Bare Bones Anthropology: The Bioarchaeology of Human Remains

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I have always been intrigued with the behavior and quality of life of prehistoric peoples—their activities, the difficulty of their lifestyles, what they ate, how they lived, and what their health was like. In my freshman year in college at Kansas State University, I came to realize that archaeology and physical anthropology had a great deal to offer in addressing these topics. During that year, I had the good fortune of taking a class in human osteology—the study of bones and teeth—with then-visiting professor of anthropology William M. Bass. In his course I learned about skeletal and dental identification, age estimation, sex identification, and prehistoric disease. That summer, Dr. Bass secured a place for me on an archaeological project excavating human skeletons near Mobridge, South Dakota, under the direction of Smithsonian physical anthropologists Douglas H. Ubelaker and T. Dale Stewart. We spent long hours after work piecing together skeletons and discussing various topics dealing with the biology and behavior of past humans. By the time I returned for classes in the fall, I was hooked.

Since then, I've studied—in college, in graduate school, and now as a professional physical anthropologist—hundreds of skeletons from all over the world. In this chapter I share with you the kinds of exciting knowledge to be learned from analysis of ancient human remains, most of which has been made possible by new technology and imaginative hypotheses. Everything that I talk about here revolves around one simple question: What can we learn about past peoples through the study of their remains?

Bioarchaeology Defined

The specialty within anthropology that is concerned with this question has been given various names over the years, including osteology, osteoarchaeology, human zooarchaeology, archaeological skeletal biology, biological archaeology, human skeletal analysis, and so forth. All of these terms adequately describe the content of the field. However, I have settled on *bioarchaeology*, a name that captures the interdisciplinary tone of this field and its emphasis on biological (or physical) anthropology in the archaeological setting.[1] Put more simply, I define bioarchaeology as the study of the human biological component of the archaeological record.

The human biological component of the past includes anything representing once-living tissues or remains found in archaeological sites. These types of remains have been found in locations worldwide, such as the ancient mummies in Egypt, the bog people in Denmark and England, and the remarkably well-preserved corpses in Greenland, Peru, and Chile, some of which are thousands of years old.[2] Certain of these remains are well known. The recent discovery and follow-up study of the "Ice Man," a well-preserved 5,300-year-old body found frozen in ice in the Austrian Alps, has received more attention in *Newsweek*, *Time*, *The Today Show*, and other popular media than have the elections of some political leaders abroad!

However, the preservation of whole or partial bodies—mummies—requires very special circumstances, such as the extremely dry conditions in the American Southwest or the practice of intentional mummification as in dynastic Egypt and prehistoric Chile.[3] Far and away, the most commonly found human remains in archaeological settings are bones and teeth, with no trace of accompanying soft tissues (for example, muscle, hair, skin). The much greater preservation of bones and teeth is made possible by the fact that they are comprised of mostly mineral matter. Teeth, for example, have a very tough outer covering—called enamel—that is highly mineralized. Consequently, teeth are especially resistant to natural processes of decay following burial. Overall, teeth and bones are better represented in the archaeological record than are soft tissues of the body. Therefore, I'll limit the scope of this chapter to what bioarchaeology reveals about past peoples based on their skeletal remains.

The Study of Bones and Teeth in Anthropology: From Typology to Process

Analysis of human skeletal remains has a long tradition in anthropology, going back centuries to the time when early anatomists, paleontologists, and natural historians were attempting to comprehend the position of living representatives of *Homo sapiens* in a greater natural order. Bones and teeth were used to determine evolutionary and biological relationships among different geographic groups of people, between living humans and potential fossil ancestors, and among humans and other living species in the order

Primates.[4] For much of the last couple of centuries, this field emphasized measurement of skulls and other bones (for example, the femur or thigh bone) for identifying racial characteristics of human groups. These typologically oriented studies resulted in generating literally hundreds of different measurements.

In the early 1900s, the founding fathers of physical anthropology in the United States, Ales Hrdlicka of the Smithsonian Institution and Earnest A. Hooton of Harvard University, developed a kind of typological analysis that was highly influential in determining the direction that the field would take in the following decades. Hooton, for example, constructed a classification scheme for the American Southwest, whereby he argued that individual crania could be typed and racial history could be inferred.[5] Other physical anthropologists began to develop cranial typologies for classifying populations within broad geographical areas.

