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New Directions in Bioarchaeology: Recent Contributions to the Study of Human Social Identities

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Abstract As a discipline that bridges the biological and social sciences, bioarchaeology has much to contribute to a contextualized and theoretically sophisticated understanding of social identities. Here, we discuss the growing methodological sophistication of bioarchaeology and highlight new developments in osteological age and sex estimation, paleodemography, biodistance analysis, biogeochemistry, and taphonomy, particularly *anthropologie de terrain*. We then discuss how these methodological developments, when united with social theory, can elucidate social identities. More specifically, we highlight past and future bioarchaeological work on disability and impairment, gender identity, identities of age and the life course, social identity and body modification, embodiment, and ethnic and community identities.

Keywords Archaeology · Physical anthropology · Osteology · Human remains

Introduction

As an academic specialization, bioarchaeology coherently unites the disparate subfields of anthropology by combining aspects of both the biological and social sciences (Buikstra and Beck 2006; Katzenberg and Saunders 2000; Larsen 1997, 2002; Wright and Yoder 2003). As the field moves beyond its roots as descriptive osteology (Armelagos and Gerven 2003; Buikstra and Beck 2006; Stojanowski and Buikstra 2004, 2005) and continues to address important critiques of its basic

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operational assumptions (e.g., Bocquet-Appel and Masset 1982; Cadien et al. 1974; Wood et al. 1992), bioarchaeologists continue to bridge evolutionary and social theory. As such, the study of human biological materials from archaeological contexts is in a key position to facilitate transdisciplinary research, to understand past and present populations through mortuary remains, and to make substantial theoretical contributions to the broadly conceived social sciences. The last of these pursuits is facilitated by an enhanced concern for greater historical contextualization of archaeological human remains and further articulation with social theory that complements and expands upon the biocultural health-related studies that anchored bioarchaeology's developmental phase in the 1970s and 1980s (Baker and Kealhofer 1996; Cohen and Armelagos 1984; Larsen 1994, 2001; Steckel and Rose 2002). We agree with Goldstein (2006, p. 377), who writes, "[c]ontext is everything." Context, in this sense, is broadly defined in relationship to operational issues of excavation practice as well as theoretical contextualization within an independent field of inquiry. We argue that sophisticated problem orientations are not possible without careful data collection in both the field and the laboratory, and that these data are most powerful when a research question with broad appeal is addressed. This, we think, is the primary defining characteristic of current bioarchaeological practice. Scholars are now addressing research questions not solely biological or evolutionary in orientation, and inferences about the social realm are more visible, paralleling recent scholarship in archaeology (see Casella and Fowler 2005; Díaz-Andreu et al. 2005; Insoll 2007; Janusek 2004; Lucas 2004; Reycraft 2005; Wells 2001). In this article we argue that the study of identity is one emerging research theme that is uniquely approachable using bioarchaeological research.

Building on Barth's (1969) influential work on the situational nature of ethnic identities, increasing numbers of scholars argue that individuals adopt and manipulate any number of coexisting social identities over the course of their lifetimes. But just what is meant by identity? Identities can be both personal and communal, ascribed and achieved, manipulated and feigned. Gender, age, status, ethnic affiliation, and religion all represent forms of social identities with associated behavioral expectations and roles. Identities are about self-perception and self-promotion as well as constraints imposed by others. It is the process of social interaction within a matrix of intangible social identities that makes the human social world so complex. Identities are "the process by which the person seeks to integrate his [or her] various statuses and roles, as well as his [or her] diverse experiences, into a coherent image of self" (Epstein 1978, p. 101).

Since nuanced identities are somewhat diffuse and difficult to encapsulate, we also outline what we explicitly reject as identity-based research in bioarchaeology. We argue that identity does not refer simply to origins, migration histories, or biological interconnections, as it may often be used. Rather, by focusing on the social construction of the human experience, the study of archaeological skeletal remains can make unique contributions to our understanding of social life in the past as well as those issues that plague the world today. We note that osteological indicators are both durable and plastic and therefore provide both mutable and immutable information about the identities people were signaling. Cranial and dental modification can be an overt stylistic display, dental pathology and paleodietary analysis can be used to identify dietary choices, activity patterns on the human skeleton can indicate particular behaviors, and biodistance analysis can be used to infer kinship and mate choices. Bioarchaeological approaches also are beneficial because of the temporally sensitive nature of the archaeological record, which allows inferences that are transformational, and not simply historical, in nature. The combination of durability, plasticity, and temporal sensitivity can be used to reconstruct past social processes in a manner simply not possible using archaeological or historical data sets alone. And, in many cases, it is the bioarchaeological data set that should be preferenced; for example, with inferences about mate exchange patterns and *mestizaje* or macroscale migration processes, the former often was inferred from historical documents while the latter was reconstructed based on material culture.

It also is clear that the importance and timeliness of social identities research will not be waning any time soon, and the integration of biological data into these discussions can be illuminating. Social pluralism based on ethnic, linguistic, or religious identities can lead to inequality with potential health disparities; analyses of health in the past can help illuminate situations where inequality is most likely to lead to health degradation. Genocides often are enacted based on ethnic identities; molecular or morphological analyses can help track the development of these distinct identities through time while the study of status and health can contextualize the potential reasons why such violence occurs. Given the continued focus on ethnic violence, tribalism, and nationalist movements in modern political discourse, understanding how identity groups form has repercussions well beyond anthropology. Finally, misperceptions and discrimination based on age, gender, or sexual orientation derive from facile, unexamined notions of the “natural order” of humanity; examination of age and gender identities in the past helps define how fluid such categories have been in human history.

Within this framework, we focus on specific analytical approaches that articulate with the study of past social identities: osteological sex estimation and gender identity; age estimation and identities based on the life course, paleodemography, and identities of inequality and disability; and biodistance analysis and ethnic or community identities. However, to more thoroughly summarize recent methodological developments in bioarchaeology, we also discuss recent advances in two areas that do not isometrically articulate with one specific identity category. First, improved biogeochemical methods allow us to study identity at different levels, from the relationship between paleodiet and gender and status identities to the role of population movement in the formation of ethnic identity. Second, a French approach to excavation that is gaining popularity beyond Europe, *anthropologie de terrain*, provides a way to reconstruct funerary rites in the absence of direct material analogs that can then be used in analogous fashion to studies of mortuary symbolism. In the first half of this article we review each of these methodological domains, highlighting significant improvements and new directions in applied research. In the second half we outline unique bioarchaeological contributions to the study of the social manifestations of identity in the past.

