, bacteria into bone, secondary to localized infection or trauma, or from systemic dissemination of bacteria in the bloodstream. It produces pitting and irregularity, as well as periosteal expansion, which produces an enlarged, irregular appearance to the bone. Osteomyelitis is typically accompanied by clocae, which are openings through the bone from which pus can evacuate.

Evidence of bone infection may indicate stress within a population in the form of malnutrition, decreased host resistance, and elevated rates of morbidity and mortality. Among the subadults of Windover, 19% showed evidence of some form of bone inflammation, either in the form of periostitis or osteomyelitis. Hutchinson (2002:118), in an analysis of inner and out coastal populations from the Late Woodland phase in

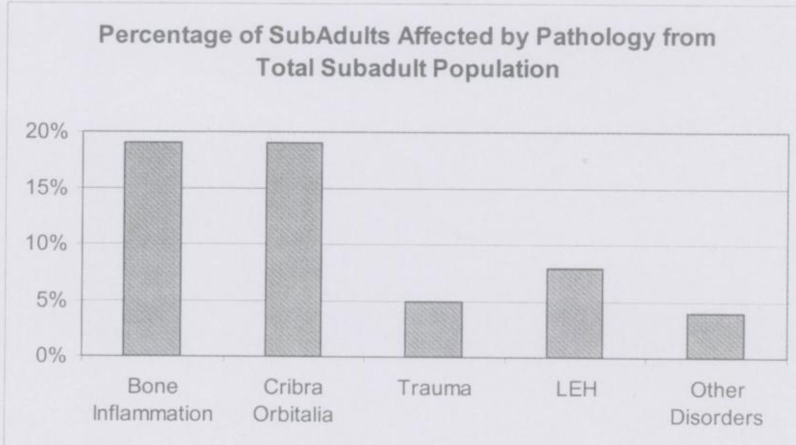

Figure 3. Pathology percentages from the total subadult population (N=67).

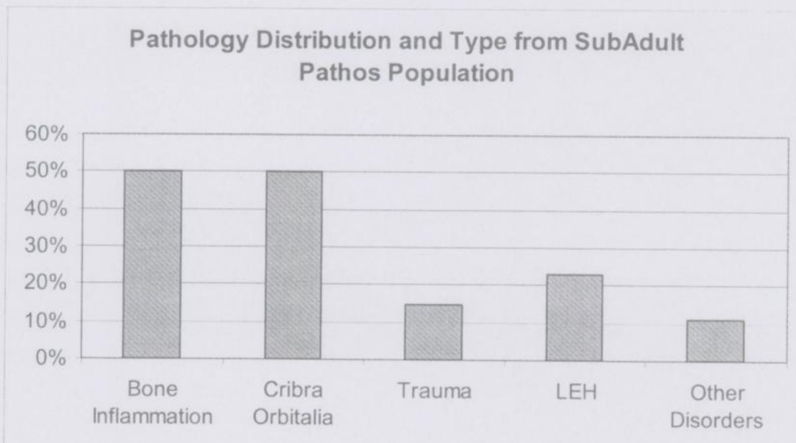

Figure 4. Breakdown of pathological conditions from pathos population (N=25).

North Carolina, found low incidences of periostitis/ osteomyelitis among subadults (1% and 2% respectively).

Bone inflammation also can be secondary to various forms of systemic infectious disease, such as tuberculosis and syphilis. However, lacking the "typical" skeletal manifestations associated with such conditions, it is difficult to diagnose these diseases in the archaeological record. None of the subadults from Windover exhibit "typical" skeletal lesions or patterns of known infectious disease, although the presence of bone inflammation is quite prominent. None of the bone inflammation was associated with traumatic skeletal injury. However, issues of selective preservation combined with the