Typological approaches to skeletal analysis have some major drawbacks, which cast doubt on their validity and meaning. Most importantly, none of the typological studies sought to address the biological significance of variation among and between human populations—the singular purpose was to identify boundaries. In recent years, however, physical anthropologists have been emphasizing the role of environmental and developmental processes that underlie the variability we see in human skeletal remains, such as in the shapes of skulls and other bones. Bones in the living person are very plastic and respond to mechanical stimuli over the course of an individual's lifetime. We know, for example, that food consistency (hard vs. soft) has a strong impact on the masticatory (chewing) muscles, which in turn influence the way skull form develops as the person grows and matures.[6] Similarly, physical activity has a dynamic influence in determining the shape of cross-sections of the femur bone.[7] New technological advances developed in the last ten years or so now make it possible to reconstruct and interpret in amazing detail the physical activities and adaptations of humans in diverse environmental settings. I'll discuss some of these advances later.

My point here is that there has been a fundamental shift in emphasis in the study of skeletal remains of past populations from typology to *process*, which means trying to explain the variation that is observed in skeletal remains throughout the world. The challenge is to understand past peoples as members of living and functioning populations—as though they were alive today. I emphasize here that bones and teeth in the living person are tissues that are remarkably sensitive to the environment. As such, human remains from archaeological sites offer us a retrospective biological picture of the past that is not available from other lines of evidence. With this perspective, we have the basis for understanding earlier peoples as members of real populations rather than as meaningless typological groups.

Current Approaches to the Study of Human Skeletal Remains

Like all scientists, bioarchaeologists formulate their research agendas by asking specific questions. Consistent with this approach, I pose four key questions and discuss the kinds of information that are used to address them in analyzing archaeological skeletal remains.

What Did People Eat? Dietary Patterns in Past Human Populations

This is an important question in anthropology because the diet (the foods that are eaten) and nutrition (the way that these foods are used by the body) of a population play an integral role in its adaptive success. We've all heard the expression, "You are what you eat." To the bioarchaeologist, the metaphor is literally true because a large number of foods leave a diagnostic chemical signature in the bones of what the person ate during his or her lifetime.[8] By looking at a group or population of skeletons from one archaeological site or prehistoric culture, we are able to document characteristics of the diet in general as well as how it varied by age, sex, or social group. Moreover, in comparing different samples of skeletons from different time periods within a region, we are able to look at how diets are altered in response to a change in circumstances, such as the adoption of a new food, technological change, population increase, or environmental disruption.

Until now, most of what we knew about the diet of past populations came from plant and animal remains excavated from prehistoric sites. Unfortunately, this kind of information rarely tells how much was eaten or in what proportions, because of the highly variable preservation of food remains. Without this information, we cannot draw inferences about the nutritional quality of the diet.

Much more precise information about diet is available from newly developed quantitative approaches based on the measurement of ratios of stable isotopes of carbon (^{12}C, ^{13}C) and nitrogen (^{14}N, ^{15}N) in bones. The isotope values are physically determined by taking a small bone sample of perhaps a few grams or so from a skeleton, converting the bone sample into a gas, and measuring the isotope values with an isotope ratio mass spectrometer.[9] This approach is based on the premise that carbon and nitrogen stable isotope ratios directly reflect the foods that the consumer ate.[10] Briefly, the isotopic ratio (denoted by the Greek letter delta, δ) values are related to the role of terrestrial (land-based) plant or marine food sources in diet. Terrestrial plants follow one of three photosynthetic pathways, either C_3 (Calvin), C_4 (Hatch-Slack), or Crassulacean Acid Metabolism (CAM). Typically, C_3 plants have very negative $\delta^{13}C$ ratios, C_4 plants have less negative ratios, and CAM plants lie somewhere between C_3 and C_4 ratios. Nitrogen isotope ratios ($\delta^{15}N$) are useful for distinguishing consumption of marine vs. terrestrial foods. These distinctions are passed along to the consumers, eventually leaving a dietary signature in the bone tissues of the humans.