Current developments in bioarchaeological research methods

Methodological developments in osteological sex and age estimation

Sex and age estimates remain fundamental to all subsequent osteological analyses and articulate directly with the study of gender and age identities in the past. In addition, sex and age estimates are used to generate a comparative framework for paleopathological, dietary, and mortuary analyses, to provide the empirical basis of past population demographic parameters, and to mitigate nongenetic factors that introduce error into biodistance analysis. Although sexing and aging methods are well known, there is a continued need to improve existing practices.

Based on recent publications, three key areas continue to receive attention and represent recognized deficiencies in bioarchaeological practice in age and sex estimation. First, methods need to be developed that can be applied to skeletal remains that are poorly preserved and fragmentary. To this end, researchers are focusing on two approaches: (1) observations that do not rely on whole-bone preservation for the application of a discriminant model (Frutos 2003; Safont et al. 2000), and (2) skeletal elements that tend to preserve well due to their size and density (e.g., Barrio et al. 2006; Case and Ross 2007; Lynnerup et al. 2006). Such approaches are particularly appropriate since the Native American Graves Protection and Repatriation Act (NAGPRA) legislation, and similar laws enacted in other countries (Seidemann 2004), has impacted problem-oriented burial mitigation. Many of the largest and best-preserved comparative samples are being repatriated, creating an academic climate in which sampling designs are more limited and less exclusive. Focusing on those aspects of the human skeleton most likely to preserve is therefore important.

The second issue is the population-specific nature of many statistical models of sex assessment. A statistical formula derived for one population with a certain range of male and female metric variation cannot be blindly applied to other populations. Population specificity is particularly challenging for continuous-scale measurements (Ramsthaler et al. 2007; Ubelaker et al. 2002) but also applies to ordinal- or nominal-scale observational data (Đurić et al. 2005; Rogers 2005; Walrath et al. 2004; Williams and Rogers 2006). In response, new mathematical approaches that avoid the pitfalls of published discriminant function models are starting to appear. Albanese (2007) presents a method based on using the overall sample mean to calculate the most accurate male-female sectioning point for a univariate variable. This approach avoids extrapolating published statistical models and is useful for bioarchaeological data sets that contain multiple individuals. An even more flexible approach using mixture models was presented by Kramer and Konigsberg (1999) and applied for the purposes of sex assessment by Konigsberg and Frankenberg (2007). Mixture analysis is a more general form of discriminant function analysis that is internally generated for a sample, does not rely on existing known-sex discriminant function models, and is well suited for large bioarchaeological data sets that contain multiple individuals. These novel approaches advance the field significantly more than additional case studies demonstrating the effectiveness, or ineffectiveness, of a particular published method in a specific population. Although traditional discriminant function approaches are required for forensic anthropology, there is no need to rely on those methods in bioarchaeological research involving large data sets rather than individual cases.

A third challenge for osteologists is sex assessment of subadults. The inability to reliably estimate the sex of preadult individuals hinders analysis of gender and life course identities in past populations as well as comparative analyses of diet and health differences among the younger age classes. This has led to a partial invisibility of subadults in bioarchaeological research design. Recent efforts in sexing subadults have focused on the pelvis and the mandible, producing mixed results. For example, while Franklin et al. (2007) found no size-based mandibular differences between males and females, Loth and Henneberg (2001) noted significant differences in mandible shape, which Scheuer (2002) was unable to reproduce. Others have taken a more holistic approach in their validation studies. Sutter (2003) returned very strong results using eight different published features. Importantly, Sutter's (2003) work used mummies for whom the sex was known without error, but this highlights a key problem for the future. The number of known-sex subadult individuals in comparative collections is exceedingly small; this is the major impediment to progress. As with many traits for adults, there also is likely to be considerable population specificity of subadult sexual dimorphism. Odontometrics may provide a suitable solution and is already promising (e.g., Kondo and Townsend 2004).

New developments in age assessment reflect a reaction to the critiques of paleodemography that emerged during the 1980s, in particular the poor correlation between biological and chronological age, especially for individuals older than about 50 years. As a result, recent scholarship on osteological age assessment has focused on identifying morphological variation that is more highly correlated with chronological age-at-death and on revising existing aging standards to identify markers that may increase the upper limit of estimated ages. There also has been some concern with interpopulation variation and the effects of different disease processes on rates of aging. For the most part, authors have focused on validating existing methods for the os pubis (e.g., Đurić et al. 2005; Hoppa 2000), auricular surface (e.g., Buckberry and Chamberlain 2002; Igarashi et al. 2005), and sternal rib ends (e.g., Kurki 2005; Schmitt and Murail 2004). Because of its beleaguered history, cranial suture closure has received less attention (Ginter 2005). Several authors have explored digital imaging rather than direct bone observation for pubic age estimation (e.g., Hutchinson and Russell 2001), reflecting a concern with in-field or remote archiving of aging information. Scholars also continue to explore the potential of cementum annulation, a destructive technique that can produce very accurate estimates of age based on regular deposition of cementum on the tooth root (Wittwer-Backofen et al. 2004). A potentially significant new method also has recently been proposed in the form of acetabular changes similar to those seen on the pubic symphysis and auricular surface (Rissech et al. 2006; Roúge-Maillart et al. 2004). This is particularly important because the identification of entirely new aging systems is a rarity. Subadult age estimation has received much less attention, in recognition of the fact that growth processes produce more accurate age estimates for subadults than the deterioration and joint breakdown used to age adults.

Most studies of subadult age estimation have considered revised standards of epiphyseal closure or growth rates (Crowder and Austin 2005).