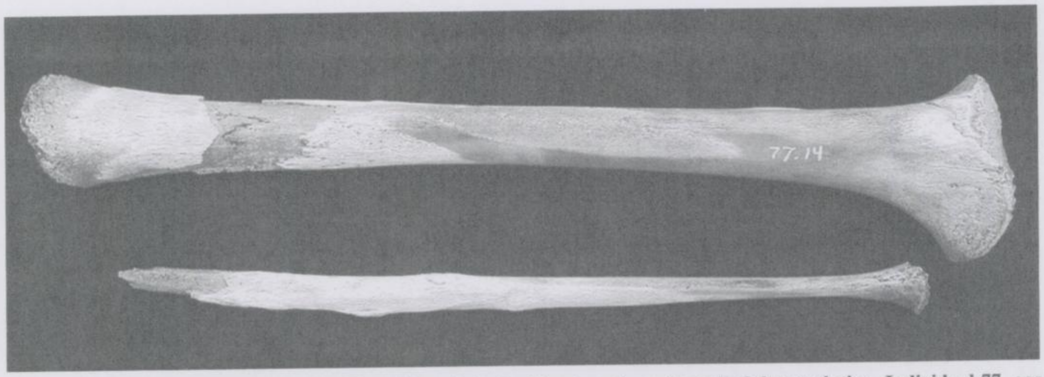

Figure 5. Example of cloaking periostitis with pathological fracture from the subadult population, Individual 77, age 10 (Photo courtesy of G. Sutton).

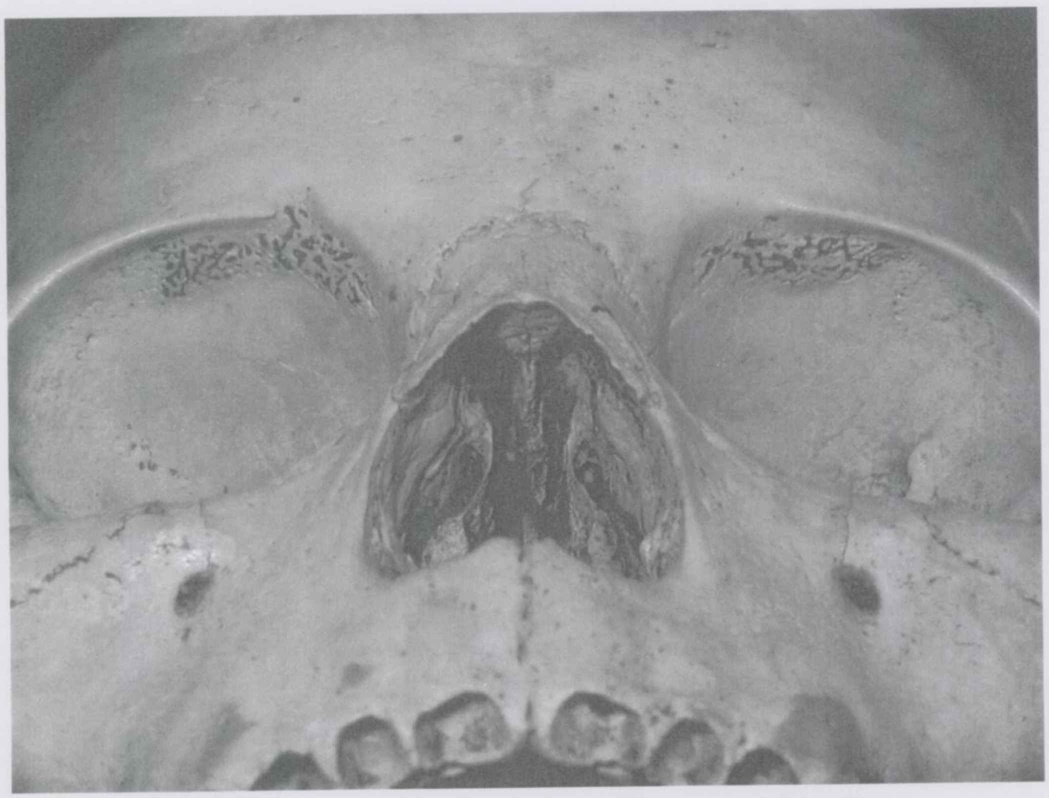

Figure 6. Cribra orbitalia in subadult remains, Individual 36, age 6 (Photo courtesy of G. Sutton).