Corn (or maize) was the only C_4 plant of dietary importance in North America (most other plants were C_3) at the time Europeans first arrived in the New World.[11] For some time, archaeologists have wanted to know when corn achieved its dietary importance in native New World societies. This new technique helps answer this question. Based on the measurement of stable isotope ratios of carbon from human bone samples taken from archaeological sites all over the eastern United States dating from the period of 500 B.C. to A.D. 1500, we have learned that the rate of increased dependence on corn varied from region to region. In general, heavy reliance on this plant did not occur until late in prehistory, certainly after A.D. 800 to 900.[12]

Why is it important to know that corn was so heavily used by Native Americans, or by any other population for that matter? For understanding prehistoric health, the answer is simple. Corn is a notoriously poor source of nutrition—it lacks a couple of essential amino acids (amino acids that the human body doesn't produce by itself), it is deficient in niacin, and it has phytate, a chemical substance that actually prohibits iron from being absorbed by the body tissues. These factors alone indicate that if there is an over-reliance on corn—which we see in many third world nations today—then growth potential is compromised and there is a risk of iron deficiency.[13] Moreover, maize is a carbohydrate with a high sugar component. Anyone who eats sugar knows the outcome of its consumption—tooth decay! It comes as no surprise, then, that mounting bioarchaeological evidence shows a decline in quality of life among many late prehistoric societies of the eastern United States and elsewhere.[14]

From a sociopolitical perspective, corn played an important role in both the emergence of complex societies and in the increase in population size of Native Americans during late prehistoric times. Therefore, in one sense, corn agriculture contributed to the "success" of Native Americans before contact with Europeans, if we measure success by population increase and greater social complexity. However, the cost of this apparent success was a reduction in quality of life for many thousands of individuals.

Isotopic analysis of bones in bioarchaeological studies has also increased our understanding of status and gender differences within prehistoric societies. For example, at the ancient Maya center of Copán, Honduras, high-status individuals buried in elaborate tombs have a much greater range of carbon isotope values than commoners—in fact, more than two times greater.[15] This suggests that higher-status individuals had a more varied diet and better nutrition than lower-status individuals. Moreover, in this society, females had a higher prevalence of dental caries (tooth decay), probably due to their higher consumption of carbohydrate-rich corn. This gender distinction has also been documented in many other late prehistoric sites in North America where the populations were dependent on corn.[16]

What Were Activity Patterns and Workloads Like? Reconstructing Lifestyles in the Past

A defining characteristic of humans is their lifestyle, which to a bioarchaeologist includes their physical behaviors and other attributes that contribute to movement and habitual activities. Hunter-gatherers, or populations dependent on wild plants and animals for sustenance, are often said to be highly mobile—they seem to be always on the move in search of food, never settling down in one place. Agriculturalists, on the other hand, are often perceived as sedentary. They seem to stay in one place year-round tending their crops and livestock. These characterizations of hunter-gatherer and agricultural lifeways point to the important link between mobility and the business of acquiring food and other essential resources in human populations.[17]

In addition to being highly mobile, it is often assumed that hunter-gatherers lead difficult and physically demanding lives. The archaeologist Robert J. Braidwood went so far as to say, in his popular textbook in the late 1960s, that hunter-gatherers live "a savage's existence, and a very tough one…following animals just to kill them to eat, or moving from one berry patch to another (and) living just like an animal."[18]

In order to address the general discussion of hunter-gatherer lifestyles, an international conference called "Man the Hunter"was held in 1966. Following the conference—and especially the provocative findings of Richard B. Lee's observations of the !Kung of northern Botswana[19]—a consensus developed among anthropologists that, contrary to the popular perception of hunter-gatherer lifeways as "nasty, brutish, and short," hunter-gatherers actually had it pretty good—they were not subject to much work, and, overall, life for them was leisurely and plentiful.[20]

Physical anthropologists have been looking at levels of difficulty of work in different lifeways for quite some time. Osteoarthritis is an important indicator of level and pattern of activity in humans. Osteoarthritis is a disorder that results from cumulative physical wear and tear on the joints, especially those joints involved in movement from one place to another (for example, the hip and leg joints).[21] In addition, nonweight-bearing joints that are involved in other types of motion—such as the elbow, wrist, and shoulder—are subject to different kinds of physical demands, such as in the lower back.