These new directions in observational aging protocols are paralleled by a similar concern with greater mathematical sophistication in terms of how age indicators are actually converted into an estimated age-at-death. Although phase systems—where morphological changes are described in discrete phases that the observer tries to "match"—remained deeply entrenched in osteological practice, even after the critique of Bocquet-Appel and Masset (1982), recent studies have attempted to move beyond this nearly 100-year-old approach to osteological age estimation. The phase-system approach suffers from age mimicry because age estimates mimic the comparative sample on which the estimation is based. The importance of Bayes theorem for minimizing age mimicry is now apparent (Lucy et al. 1996) and widely used (e.g., Gowland and Chamberlain 2002). It is particularly encouraging that pioneering studies such as Rissech et al. (2006) are based on these more sophisticated statistical approaches. The transition analysis method proposed by Boldsen et al. (2002) will likely completely replace the existing phase systems; Boldsen et al. (2002) redefine observational scores for the pubic symphysis and auricular surface to extend the limits of age estimation beyond 50 years. As an example of its successful application, as well as an accessible description of the mathematics behind transition analysis, we refer to Buikstra et al.'s (2006) analysis of age-at-death of Janaab'Pakal, an elite Maya ruler, which illustrates the dangers of using traditional phase systems for age estimation.

Methodological developments in paleodemographic analysis

Paleodemography uses age and sex estimates to infer fertility and mortality rates as well as age structures of past populations. Such inferences are important for three reasons. Demographic data, and age structures in particular, elucidate interpretations of health indicators in past populations (see Baker and Pearson 2006), inform inferences of adaptive success as measured by population growth or decline, and establish a baseline for biodistance analyses that focus on microevolutionary processes of gene flow and genetic drift. Although paleodemography may be more tangential with respect to social identities research, interpretations of health inequalities do require a paleodemographic baseline.

In the wake of severe criticisms of paleodemography and the inaccuracies of osteological age estimation (Bocquet-Appel and Masset 1982), new tools for estimating past mortality structures have emerged in the last decade (Hoppa and Vaupel 2002). Yet there appears to be no single standard methodology, and scholars continue to grapple with basic methodological assumptions and analytical issues. These have been recently summarized as the four-part Rostock Manifesto by Hoppa and Vaupel (2002; see also Konigsberg and Frankenberg 2002). The first component of the Rostock Manifesto is the need for more reliable osteological indicators of age, particularly those sensitive to older age intervals (Boldsen et al. 2002). As detailed above, the search continues for these indicators of advanced age, and new methods are constantly being introduced and tested. The other three components of the

Rostock Manifesto relate to statistical issues. Better mathematical models and methods are needed to estimate (1) the probability of observing a series of osteological age indicators for a specific age interval, (2) the probability of falling within a certain age interval given a series of observed osteological indicators, and (3) the distribution of age-at-deaths in the subject population (Hoppa and Vaupel 2002). The last of these implies that the age structure of the target population must be known to estimate individual ages to then reconstruct that same age structure. Although these statistical issues have been explored (Hoppa and Vaupel 2002; Konigsberg and Frankenberg 2002; Muller et al. 2002), a unified consensus remains elusive. Nonetheless, the problems of age estimation, and age mimicry in particular, are important to consider when interpreting osteological data on the human life course. Gowland and Chamberlain (2002), for example, reconsider the evidence for Roman infanticide based on a purported spike in the number of perinatal individuals identified in the archaeological record. These authors found that the peak in the age profile was an artifact of age mimicry and therefore not evidence for infanticide. We suspect other life course inferences such as weaning age and parity status may similarly suffer the effects of age mimicry and argue that continued work is needed on age estimation and paleodemographic methods.

That paleodemographers continue to reconsider basic theoretical assumptions, with more limited nonmethodological application, is a testament to the rigor of its current practitioners. This is, unfortunately, a small list, likely reflecting the steep mathematical learning curve, increasingly sophisticated modeling, and current lack of user-friendly software support. With few recent application-focused publications (e.g., Drusini et al. 2001; Margerison and Knüsel 2002; Nagaoka et al. 2006), all using modified life table analysis, it would appear that paleodemography has yet to become an accessible research tool for most bioarchaeologists. The difference in application-based publishing of paleodemography and biodistance analysis, as discussed below, is stark and likely related to the lack of user-friendly software for paleodemographic analyses. Although both paleodemography and biodistance analysis are mathematically rigorous, the former lacks a codified "procedure" supported by widely available software such as the quantitative genetics software RMET, as discussed below (Relethford 2003; Relethford et al. 1997).

Methodological developments in biodistance analysis

Biodistance analysis considers patterns of skeletal or dental phenotypic variation within the context of microevolutionary theory to reconstruct population history and population structure. Population history refers to the inferred pattern of ancestor and descendant relationships and evolutionary histories among populations and reconstructs historical connections based on phenetic similarity (Relethford 1996). Population structure refers to the patterns of genetic variation among a series of contemporaneous populations and incorporates systems of integration based on gene flow and genetic drift (Relethford 1996). Population history studies tend to be continental in scale, while population structure studies are more regionally focused (Buikstra et al. 1990; Larsen 1997). Intracemetery approaches reconstruct elements of social organization such as postmarital residence practices or patterns of kinship relationships, both of which have biological signatures (e.g., Stojanowski and Schillaci 2006). Because of greater articulation with social identities research, we focus on regional population structure analyses in this review. In particular, by providing inferences about the way communities are integrated and how the pattern of integration changes through time, biodistance analysis is well positioned to reconstruct the formation and transformation of ethnic and community-level identities in the past (Nystrom 2006; Stojanowski 2005b).