Figure 7. Example of a healed clavicular fracture in a 2-year old, Individual 134, age 2 (Photo courtesy of G. Sutton).

possibility of traumatic injury not manifesting on the skeleton must be taken into consideration. Lacking associated trauma, it may cautiously be assumed that the periostitis found among the subadults from Windover was the result of infectious processes or nutritional deficiencies experienced within the population.

Cribra Orbitalia

Cribra orbitalia is defined as lesions in the form of bilateral pitting of the orbital part of the frontal bone (White 2000:524). It has been associated with iron deficiency anemia, infectious disease, and nutrient losses due to diarrheal diseases. In an examination of over 400 crania from European, tropical, and sub-tropical individuals, it was concluded that iron deficiency anemia, resulting primarily from parasitism, was strongly associated with the occurrence of cribra orbitalia (Mittler and Van Gerven 1994:293). Cribra orbitalia has also been linked to nutritional deficiencies associated with scurvy (Ortner et al. 1999:322). The high incidence among Windover subadults could be due to any of these causes. Cribra orbitalia is often associated with diploe expansion of the cranial bones, known as porotic hyperostosis. Analyses based on carbon and nitrogen bone-collagen values and archaeobotanical information were consistent with a subsistence strategy that utilized river-dwelling fauna and a range of terrestrial flora (Tuross et al. 1994:296). Although the people from Windover followed a typical gatherer/hunter/fisher subsistence strategy, they could have suffered from deficiencies in nutrition leading to anemia. They also could have been exposed to infectious agents or parasites, which could subsequently have caused bony changes in the form of cribra orbitalia among sub-adults from this population. However, when the number of subadults less than ten years of age exhibiting cribra orbitalia was compared to other preagricultural groups from the southeastern Georgia Bight (Larson et al. 2002:424), the subadults from Windover exhibited a lower incidence of this condition (11% in Windover subadults versus an overall 38% from subadult samples from the Georgia Bight).

Trauma

Trauma can be defined as any bodily injury or wound and is one of the most common pathological conditions seen in human skeletal remains, appearing regularly in the paleopathological literature (Roberts and Manchester 1995:65). The examination of fractures among individuals and fracture patterns within populations provides us with a great deal of information about their daily activities (Nakai et al. 1999:77). In a previous analysis of fractures from Windover (Smith 2003), it was noted that the frequency of traumatic injury among subadults was low. Of 67 sub-adults, only four displayed evidence of fracture. The fractures observed included one depressed cranial fracture, one clavicular fracture, one