What does osteoarthritis look like in the skeleton? Bioarchaeologists typically observe tiny projections or spicules of bones that protrude from the margins of the bones that make up joints (Figure 1). Nonarthritic joints lack these projections. In more severe cases, the cartilage that normally lines the ends of the bones wears away if the stress on the joint is severe enough. This results in direct rubbing of bone on bone within an articular joint and produces polishing (eburnation) of joint surfaces (Figure 1). In prehis-

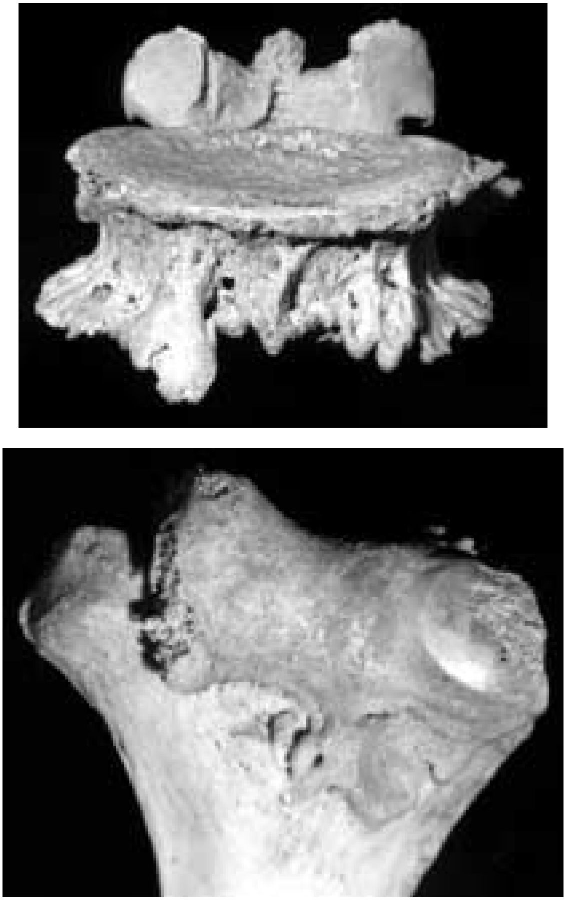

Figure 1
Top: Osteoarthritis of Lumbar Vertebra
Note the projections of bone on the margin of the joint surfaces

Bottom: Elbow Joint Showing Polishing (Eburnation) on Part of Surface
The bone shown is the end of the humerus, or upper arm bone.

(Photographs by Barry Stark; reproduced with permission of Academic Press, Inc., from Clark Spencer Larsen, "Bioarchaeological Interpretations of Subsistence Economy and Behavior from Human Skeletal Remains," in Michael B. Schiffer, ed., *Advances in Archaeological Method and Theory*, vol. 10.)

toric skeletons, common sites of polishing are the ends of the femur and tibia, especially in the knee joint, and the ends of the radius (one of two bones of the lower arm) and humerus in the elbow joint.

The observation of these degenerative changes in archaeological skeletons gives important insight into past activity loads and patterns. For example, physical anthropologists have been able to reconstruct in some detail the different kinds of activities that people undertook in the past based on the pattern of osteoarthritis within individual skeletons, that is, from the joints most commonly affected. Comparison of the elbow joints of Eskimos and ancient Peruvian Indians indicates very different patterns of osteoarthritis involvement.[22] Eskimos have more osteoarthritis of the elbow joint than Peruvian Indians. How is this difference between populations linked with their activities? Through ethnographic field studies, anthropologists know that Eskimos make heavy use of the atlatl (spear thrower) in hunting animals such as seals. Thrusting of the atlatl places severe demands on the elbow, which ultimately results in osteoarthritis in older adults. Because most individuals are right handed, there is a higher frequency of degenerative changes in the right elbow than in the left elbow in Eskimos. Peruvian Indians did not use the atlatl and, therefore, experienced relatively less mechanical demand in the elbow. The differences between Eskimos and Peruvian Indians in elbow osteoarthritis is related directly to how they used the elbow joint.