Regional biodistance analysis has undergone significant methodological transformations in recent years (Relethford 2003), which has greatly improved scholars' ability to make inferences beyond the biological and evolutionary realm. Typically, phenotypic distances are calculated based on odontometric (Kieser 1990), craniometric (Howells 1989), cranial nonmetric (Hauser and De Stefano 1989), or dental morphological (Scott and Turner 1997) observations and visually summarized using statistical ordination techniques. Affinity patterns are then compared with archaeological or historical data as a basis for interpretation. Because no specific population genetic parameters are estimated, this approach is model-free (Relethford and Lees 1982) and relies on "statistical analogies to specific population structure models" (Relethford and Blangero 1990, p. 6). Beginning in the 1980s, however, researchers became interested in modifying allele-based population genetic analyses for use with anthropometric or other continuous phenotypic data. Specifically, these workers modified the Harpending and Jenkins (1973) R-matrix, or relationship matrix, model (Relethford and Blangero 1990; Williams-Blangero 1989a, b; Williams-Blangero and Blangero 1989) and the Harpending and Ward (1982) model for detecting differential extralocal gene flow for use with continuous, quantitative data (Relethford and Blangero 1990). These methods for estimating an R-matrix were fine-tuned (Relethford 1991a, b, 1996; Relethford et al. 1997) and codified in the statistical software package RMET, which performs the calculations for multivariate data sets of continuous scale (Relethford 2003; Relethford et al. 1997). Such analytical developments place analysis of paleomorphological microevolution within a population genetic framework and, under certain circumstances, are model bound in that parameters from theoretical models are directly estimated from the data (Relethford and Blangero 1990; Relethford and Lees 1982). These more sophisticated approaches have almost completely supplanted traditional multivariate statistical approaches for landmark data, including anthropometric (e.g., Jantz and Meadows 1995; Konigsberg and Ousley 1995; Reddy et al. 2001), craniometric (e.g., Jose et al. 2002; Powell and Neves 1999; Steadman 1998; Tatarek and Sciulli 2000), and odontometric variables (e.g., Scherer 2007; Stojanowski 2004, 2005a, b). While promising, quantitative R-matrix analysis was developed for use with near contemporaneous populations, and its use in archaeological contexts should be used sparingly unless the following four conditions are met: (1) the populations are roughly contemporary and could reasonably have exchanged mates, (2) the populations can reasonably be considered part of a *regional* mating network, (3) the archaeological samples are of similar temporal duration, and (4) the archaeological samples have similar use histories (temporal variation) and burial catchment areas (geographic variation).

We argue that these newfound methods, including geometric morphometrics (Richtsmeier et al. 2002), have not changed problem orientations significantly. Population history and analysis of biological identity as "origins" remain the dominant focus (e.g., Mooder et al. 2006). Armelagos and Van Gerven (2003) have recently drawn attention to this lack of development and consider the analysis of historical relationships to be irrelevant and typological. Use of model-bound approaches, however, is not typological because there is an equal emphasis on variation and central tendency and the goal is not to reduce variation to a number of essentialized categories. The field is beginning to address complementary research questions that are more holistic in orientation and move beyond migration as an explanatory mechanism. Consideration of the relationship between social and biological identities is one future direction (Nystrom 2006; Stojanowski 2005b); the development of R-matrix methods allows researchers to redefine their problem orientations. Biodistance analysis is not simply about who is related to whom, but how those relationships changed through time and the potential significance of increasing or decreasing biological integration from a social perspective. Continued interest in intracemetery biological variation also lends itself to interpretation of social phenomena such as kinship structures (e.g., Corruccini and Shimada 2002; Shimada et al. 2004) and postmarital residence practices (e.g., Stojanowski and Schillaci 2006), neither of which are typological or historical.

Methodological developments in biogeochemistry

Bone chemistry and bioarchaeology have been closely intertwined since their inception in the 1970s. In general, the last 30 years have seen an increasingly sophisticated understanding of the advantages and disadvantages of various techniques. Paleodietary analyses using light stable isotopes are now common and accepted methodologies (e.g., Katzenberg 2000; Schoeninger and Moore 1992; Schwarcz and Schoeninger 1991; Tykot 2006). Our increasing understanding of the complex behavior of carbon and nitrogen isotopes in the human body has led to a better appreciation of the age and sex variability of bone turnover rates and the long residence time of carbon in bone collagen (Hedges et al. 2007). In addition, Kellner and Schoeninger (2007) recently demonstrated that bivariate plots of $\delta^{13}C_{apatite}$ and $\delta^{13}C_{collagen}$ provide the most accurate paleodietary reconstructions; these findings, based on both experimental and archaeological data, improve upon earlier methods using $\Delta^{13}C_{collagen\text{-}apatite}$. Finally, recent work in compound-specific carbon isotope analysis, in which the carbon isotope signatures of cholesterol and specific essential and nonessential amino acids and fatty acids are analyzed to explore total protein intake, whole-diet carbon, and omnivory, holds promise for paleodiet studies (e.g., Fogel and Tuross 2003; Jim et al. 2004; McCullagh et al. 2005; Zwank et al. 2003).

Scholars also are investigating new tools to investigate paleodiet, such as sulfur isotopes ($\delta^{34}S_{collagen}$), which have been useful in elucidating the consumption of marine, freshwater, and terrestrial resources (Fernández et al. 2003; Privat et al. 2007; Richards et al. 2001). While potentially complementary to paleodiet data derived from carbon and nitrogen isotopes, more research on variability in different ecosystems and geographic regions and on the behavior of sulfur in the body is necessary (Craig et al. 2006; Richards et al. 2003). Calcium isotopes ($\delta^{44/42}Ca_{apatite}$) also have been used recently to elucidate past dairy consumption (Chu et al. 2006). In addition, there is evidence that the isotopes ^{44}Ca and ^{40}Ca vary according to trophic level (Clementz et al. 2003; Skulan and DePaolo 1999; Skulan et al. 1997), so that $\delta^{44/40}Ca$ may be useful as an indicator of marine resource consumption. Although not widely used, directly identifying calcium sources in the diet would be very useful for residential mobility studies that rely on the substitution of various elements such as strontium, lead, and barium for calcium in hydroxyapatite.