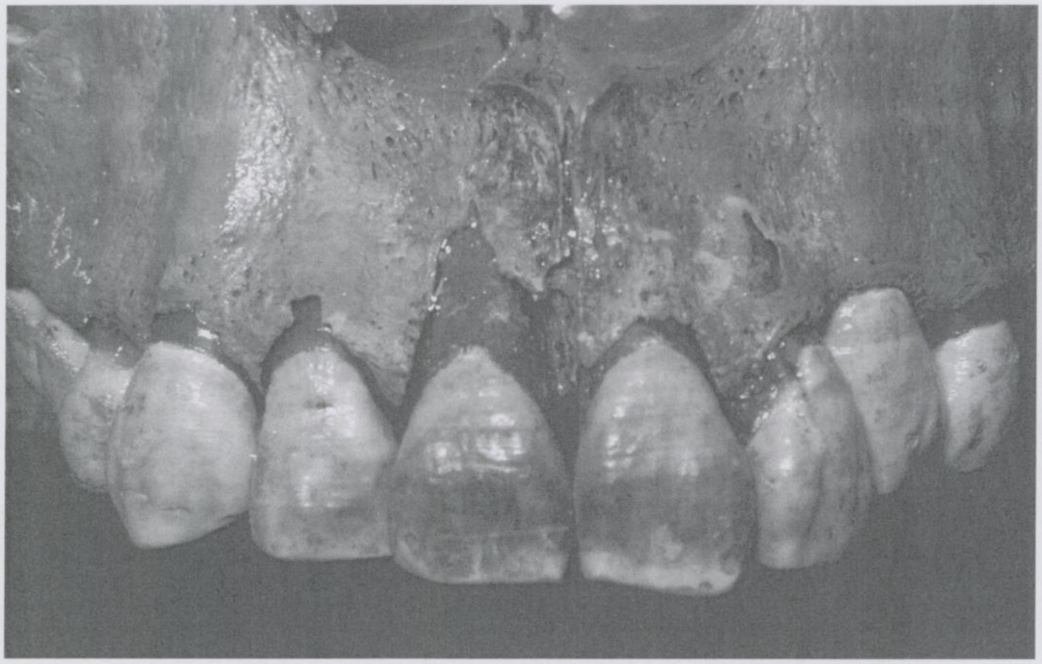

Figure 8. Example of enamel hypoplasias in a maxilla, Individual 112, age 14 (Photo courtesy of G. Sutton).

fracture of the ischiopubic ramus, and one pathological fracture of the tibia. All fractures, with the exception of the tibial fracture, were well healed at the time of death. When compared to another large archaeological skeletal population, from Libben, Ohio (Lovejoy and Heiple 1981:537), the subadults from Windover exhibit equal numbers of traumatic injuries (four fractures from subadults <20 years of age from Libben).

Linear Enamel Hypoplasia

Linear enamel hypoplasia (LEH) is a condition characterized by transverse lines, pits, and grooves found on the surfaces of tooth crowns and indicative of general stress to the individual (White 2000:115). Often termed "indicators of stress" they consist of deficiencies in the enamel matrix composition and are well represented in the archaeological record. Enamel hypoplasia is judged to be a non-specific, although sensitive, indicator of stress because it can be brought about by many factors, including nutritional deficiencies, infectious diseases, and metabolic disruptions (Moggi-Cecchi et al. 1994:299). Many recent studies have attempted to use hypoplasias as indicators of the level of generalized metabolic stress present in a given population (Duray 1990). Eight percent of the total subadults (N=6) from Windover exhibit LEHs, 23% of the pathos population. Hutchinson (2002:118) found a significantly higher percentage of subadults affected by enamel hypoplasias among inner and outer coastal populations from the Late Woodland (18% and 9%, respectively). Along with hypoplasias, the subadults from Windover also suffered from dental attrition, caries, and abscesses.

Other Disorders

There are two other types of pathologies noted among the subadults from Windover, both involving the spinal column. One individual exhibits a separated neural arch in the first sacral vertebra. Known as spondylolysis, this condition consists of the failure in ossification union of the vertebra, resulting in separation of the vertebra into two parts, ventral and dorsal (Aufderheide and Rodriguez-Martin 1998:63). The other form of disorder is spina bifida. Spina bifida is a commonly mentioned abnormality in reports of archaeological specimens (Ortner and Putschar 1981:356). A total of five individuals from Windover exhibited spina bifida. Two of these individuals were subadults, exhibiting various degrees of expression of the disorder. The term spina bifida encompasses a continuum of increasingly severe defects involving failure of the vertebral neural arches to completely enclose the posterior spinal column (Dickel and Doran 1989:325). The genetic influence on the presence of spina bifida has been supported by familial and genealogical data. However, some studies have