Physical anthropologists have found that, in contrast to Eskimos, some prehistoric native groups in the American Southwest have equal distribution of osteoarthritis involving both elbow joints, especially in women.[23] This pattern likely relates to the use of grinding stones, an activity that involves both arms for processing corn kernels into flour. In recent Southwestern societies this work is performed exclusively by women.

All human populations, regardless of time or place, have osteoarthritis. However, because some human groups are subjected to relatively greater amounts of physical labor than other groups, we should expect to see more osteoarthritis in them. In general, mobile hunter-gatherer groups tend to have relatively higher levels of osteoarthritis than sedentary groups.[24] In order to examine the effects of major adaptive shifts on human populations, I have looked at patterns of osteoarthritis in a large number of skeletons from prehistoric hunter-gatherers dating from about A.D. 500 to 1150 from the Georgia Atlantic coast and compared them with later corn agriculturalists from the same region dating from about A.D. 1150 to 1450. The hunter-gatherers collected wild plants, hunted animals (for example, deer), and did a great deal of fishing. Their descendants in later prehistoric times ate the same kinds of foods, but maize was introduced about A.D. 1100 or so and rapidly became a central part of diet. Based on my reading of bioarchaeological reports on osteoarthritis in hunter-gatherers and agriculturalists from prehistoric sites—showing that hunter-gatherers have a tendency for higher levels of osteoarthritis—I thought that the earlier hunter-gatherers would have more osteoarthritis than the agriculturalists living on the Georgia coast. Comparison of the two groups of skeletons from the region confirmed my hypothesis.[25] This finding suggests that there was a decline in workload with the increased focus on corn in this region.

Since the early 1980s I have been collaborating with archaeologists and physical anthropologists on the study of skeletons from Spanish missions located in coastal Georgia and in northern Florida.[26] These missions were established by the Spanish Crown in cooperation with the Roman Catholic Church during the late 1500s and throughout the 1600s in order to introduce Christianity to native populations and also to stake a claim to this region of southeastern North America. The Spanish relied on Indians as a labor source for raising crops, building projects, and labor transport. By all accounts, these labor demands were excessive, and they took a heavy physical toll on Indian groups in the region.[27] What should we expect to see in osteoarthritis prevalence in these mission Indians, the descendants of the prehistoric populations from the region? In looking at their skeletons, my colleagues and I have found that osteoarthritis increased dramatically in mission Indians.[28] For example, if we look at one joint—the adult male lumbar (lower back) vertebra—the frequency of individuals affected by osteoarthritis jumped from 16 percent in late prehistoric agriculturalists to 53 percent in mission Indians. As predicted, the increase in osteoarthritis indicates that the workload of mission native groups was indeed much higher. In this case, historic writings for the time period are verified by human skeletal analysis.

Although the osteoarthritis findings allow the bioarchaeologist to characterize patterns and levels of workload in extinct human societies, the accurate interpretation of the disorder is clouded by the fact that genetic predisposition, body weight, age, and other predisposing factors influence its presence. Therefore, like any scientific investigation, it is important that we go to other lines of evidence that might confirm findings based on the study of osteoarthritis in archaeological skeletons. So we turned to the analysis of bone structure in relation to physical activity.

In the late 1800s the German anatomist and orthopaedic surgeon Julius Wolff recognized the great sensitivity of bone to physical or mechanical stimuli.[29] He argued that in the living human skeleton, bone is placed where it is needed in response to physical demands. A century of follow-up experimental and other evidence has accrued that strongly supports what has become known as Wolff's Law of Bone Remodelling (abbreviated as Wolff's Law).