Other methodological developments in the use of biogeochemical techniques focus on analyses that can influence our approaches to the social identities of individuals. Developments in sampling have led to a finer resolution through the use of laser ablation and microsampling techniques. While much of this work has involved faunal material (e.g., Balasse 2003; Balasse et al. 2001, 2002; Cerling and Sharp 1996), these techniques could allow researchers to complement bulk sample analysis of bone collagen and apatite with analysis of enamel samples that provide a fine-grained resolution of dietary changes over time (e.g., Bell et al. 2001; Sponheimer et al. 2006). Similarly, isotopic data from modern human hair samples demonstrate the ability of hair analysis to provide information about dietary variability (O'Connell and Hedges 1999; O'Connell et al. 2001; Petzke et al. 2005; Sharp et al. 2003). While limited to archaeological sites with exceptional preservation, paleodiet studies of human hair are an invaluable source of information on individual dietary changes over the weeks or months before death (e.g., Knudson et al. 2007; Roy et al. 2005; Wilson et al. 2007).

Microsampling also has the potential to elucidate residential mobility at the level of the individual. The use of heavy- and light-isotope analyses, such as strontium, lead, and oxygen isotopes, to investigate residential mobility is a relatively recent development. In the ten years that isotopic mobility studies have been commonly utilized, scholars have elucidated residential mobility, including migration and colonization, in regions as diverse as the American Southwest (Ezzo et al. 1997; Price et al. 1994), Mesoamerica (e.g., Price et al. 2006; White et al. 2004; Wright 2005a, b), Andean South America (e.g., Knudson and Buikstra 2007; Knudson and Price 2007), Southeast Asia (Bentley et al. 2005, 2007), and northern Europe (e.g., Bentley et al. 2003; Montgomery et al. 2005; Price et al. 2001). While most of these studies have focused on population-level mobility or migration, these approaches have much to contribute to investigations of mobility throughout one individual's lifetime (e.g., Muller et al. 2003; Sealy et al. 1995).

As the use of biogeochemical techniques to identify residential mobility becomes more common, our understanding of the complex issues involved in generating and interpreting these data have become more refined (Bentley 2006). Recent publications have focused on modeling the role of strontium from various sources to interpret residential mobility (Montgomery and Evans 2006; Wright 2005a). Scholars are also approaching the key issue of how to define "local" versus "nonlocal" individuals in residential mobility studies in a number of different ways, including using modern and/or archaeological fauna and statistical analyses of archaeological human strontium isotope data (Bentley 2006; Bentley et al. 2004; Evans and Tatham 2004; Wright 2005a).

For both light- and heavy-isotope analyses, as well as elemental concentration analyses, identification of a biogenic (rather than diagenetic), isotopic, and elemental signature is of utmost importance. A number of scholars continue to provide new approaches to removing, identifying, and evaluating diagenetic contamination (e.g., Hedges 2002; Lee-Thorp 2002; Lee-Thorp and Sponheimer 2003; Price et al. 2002; Schoeninger et al. 2003). While tooth enamel is resistant to contamination (e.g., Budd et al. 2000), questions remain about the diagenetic susceptibility of bone (Hedges 2002), including the use of solubility profiling techniques to remove diagenetic contamination of strontium from bone samples (e.g., Trickett et al. 2003).

Part of the increasing sophistication of studies that use biogeochemical techniques reflects larger changes in archaeological chemistry and archaeometry. As numerous scholars have noted (e.g., Killick and Young 1997; Pollard 1995; Trigger 1989), anthropologists need to be *producers* of biogeochemical data rather than *consumers* in order to most appropriately generate and interpret biogeochemical data. Importantly, a number of anthropology programs in Europe, particularly in the United Kingdom, and in the United States now provide undergraduate and graduate training in the application of biogeochemistry to bioarchaeological questions.

Methodological developments in excavation techniques: *anthropologie de terrain*

One methodological development that has potential for reconstructing mortuary identity and past social processes is variously called *anthropologie de terrain*, field anthropology, or archaeothanatology (Duday 2006; Duday and Guillon 2006). *Anthropologie de terrain* is, in part, a field method developed in France and still used largely in Europe, but to characterize it solely as such can lead to criticism that it is nothing more than the application of careful excavation techniques, with the implication that those unaware of the approach are somehow performing poorly in the field. In contrast, *anthropologie de terrain* represents a holistic and dynamic approach to burial excavation whose purpose is to understand the circumstances of burial through painstaking reconstruction of the totality of events and taphonomic processes that occurred from the time of burial to the time of excavation (Duday 2006). Essentially, *anthropologie de terrain* is concerned with human anatomy, including the way a body decomposes and how the decomposition process interacts with the constructed grave environment to affect the final spatial configuration of skeletal elements and fragments exposed upon excavation. In addition to the interaction between the built grave and decomposing body, there also are natural influences on the body, including flooding, root activity, insect activity, and burrowing animals. In this sense, *anthropologie de terrain* represents a new way of conceptualizing human burials, combined with the time and technical expertise to carefully dissect and interpret them in the field. The approach allows one to infer the presence of coffins, shrouds, baskets, body ligatures, and other types of grave architecture that served to constrain the body and inhibit movement of skeletal elements after disarticulation, or prolong the negative space inside a coffin within which the skeleton disarticulated. One can determine whether hyperflexed burials were secured in this position at the time of death, whether disarticulation represents post-interment human disturbance or secondary burial, and whether deviations from anatomical position may represent decapitation or natural decomposition processes. *Anthropologie de terrain* proceeds under the assumption that every deviation from anatomical articulation has an explanation, and this explanation is worthy of discovery. However, financial and temporal constraints, a greater commitment to population-based research, and a lack of publications in English have precluded widespread adoption of *anthropologie de terrain* in the United States.

Bioarchaeology and social identity

Social identity, health, disease, and disability

Some of bioarchaeology's most well-known contributions have been to our understanding of prehistoric health, particularly those changes associated with the transition to agriculture and the arrival of Europeans in the New World. Numerous studies have documented the decline in health and quality of life with the advent of maize agriculture, a condition exacerbated by the Columbian exchange that resulted in the near extinction of indigenous populations throughout the New World (Baker and Kealhofer 1996; Larsen 1994, 2001; Larsen and Milner 1994; Steckel and Rose 2002). This important work continues and is complemented by methodological advances in paleopathological analysis (Baker and Pearson 2006; Boldsen 2005) and recent social and biological histories of diseases that were important in the past as well as the present (e.g., Powell and Cook 2005; Roberts and Buikstra 2003).