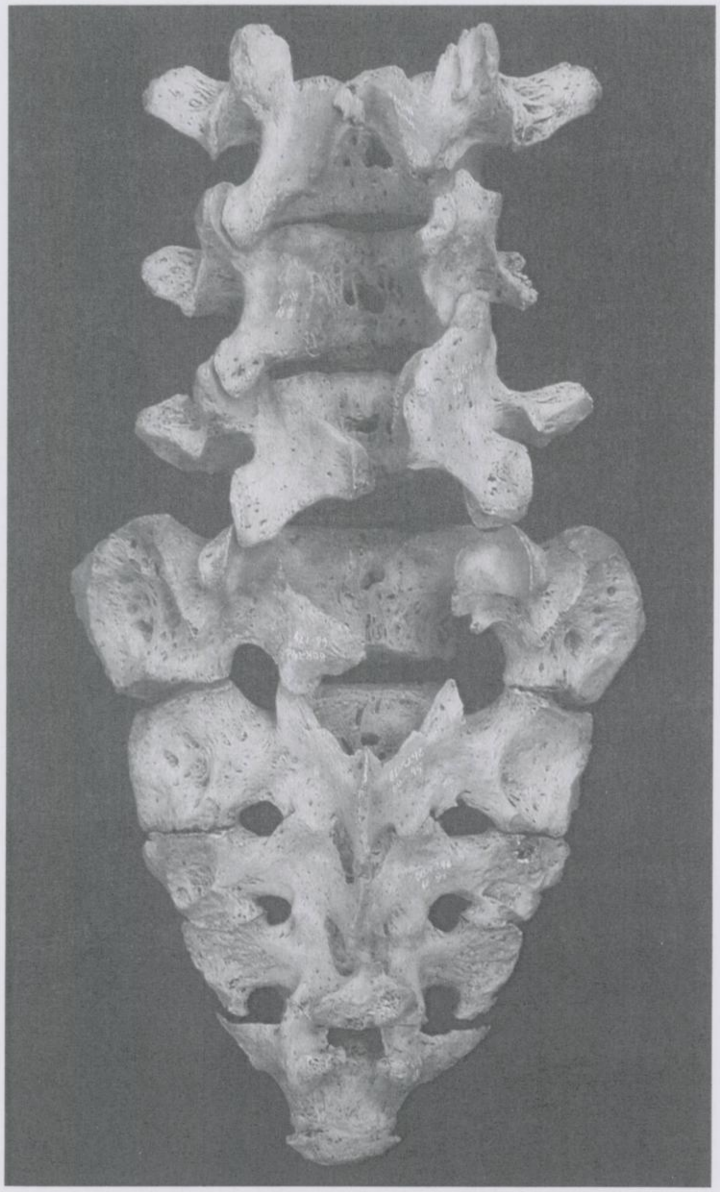

Figure 9. Example of spina bifida in an 18-year old, Individual 66 (Photo courtesy of G. Sutton).

noted short-term secular changes, seasonal fluctuations, and changes in incidence after migrant resettlement in different environments, leading to the strong possibility of external influences (Dickel and Doran 1989). One individual (#66, age 18) has a more severe form of the disorder, with separation of the neural arches from the third lumbar vertebra to the second sacral vertebra (Figure 9). This individual has associated pathologies, such as scoliosis and bone inflammation of the lower extremities and appears to have suffered from loss of the right foot as well as disuse atrophy of the long bones. The second example of spina bifida is a less severe form, affecting only the sacral vertebrae with no associated disorders.

Summary of Pathologies

"Stress" in a population is a product of three key factors, including (1) environmental constraints; (2) cultural systems; and (3) host resistance (Larson 1997:6). A summary of the pathologies observed among the subadults from Windover indicate that 1/5 of the total population of individuals under 18 years of age exhibited some form of skeletal anomaly that can be attributed to stress. The frequency of periostitis, cribra orbitalia, and enamel hypoplasia suggests the possibility that the diets of subadults were either not fortified with adequate amounts of iron, they suffered from some form of infectious disease, they were subjected to parasitism, or a combination of these factors.