We now know that over the period of one's lifetime the long tubular bones of the skeleton (for example, femur) are constantly subjected to mechanical stimuli, especially bending and twisting forces resulting from all sorts of physical activity, such as walking, running, lifting, climbing, or even standing. In archaeological remains, we can actually measure the bone's response to the stresses that the person experienced while he or she was alive. We do this by measuring the "strength" of the bone's cross section anywhere along the diaphysis (the long shaft of the bone), just as an engineer would measure the strength of an I-beam or other materials that are used to construct a building.[30] This is based on a simple engineering principle: For any given location along a beam (or long bone diaphysis), the further the material is away from the center of a cross section, the greater its overall strength or resistance to mechanical forces (especially bending and twisting) at that location.[31] Bending a ruler illustrates this principle. If you hold each end of a ruler—one end with your left hand and one end with your right hand—and apply pressure with your thumbs to the middle of the ruler's flat surface in the direction away from your body, it bends easily. However, if you rotate the ruler 90° and try to bend the ruler by applying pressure along the narrow edge, there is little or no give. The small amount of give is due to the fact that there is simply more material in the cross section that is distributed away from a central axis, thus giving the ruler more strength or resistance to bending in this direction.

A long bone is a special kind of beam in that it is hollow. Therefore, we have to be able to measure the cross section of just the bone matter excluding the hollow space. There are a couple of ways of doing this. One way is to physically cut the bone with a saw at the region where the strength is to be measured, but this results in destroying some of the bone in order to get the measurement. A more desirable alternative has been made possible in recent years by the availability of noninvasive technology, such as computed axial tomography (CAT scans), whereby accurate images of bone cross sections are produced without cutting.

When we have a cross section image, it is then projected onto a screen, and the bone cross section is traced with an electronic stylus interfaced directly with a computer. This stylus records key points along the bone perimeter and automatically calculates cross-sectional geometric properties (values that represent measures of bone strength). This approach is especially valuable because it allows for the recording and storing of thousands of strength values and the study of many skeletons at one time.

The elegance of the structural approach is that we can directly measure the strength of bones—high values of strength indicate that the person's bones adapted to high physical demands during his or her lifetime, and conversely, low values of strength indicate reduced exposure to physical demands. In a decade-long collaboration between Christopher Ruff and me, we have determined section properties for prehistoric and mission period femora and humeri from Georgia and Florida. This comparison was ideal for testing our hypotheses about work load and activity because of the availability of the osteoarthritis data base for these same populations. The cross-sectional analysis showed a reduction in bone strength in comparing the prehistoric agriculturalists with prehistoric hunter-gatherers, which is consistent with our earlier conclusions about decline in workload.[32] The comparison of the mission femora and humeri revealed that the Indians had generally stronger bones than the prehistoric Indians, thus representing a reversal of the trend that we saw in the prehistoric populations. Our hypothesis of increasing workloads in mission Indians was also confirmed.

How Healthy Were Earlier Peoples? Health Status and Illness in the Past

Human skeletons from archaeological sites offer an enormous opportunity to examine the history of human health, especially before the time of written records. The drawback of skeletal evidence of disease is that relatively few specific diseases leave a diagnostic signature on the skeleton. Moreover, some diseases result in either rapid death or rapid recovery, thus leaving no time for a skeletal impression to be made. On the other hand, there are a number of chronic infectious diseases—diseases that the individual lives with for a lengthy period of time (months or years)—for which there is a distinctive pattern of skeletal involvement. The study of disease in the past, called *paleopathology*, is very important to bioarchaeology because it has fostered a greater understanding of the problems that human populations experienced in the past, especially in regard to factors such as diet, environment, population size, and other circumstances that might affect disease susceptibility and transmission.

Paleopathological investigations have contributed a great deal of information for dispelling misunderstandings about disease and quality of life in prehistoric societies. For example, the myth persists that before Columbus arrived in the New World, Native Americans lived in an essentially disease-free environment.[33] Sociologist Russell Thornton stated that "there are overwhelming indications that the peoples of North America and the entire Western Hemisphere were remarkably free of serious diseases before the Europeans and Africans arrived."[34] Based on my own studies and in reviewing numerous reports of human skeletons from prehistoric archaeological sites in North America and South America, I have come to the conclusion that prehistoric Native Americans were far from disease-free. Tuberculosis, an infectious disease caused by the bacillus *Mycobacterium tuberculosis*, was long thought to have been transported to the Americas from Europe. However, tubercular bone lesions—expressed in the form of pitting and loss of bone tissue, especially in the lower vertebrae (spine)—have been documented in many prehistoric remains in North and South America (Figure 2).[35] New evidence supporting the presence of TB in prehistoric societies has for the first time been observed in DNA extracted from lung and lymph tissue from a one-thousand-year-old Peruvian mummy.[36]

In addition to TB, a group of infections called treponematosis—which includes both venereal (sexually-transmitted) and nonvenereal forms of syphilis—has also been observed in numerous prehistoric skeletons throughout the Americas. Among other skeletal changes, this disease results in abnormal expansion of long bone diaphyses, such as in the tibia. The form of syphilis in prehistoric skeletons is probably nonvenereal.