While many previous bioarchaeological health studies used paleopathological data from individuals to look at broad-scale trends and processes, much recent work is using similar kinds of data to look at *individual* experiences in the context of larger social issues to provide nuanced understandings of health and disease in the archaeological record. Fay (2006) introduces the concept of *disease culture*, which contextualizes paleopathological data in the culturally specific views of the disease. By conceptualizing individual burials within the disease culture of late medieval and Tudor England, Fay (2006) uses paleopathological, bioarchaeological, and historical evidence to argue that the variability in burial practices of individuals with chronic diseases such as leprosy represents variable, and sometimes hierarchical, social and economic roles during life. This is in contrast to monolithic views of chronic illness, which emphasize the dichotomy between those with or without chronic illnesses.

Another important new aspect to bioarchaeological investigations of health and disease is the incorporation of social science theory on disability. Bioarchaeologists are increasingly distinguishing between *disease*, which is a temporary or permanent pathological condition, *impairment*, the physical or mental state that may result from a disease, and *disability*, which is the relationship between society and individuals with impairments (Shakespeare 1999, p. 100). Since disability does not *necessarily* result from impairment, which in the archaeological record is the physical manifestation of a disease or traumatic event, disability cannot be studied from an etic perspective (Cross 1999; Roberts 1999). In her ground-breaking work, Dettwyler (1991) argued that paleopathological analyses can identify disease and impairment but cannot alone be used to determine disability.

These approaches to reconstructing disability in the past are currently underutilized by bioarchaeologists. One exception is Hawkey's (1998) use of activity pattern and paleopathological data to successfully provide a nuanced reconstruction of impairment and disability in Late period (A.D. 1550−1672) Gran Quivira Pueblo, New Mexico (see also Knüsel 1999). Hawkey (1998) moved beyond documenting a debilitating case of chronic juvenile arthritis in one young adult male to discuss impairment, compassion, and his role in the community, where his burial location and position incorporate aspects of both subadult and adult burials. Despite the importance of these distinctions, little bioarchaeological work that distinguishes between impairment and disability has been published recently. We argue that bioarchaeology would benefit from a continued focus on the individual in studies of health and disease, and from an increased awareness of the implications of disease, impairment, and disability in our interpretations. Bioarchaeological research on health and disease has much to offer identity studies, including the health effects of occupational (Mays 2006), status (Buzon 2006) and/or gender identities (Sullivan 2004), and the role of impairment in determining other identities. Future bioarchaeological work can use contextualized skeletal and dental data to reconstruct how an individual's social identity changed, or was sustained, after undergoing debilitating or disfiguring diseases.

Gender identity

While methodological innovations in sex assessment of skeletonized remains continue, as discussed above, bioarchaeological approaches also are beginning to explicitly address the relationship between biological sex and gender (Díaz-Andreu 2005; Geller 2005; Sofaer 2006a, b; Stone and Walrath 2006; Walker and Cook 1998). We agree with Walker and Cook (1998) that the distinction between gender, which is a social identity, and sex, which is a biological identity, is a vital one, though the terms unfortunately continue to be used interchangeablely. Because of the ability of bioarchaeologists to provide information on biological sex that, when contextualized, can elucidate gender roles and gendered behavior, the bioarchaeological study of sex and gender is important and growing rapidly.

Bioarchaeological studies of sex and gender reflect larger developments in the archaeology of gender. From its inception in the 1980s, scholars critiqued androcentrism in archaeological practice and rectified the "invisibility" of women in the archaeological record (Brumfiel 1992; Conkey and Spector 1984; Gero and Conkey 1991). As the field has grown and matured, archaeological approaches to gender have become more nuanced by utilizing a third-wave feminist agenda, either implicitly or explicitly, that incorporates age, race, and ethnic identities (Díaz-Andreu 2005; Meskell 2001; Wilkie and Howlett Hayes 2006; Wylie 1991). In addition, some recent approaches to sex and gender have incorporated the social science literature on queer theory, which destabilizes the categories of both sex and gender, challenges the dichotomy of biological female or male, and provides a more inclusive view of biological sex and sexuality (e.g., Butler 1993, 1999). While archaeological investigations that utilize queer theory are rare (e.g., Reeder 2000; Voss 2000), this is an important aspect of the most recent approaches to sex and gender. Geller (2005, p. 604), for example, utilizes ethnohistoric, ethnographic, and archaeological data to argue that one individual buried at the Maya site of Dos Barbaras "engaged in gender-bending ritual performances during life." Geller (2005, p. 604) also emphasizes the importance of contextualizing sex and gender in the past and evaluating "the feasibility of our binaries, whether male/female, sex/gender, XX/XY, realizing that the line between them may not be a strict division but a permeable boundary."

Scholars continue to address the social, political, and economic repercussions of identities based on age, sex, and/or gender. A number of scholars have recently used biogeochemical data to examine paleodietary practices and their relationship to gender identities (Ambrose et al. 2003; Barrett and Richards 2004; White 2005). To examine the complex relationships between Maya food consumption, gender, and status before and after the Spanish Conquest, White (2005) examined paleodiet through carbon and nitrogen isotope analysis. She documented increased consumption of protein by biological males and argued that "males had greater access to socially valued and ideologically based foods" (White 2005, p. 373). Rather than simply examining the relationship between isotopic data and biological sex, White (2005) drew upon archaeological, ethnohistoric, and biogeochemical data on Maya gendered subsistence behavior to elucidate the ritual lives of elite women and men and the complementary, yet hierarchical, social roles. Other scholars have examined gendered patterns of mobility and their relationship to social, economic, and political change in the past (Bentley et al. 2003, 2005, 2007). Bentley et al. (2007), for example, interpreted the temporal changes in the migration of biological females at Khok Phanom Di (c. 2100–1500 B.C.) as a shift from patrilocality to matrilocality, with an accompanying shift in gender relations.

Identities of age, life cycles, and life courses

As in archaeological studies of gender identities, where bioarchaeological approaches to identifying biological sex are vital, bioarchaeological analyses of age determination are crucial to understanding age identities (Gowland 2006; Sofaer 2006a). Methodological advances in osteological age assessments were discussed previously. Here we focus on new theoretical developments, including the differentiation of biological and social ages and the human life cycle and life course.