Stable carbon and nitrogen analysis from bone collagen indicates the people of Windover were subsisting primarily on riverine fauna and local flora. These may have included turtle, catfish, and duck, as well as prickly pear and hickory nut (Tuross et al. 1994:296). Although the temperate climate of Florida provides a variety of flora and fauna year-round, perhaps the people of Windover encountered periods when protein sources were less than abundant. Cribra orbitalia and other types of porotic hyperostosis are valuable markers of nutritional stress, which have been applied widely to archaeological remains (Mittler and Van Gerven 1994:287). Iron deficiency anemia could have accounted for the incidence of cribra orbitalia and also could have made the subadults more prone to infectious disease. Tibial periostitis has been suggested by many to be one of the many indicators of stress visible in the skeletal record (Roberts and Manchester 1995). As stated above, periostitis is associated with stress, trauma, and infectious disease. Generally, populations undergoing adaptive shifts from foraging to part-time or intensive farming show an increase in prevalence of periostitis and bone infection (Larson 1997:85). This is not to suggest that the people of Windover were shifting subsistence strategies. However, archaeobotanical evidence suggests that they were utilizing the mortuary pond in the latter summer/early fall period (Newsom 2002), which means they were traveling to different areas at different times of the year. This mobility could have been due to fluctuations in available resources. These fluctuations could have been severe enough at times to cause periods of malnutrition among the subadults of this population.

Another factor that could account for nutritional deficiencies among the children of Windover is parasitism. Even when diets contain sufficient amounts of iron, parasitic infections can result in severe iron deficiency anemia (Larson 1997). In a study on rural Guinea children in Africa, 53% of a total of 286 children sampled tested positive for infection from soil-transmitted nematodes (Glickman et al. 1999). This study attributed a large percent of these infections to geophagia, the cultural practice of ingesting dirt. The dentition from Windover exhibits severe attrition, indicating they must have encountered high amounts of grit in their diet. Perhaps some of this grit was in the form of dirt, which could act as a means of transmission for these types of parasites. Close proximity to water also could have provided a source of parasitic infection.

The sensitivity of the human skeleton to impoverished environments, especially during the years of growth and development, is revealed by the study of a range of stress indicators, including various skeletal and dental pathological conditions (Larson 1997:61). The availability of comparative data from subadults in the archaeological record is limited. However, in comparison to other subadults from varying regions and temporal periods, the subadults from Windover experienced similar incidences of traumatic injury, lower incidences of cribra orbitalia and enamel hypoplasia, yet significantly higher levels of periostitis/osteomyelitis. Whatever the cause for the number of skeletal indicators of stress that appear among the people from Windover, 20% of the subadults from this population exhibit bone lesions that can be attributed to stress. The analysis of subadult pathologies among Archaic populations can attest to the challenging aspect of subsistence in early Florida populations.

Acknowledgments

I wish to thank Dr. Glen Doran for the use of the Windover collection and for his guidance and assistance throughout this project. I wish to thank Greg Sutton for his beautiful photography and for his continuous support, each and every day.

References Cited

Aufderheide, Aurthur C., and Conrado Rodriguez-Martin
1998 *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge University Press, Cambirdge.

Dickel, David N. and Glen H. Doran
1989 Severe Neural Tube Defect Syndrome from the Early Archaic of Florida. *American Journal of Physical Anthropology* 80:325-334.

Doran, Glen H. (editor)
2002 *Windover: Multidisciplinary Investigations of an Early Archaic Florida Cemetery*. University Press of Florida, Gainesville.

Doran, Glen H., and David N. Dickel
1988 Multidisciplinary Investigations at the Windover Site. In *Wet Site Archaeology*, edited by Barbara A. Purdy. Telford Press, Caldwell.

Doran, Glen H., Dave N. Dickel, William E. Ballinger, O. Fran Agee, Philip J. Laipis, and William W. Hauswirth.
1986 Anatomical, Cellular and Molecular Analysis of 8,000-yr-old Human Brain Tissue from the Windover Archaeological Site. *Nature* 323: 803-806.