Most infectious conditions observed in human skeletons are not identifiable as to the specific diseases that caused them. The study of nonspecific infections lends important insight into general

Figure 2
Large Pits on Sides of Vertebrae, Which Are Probably Due to Advanced Tuberculosis in an Indian from Prehistoric Georgia
(Photograph by Mark C. Griffin)

characteristics of human health prior to European contact. The most common of these infections are called periostitis or periosteal reactions because they involve the periosteum, the outer covering of bone. In this regard, the periosteum becomes swollen, and the surface is roughened (Figure 3). There is now abundant evidence from the study of skeletons from numerous archaeological sites for the presence of these infections well before European contact. In some prehistoric sites, well over half of adults have periostitis (or a more severe form of the infection called osteomyelitis).[37]

Interestingly, bioarchaeologists are finding that populations with relatively high frequencies of infections—specific and nonspecific—tend to be late prehistoric, especially in eastern North America.[38] I believe that this is likely related to the fact that population size was highest during this time and that population tended

Figure 3
Periostitis or Osteomyelitis from Prehistoric Georgia Indian

(Photograph by Mark C. Griffin)

to be concentrated in some regions in sedentary, densely crowded communities. Population crowding provides the conditions that are conducive to the spread of infectious disease because of closer contact between people and rapid transmission of pathogens (agents such as bacteria that cause disease). Additionally, crowding oftentimes results in reduced sanitary conditions, thus creating an additional health hazard. Recall from my previous discussion that the increased reliance on corn resulted in a decline in nutrition in late prehistoric societies in the eastern United States. Infection and poor nutrition have a synergistic relationship. That is, an infection interferes with nutrition and undernutrition lowers resistance to infection. Therefore, the general decline that we see in health was likely caused by poor nutrition, by infections, and by the synergy of nutrition and infection.

Teeth from archaeological sites offer a unique perspective on the human condition. Unlike bone tissue, once formed, teeth do not change their shape or structure except from excessive wear or cavities. Teeth are also highly sensitive to physiological problems that might arise during the years that they are developing. The crowns of secondary, or permanent, teeth (the teeth that replace the primary, or milk, teeth) begin to form a little after birth (the first molar) and are completely formed by about age twelve (the third molar). During this period, disease, poor nutrition, or a combination of both may result in disruption of the enamel formation, resulting in defects called hypoplasias. The most common type of defect is a linear groove around the tooth crown that reflects the completeness of the tooth at the time of the disruption (Figure 4).[39]

Hypoplasias have been found in numerous archaeological teeth worldwide.[40] These stress markers provide bioarchaeologists with an important source of information on quality of life in past human groups. Alan Goodman and his colleagues have examined

Figure 4
Hypoplasias on Incisors (Two Middle Teeth) of Child

Note the series of horizontal lines across these teeth.
(Photograph by Barry Stark)

the frequency of hypoplasias in populations undergoing the transition to intensive corn agriculture in the prehistoric Midwest at the Dickson Mounds site, Illinois. Given what I have said elsewhere in this chapter about declining health in corn agriculturalists in prehistoric North America, I think you can probably guess what they found in their research on dental defects. In comparison of incipient agriculturalists with full-blown corn agriculturalists they found an increase in the frequency of people affected by hypoplasia from 45 percent to 80 percent, thus demonstrating an elevation in physiological stress levels.[41]

How Can Interactions between Populations Be Observed? Measuring Conflict in Past Societies

Violence is a form of interaction that has been studied by anthropologists from a variety of approaches, but it is not always easy to find in the archaeological record. Bioarchaeologists have recently made a contribution by methodical study of the skeletal remains of the victims of conflict. We are learning that human remains offer an important perspective on the biological costs of conflict that is not available from other data sources.