Some scholars have argued that archaeologists have addressed the past as if it were peopled by adults, ignoring the lives and contributions of subadults and older adults (Lucy 2005). An increasing number of scholars are attempting to address this critique through, for example, the bioarchaeological study of childhood in the Byzantine Near East (Perry 2006) and infants in the Irish Neolithic and Early Bronze Age (Finlay 2000). One crucial development is the distinction between *chronological age*, as measured in days or years since birth, *developmental age*, which bioarchaeologists identify through the physical evidence of the developmental stage during which an individual died, and *social age*, which is the socially and culturally constructed age or age category to which an individual belongs (e.g., Sofaer 2006a). It is the complex interaction between chronological, developmental, and social ages, as well as other identities such as gender, that informs bioarchaeological studies of age identities. Bioarchaeologists also are increasingly situating their work in the context of life cycles and/or life courses. The term *life cycle*, which is widely used in evolutionary studies, has been criticized as overemphasizing biological and cross-cultural aspects of the human experience (Gilchrist 2000). Many scholars now use the term *life course* to emphasize the importance of contextualizing the physical life cycle (Gilchrist 2000). While these theoretical approaches have not been adopted widely, a number of scholars have used mortuary artifacts to examine age and sex identities within the context of the life course, including key cultural events in the life course (Sofaer Derevenski 2000; Stoodley 2000).

Social identity and body modifications

A number of scholars are currently using well-established techniques in identifying body modifications to address new questions regarding individual social identities and their role in larger processes in the past. In these cases, social identities are written directly on the body in the form of body modifications. Bioarchaeologists can provide a unique perspective of cranial modification, which is imposed on an individual during the first years of her or his life as a permanent, highly visible, and lifelong sign of a social or ethnic identity (Blom 2005; Blom et al. 1998; Hoshower et al. 1995; Torres-Rouff 2002). In populations where individuals exhibit this signal of identity, bioarchaeologists have elucidated the role of social diversity (Blom 2005; Blom et al. 1998), the use of cranial modification to maintain social boundaries in multiethnic polities (Blom 2005; Torres-Rouff 2002), and the loss of an ethnic marker during periods of culture change (Logan et al. 2003). Blom (2005) utilizes bioarchaeological identification of diverse cranial modification styles in the large and complex Tiwanaku polity as well as Andean ethnohistoric and ethnographic data and the larger body of social theory on ethnic identities. She argues that individuals from ethnically homogeneous outlying areas were drawn to the vibrant and heterogeneous urban center of Tiwanaku, where cranial modification was one aspect of maintaining a fluid boundary between two distinct environmental zones (Blom 2005).

In contrast, other body modifications that are not necessarily conferred during childhood can be used to understand specific identities based on status, occupation, or social and political affiliation in the case of labret use (Torres-Rouff 2003) and dental modification (Geller 2006; Williams and White 2006). Dental modification styles are used to identify individuals as, for example, slaves from western and central Africa (Price et al. 2006; Sealy et al. 1995). Some scholars, however, are beginning to focus on the modification process itself and its larger social meaning. Geller (2006, p. 286) writes that "…it is often during rites of passage that changes are wrought to the body—foreskins are excised, nasal septa are pierced, body parts are tattooed, dentition is modified." During this process, the individuals involved are challenged both physically and mentally, with the modification process ending in both a changed body and a new identity (Geller 2006).

Embodiment and social identities

Much work on the bioarchaeology of identity draws implicitly on theoretical approaches to embodiment, in which social meaning and personal expression is incorporated into the body (e.g., Fowler 2004; Hamilakis et al. 2002; Joyce 2005). Joyce (2005, p. 152) advocates the "analysis of the production and experience of lived bodies, in which surface and interior are no longer separated." Archaeologists have used embodiment as a way to conceptualize identity construction. Through clothing, ornamentation, body modification, gestures, and posture, individuals constantly construct and manipulate their identities to self-identify themselves as members of new or different groups (Fisher and DiPaolo Loren 2003).

Much of the pioneering work in embodiment in archaeology has utilized iconographic and historical data (Bachand et al. 2003; DiPaolo Loren 2003; Fisher and DiPaolo Loren 2003; Joyce 2000, 2003, 2005; Meskell 1999). Researchers are now incorporating bioarchaeological approaches as well (Blom 2005; Sofaer 2006a). This is a vital, and overdue, addition to the development of an archaeology of embodiment; through the contextualized analysis of archaeological human remains, bioarchaeologists can provide direct information on the lived experiences of individuals. These bioarchaeological contributions are discussed in more detail by Sofaer (2006a, p. xiii), who argues that recent approaches to the body, such as embodiment, "increasingly view the body as a social construction that is contextually and historically produced, but hardly touch on the human remains themselves." Sofaer (2006a) attempts to bridge this divide through her use of materiality in studies of human remains, although we hope that bioarchaeologists continue to develop new approaches to incorporate both physical and social bodies into their research.

Ethnic and community identities

As with the concept of identity itself, there are almost as many definitions of ethnic identity as scholars studying it. Instrumentalists, beginning with Barth (1969), view ethnic identities as serving material or economic motives; groups form in the context of competition over resources, and ethnic identity is highly flexible, fluid, and invoked or suppressed situationally (A. Cohen 1969, 1974; R. Cohen 1978; Glazer and Moynihan 1975; Nagata 1974). On the other hand, primordialists view ethnic identities as serving psychological motives such as the human need for acceptance and belonging, and note the persistence of ethnic sentiment in the absence of rational benefits (Bromley 1974; De Vos 1995; Epstein 1978; Geertz 1963; Keyes 1981). Ethnic identity has both instrumentalists and primordialist aspects (McKay 1982), and attempts to move beyond exclusively instrumental or primordial approaches have met with some success (Bentley 1987; Jones 1997). Although a unified theory of ethnic identity remains elusive, most scholars agree that communities, or groups of people who share a social identity, are ethnic groups only when the basis of group belonging is related to real or fictive descent from a common ancestor. This distinction between an ethnic community and any other form of social community has obvious and intriguing biological analogs. Jones (1997, p. xiii) succinctly defines *ethnic identity* as "that aspect of a person's self-conceptualization which results from identification with a broader group in opposition to others on the basis of perceived cultural differentiation and/or common descent."