Duray, Stephen N.
1990 Deciduous Enamel Defects and Caries Susceptibility in a Prehistoric Ohio Population. *American Journal of Physical Anthropology* 81:27-34.

Glickman, L. T., A. O. Camara, N. W. Glickman, and G. P. McCabe
1999 Nematode Intestinal Parasites of Children in Rural Guinea, Africa: Prevalence and Relationship to Geophagia. *International Journal of Epidemiology* 28:169- 174.

Hutchinson, Dale T.
2002 *Foraging, Farming, and Coastal Biocultural Adaptation in Late Prehistoric North Carolina*. University Press of Florida, Gainesville.

Larson, Clark S.
1997 *Bioarchaeology: Interpreting Behavior from the Human Skeleton*. Cambridge University Press, Cambridge.

Larson, C. S., A. W. Crosby, M. C. Griffin, D. L. Hitchinson, C. B. Ruff, K. F. Russell, M. J. Schoeninger, L. E. Sering, S. W. Simpson, J. L. Takacs, and M. F. Teaford.
2002 A Biohistory of Health and Behavior in the Georgia Bight. In *The Backbone of History*, edited by Richard H. Steckel and Jerome C. Rose. Cambridge University Press, Cambridge.

Lovejoy, C. Owen, and Kingsbry G. Heiple
1981 The Analysis of Fractures in Skeletal Populations with an Example from the Libben Site, Ottawa County, Ohio. *American Journal of Physical Anthropology* 55:529-541.

Mittler, D. M., and D. P. Van Gerven
1994 Developmental, Diachronic, and Demographic Analysis of Cribra Orbitalia in the Medieval Christian Populations of Kulubnarti. *American Journal of Physical Anthropology* 93:287-297.

Moggi-Cecchi Jacopo, Elsa Pacciani, and Juan Pinto-Cisternas
1994 Enamel Hypoplasia and Age at Weaning in 19th-century Florence, Italy. *American Journal of Physical Anthropology* 93:299-306.

Nakai, Masashi, Koji Inoue, and Sinsuke Hukuda
1999 Healed Bone Fractures in a Jomon Skeletal Population from the Yoshigo Shell Mound, Aichi Prefecture, Japan. *International Journal of Osteoarchaeology* 9:77-82.

Newsom, Lee A.
2002 Paleoethnobotany of the Archaic Mortuary Pond. In *Windover: Multidisciplinary Investigations of an Early Archaic Florida Cemetery*, edited by Glen H. Doran. University Press of Florida, Gainesville.

Ortner, Donald J., Erin H. Kimmerle, and Melanie Diez
1999 Probable Evidence of Scurvy in Subadults from Archaeological Wites in Peru. *American Journal of Physical Anthropology* 108:321-331.

Ortner, Donald J., and Walter G. J. Putschar
1981 *Identification of Pathological Conditions in Human Skeletal Remains*. Smithsonian Institution Press, Washington, D.C.

Roberts, Charles, and Keith Manchester
1995 *The Archaeology of Disease*. Second edition. Cornell University Press, New York.

Smith, Rachel K.
2003 Analysis of Skeletal Fractures from Windover (8BR246) and Their Inference to Lifestyle. Unpublished Master's thesis, Department of Anthropology, Florida State University, Tallahassee.

Stojanowski, Christopher M., Ryan M. Seidemann, and Glen H. Doran
2002 Differential Skeletal Preservation at Windover Pond: Causes and Consequences. *American Journal of Physical Anthropology* 119:15-26.

Tuross, Noreen, Marilyn L. Fogel, Lee Newsom, and Glen H. Doran
1994 Subsistence in the Florida Archaic: The Stable-isotope and Archaeobotanical Evidence from the Windover Site. *American Antiquity* 59(2):288-303.

White, Tim D.
2000 *Human Osteology*. Second edition. Academic Press, New York.