George Milner has recently completed a study of a series of several hundred skeletons from the late prehistoric (ca. A.D. 1300) Norris Farms cemetery located in west-central Illinois.[42] He presents incontrovertible evidence that a significant portion of deaths in this population were due to violence. Some 16 percent of the skeletons show evidence of malevolent trauma, including scalping, mutilation, decapitation, massive skull fractures, and arrow wounds. Most injuries were lethal, but at least five adults—all women—have well-healed scalping marks on their skulls, indicating that they survived an attack or attacks. Archaeological evidence indicates that the attacks likely occurred over the span of several decades. Thus, the deaths were accretional rather than catastrophic, which is a feature of chronic intergroup warfare that anthropologists have documented in small-scale societies in the twentieth century (for example, among the Yanomami).[43]

Although warfare in the Norris Farms population could be due to several factors, Milner points to the fact that population conflicts may have surfaced because of competition with other groups in the region for food resources. Analysis of food remains from the Norris Farms village indicates that there was an abnormally low diversity of animal and plant resources available to the local population. Other evidence from the study of these skeletons shows that the population was highly stressed. For example, presence of tuberculosis, enamel hypoplasias, and lesions in the eye sockets and flat bones of the skull (called cribra orbitalia and porotic hyperostosis, respectively, representing bouts with iron deficiency anemia) indicate generally poor health.

Milner's reading of the bioarchaeological literature shows that the Norris Farms site is not an isolated occurrence of warfare in the past, but rather represents a pattern of widespread conflict, especially during later prehistory in eastern North America. He argues that escalation of conflict occurred during a time of population growth, sedentism, and probable increase in competition for productive land for raising crops.[44]

FUTURE GROWTH OF BIOARCHAEOLOGY

From early in the nineteenth century, human skeletal analysis has been recognized by anthropologists and allied disciplines as important for understanding variation and evolution of earlier societies. In recent years, the appreciation for human remains in archaeological settings for informing us of past lifeways and the human condition generally has resulted in a tremendous growth in the field.

The study of human remains in some areas of the world has become increasingly controversial as many native groups express religious and political concerns and indicate their desire for "repatriation" of skeletal remains to affiliated tribes. However, largely as an outgrowth of discussions leading to the development of the Native American Graves Protection and Repatriation Act in 1990,[45] a new spirit of compromise between anthropologists advocating permanent preservation of existing collections and members of many Native American groups has emerged. I am optimistic that this emerging dialogue between anthropologists and native groups, coupled with the advances made in recent years in bioarchaeology, will result in continued growth in the field for many years to come.

NOTES

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Research TOC

Bioarchaeology is the study of human remains from archaeological sites. Human bones and teeth provide a huge amount of information about the health and lifestyle of past populations. These tissues record a cumulative history of disease, physiological stress, trauma, activity patterns, diet, nutrition, and many other factors that constitute the life history of both the individual and population. This is the first comprehensive synthesis of the subject and will be an indispensable reference for all those interested in biological anthropology and archaeology. Read more. Product details. The term bioarchaeology was first coined by British archaeologist Grahame Clark in 1972 as a reference to zooarchaeology, or the study of animal bones from archaeological sites. Redefined in 1977 by Jane Buikstra, bioarchaeology in the US now refers to the scientific study of human remains from archaeological sites, a discipline known in other countries as osteoarchaeology or palaeo-osteology. In England and other European countries, the term 'bioarchaeology' is borrowed to cover all biological Start studying Bioarchaeology and Forensic Anthropology. Learn vocabulary, terms and more with flashcards, games and other study tools.Â The study of skeletal remains and other evidence in order to determine the causes and context of death with respect to legal and criminal matters. Genetic Information. -Individual ID -Ancestry -Sex. Skeletal Information. -Age -Sex -Ancestry -Injury, Stress, Disease. Context of Death. -Premortem injury -Perimortem trauma -Postmortem context. Steps in a Forensic Investigation. -Collect data from field site/crime scene -Laboratory Processing -Biological Profile -Taphonomy -Identity and Identification. What is the primary data source for bioarchaeologists and forensic anthropologists? Feild sites