As demonstrated by recent research on other types of social identities, most scholars no longer equate identity with ethnic identity or ethnicity. In fact, Gowland and Knüsel's (2006) recent and highly influential volume has only a single chapter that discusses ethnic identity. From a bioarchaeological perspective, ethnic groups can provide a convenient comparative framework for comparisons of health, status, and various forms of body modification. Here, however, we differentiate between the study of the *repercussions* of ethnic identity and *ethnogenesis*, which is the study of how ethnic groups form and transform through time (Moore 1994, 2001). We also note that the reification of ethnic groups as analytical categories is diametrically opposed to their situational nature and the shift in anthropological thinking away from the bounded tribal social group. Barth's (1969) enduring influence is his insight about the importance of the ethnic boundary rather than its cultural content; bioarchaeologists are well served to embrace the distinctions between tribe and ethnic group as analytical categories (see Banks 1996; Jenkins 1997; Jones 1997).

There has been a tremendous amount of research on the biological bases of ethnic identities. From the social perspective, the work of van den Berghe (1978, 1981) is important, although as a sociobiological explanation based in primordialist theory it is seldom referenced in the bioarchaeological or bioanthropological literature. Van den Berghe (1978, 1981) views ethnic groups as culturally extended kin groups and ethnic competition as a form of kin selection. This is highly controversial and biological anthropologists have largely avoided discourse on why ethnic groups form. Instead, bioanthropologists have assumed the reality of ethnic groups and reified ethnic phenomena as an analytical category whose repercussions should be discovered (synchronic perspectives) or historically explained (temporal perspectives). Synchronic perspectives are much more visible and consider the relationship between social identities, including ethnic, tribal, linguistic, political, and religious identities, and patterns of genetic variation across the landscape. Research strategies include examining genetic variability within and between cultural groups, comparing the distributions of cultural and biological populations across space, and evaluating the degree of cultural and genetic diversity within a region. Analyses of linguistic-genetic covariation are most prevalent and several hypotheses testable with bioarchaeological data sets have been developed. For example, while linguistic-genetic covariation is demonstrated in regions that experienced recent demic diffusions due to the spread of agriculture, language differences do not preclude mate exchange as a rule (Hunley et al. 2007; Hunley and Long 2005; McMahon 2004).

Temporal perspectives consider the processes responsible for ethnic group formation and how the biological composition of ethnic groups may change in reference to internal or external stimuli. The literature on ethnogenesis, produced by both skeletal biologists and molecular anthropologists (e.g., Hill et al. 2006; McEvoy et al. 2004; Ricaut et al. 2006), often refers to population origins, not in geographical terms such as peopling of the New World or peopling of Polynesia, but in terms of the biological composition of an often nebulously defined contemporary social aggregate such as an ethnic, tribal, or linguistic group. In fact, ethnogenesis is used as a synonym for "formation," and any study that considers the origin of a modern population in terms of the mixing of distinct antecedent populations fits this definition of ethnogenesis equally as well (e.g., Ioviţă and Schurr 2004; North et al. 2000). Such studies are, as noted by Armelagos and Van Gerven (2003), typological in orientation. The underlying assumption is that discrete populations *did* exist in the past, with distinct genetic signatures, and that the population under current analysis is composed of some proportion of individuals from those populations. Similar anthropological investigations have been published for decades, such as the ethnogenesis of Icelanders (Pálsson 1978) and various Siberian ethnic groups (Michael 1962). In every case, discussion focuses on population composition and the contributing origin of represented types. More recent bioarchaeological contributions have moved beyond typological methods, although concern for migration, affinity, and contributing population composition remains (e.g., Hemphill and Mallory 2004; Zakrzewski 2007). Most visible within the bioarchaeological literature is the dual-origin hypothesis of Japanese ethnogenesis, which proposes that the modern Japanese have historical ancestry in antecedent hunter-gatherer Jomon populations and agricultural Yayoi populations that represent a Holocene migration from continental northeast Asia (Ossenberg et al. 2006). Hudson (1999) has done a remarkably thorough synthesis of this issue, bringing together biological, archaeological, and linguistic data to shed light on this complex process.

Bioarchaeologists are uniquely positioned to complement existing perspectives by offering the following distinct advantages over molecular techniques: (1) larger and more representative data sets, (2) widespread applicability, (3) nondestructive analyses, and (4) time depth and repeated sampling of the same population through time. This last point is most critical because it allows a more nuanced processual approach to biosocial evolution by offering the ability to carefully track patterns of variation through time, rather than studying the end-product of a long-term historical process. Nonetheless, biodistance analyses of the process of social identity formation have been limited (e.g., Nystrom 2006; Stojanowski 2005b) and remain a truly emerging focus within the discipline. In the future, we hope scholars continue to see human evolutionary biology as uniquely distinct from the biology of other organisms by virtue of the complex social identities that pervade our demographic and evolutionary histories.

Conclusion

Bioarchaeology is uniquely situated to address a wide variety of archaeological questions with relevance to our understanding of both the past and the future. Although bioarchaeology as an approach may never shed its material definition, we hope the line between this and other social sciences continues to blur as we make greater contributions to broader academia. With recent methodological developments in age and sex estimation, paleodemography, biodistance analysis, biogeochemical approaches in anthropology, and *anthropologie de terrain*, bioarchaeologists have increasingly sophisticated tools with which to address questions about past populations. However, to continue to develop the power and relevance of osteological research, practitioners must continue to apply their increasingly sophisticated methodologies to larger questions. Here we have demonstrated the invaluable long-term perspective that bioarchaeologists can contribute to studies of social identities, including identities based on health, age, sex, and ethnic affiliation. By providing the next generation of bioarchaeologists with a rigorous understanding of human remains, methodologies and techniques from the social and biological sciences, the appropriate contextualization of the bioarchaeological record, and, most importantly, the larger theoretical issues, the field can continue to develop in new and innovative directions.

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