CHAPTER III

PROBLEMS OF PRESERVATION AND SEXISM IN SEXING: SOME LESSONS FROM HISTORICAL COLLECTIONS FOR PALAEODEMOGRAPHERS

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The papers in this book clearly show that studies of historical skeletal collections can yield important information on the lives of our ancestors that is available from no other source. Osteological research is especially useful because it provides an independent source of evidence for evaluating document-based historical reconstructions (Molleson et al., 1993; Rose, 1985). It also can yield valuable insights into aspects of life, such as the relationship between social status and health, which are unrecorded or distorted in historical records.

Historical collections are also very useful for testing the assumptions that bioarchaeologists make when they reconstruct the lifeways of prehistoric people. Comparison of conclusions based on documents with those derived from skeletal research can reveal new ways of interpreting skeletal remains as well as the shortcomings of current osteological techniques. For example, differences between demographic reconstructions based on skeletal remains and burial records can provide insights into the limitations of palaeodemographic studies and suggest strategies for circumventing them.

AGE BIASES

I became interested in using historically documented collections to better understand the biases present in prehistoric skeletal collections during the analysis

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of burials from the Purisima Mission Cemetery near Lompoc, California. The Franciscan priests who operated the mission kept detailed records on the people buried in the cemetery (see Johnson, 1988). These documents show that the cemetery was used as a burial place for the Indians residing at the mission between 1813 and 1849.

Using the mission’s baptismal and death records, we constructed a mortality profile for the cemetery (Fig. 1, Walker et al., 1988). Most of the people buried in the cemetery were either infants or elderly adults. When graphed, the mission mortality profile has the U-shaped distribution typical of nineteenth-century populations with many more children and elderly people dying than young adults.
The difference between the mortality profile of the people documented to have been buried in the cemetery and the age distribution of the skeletal sample excavated from the cemetery is striking. The skeletal remains are predominantly those of young adults (Fig. 1). In other words, the age distribution of the people historical documents show were buried in the cemetery is the inverse of the age distribution obtained through osteological studies of the remains of those same people.

This inversion of the known age structure of the burial population in the skeletal sample has sobering implications for palaeodemographers working with prehistoric skeletal collections. In many studies of prehistoric populations it is tacitly assumed that the age distribution of the burials recovered from a cemetery corresponds more-or-less directly to the age distribution of the people buried in the cemetery. The Purisima burials show that making this assumption can sometimes lead to very inaccurate demographic reconstructions.

There are several plausible explanations for the disparity between the Purisima skeletal sample and the Purisima burial records. The skeletal sample of 32 burials is only 2 per cent of the 1491 people buried in the cemetery. Sample size per se, however, does not explain the difference in ages. It is very unlikely ($x^2=43.3$, $p=0.00001$) that a random sample of burials would deviate this much from the age distribution of the people known to be buried in the cemetery. Another possibility is that people of different ages are nonrandomly distributed in the cemetery. This has been documented in a mission period Amelia Island, Florida site (Saunders, 1988:5). Although we have no historical documents that suggest this practice occurred in Alta, California, it is conceivable that, for some reason, middle-aged people tended to be buried in one area of the cemetery and this was the area the archaeologist happened to excavate.

Analysis of the completeness of the Purisima burials suggests a different explanation; it seems likely that age-specific differences in preservation account for the missing children and elderly adults in the skeletal sample. The Purisima skeletons are very poorly preserved. In fact, nearly one-third of them were so fragmentary that the archaeologist was unable to remove them from the ground; for this reason we were unable to include them in our osteological analysis. Counts of the number of long bones preserved in the burials that were removed indicate that the skeletons of middle-aged adults were much better preserved (i.e., had more recoverable long bones) than those of the children and elderly adults. This makes sense in view of age changes in skeletal mass; it increases until about the age of 20, remains comparatively constant in young adults and
Figure 2
Age Changes in Skeletal Weight of Men and Women.
Based on Data in Garn (1970) and Garn et al. (1976).

then decreases after about 40 or 50 (Fig 2, Garn, 1970; Garn et al., 1976). It seems likely, therefore, that the age distribution of the Purisima sample is more a reflection of age difference in resistance of skeletons to disintegration than it is of the demographic structure of the population it is derived from (Walker et al., 1986).

Subsequent research on a variety of historical and prehistorical collections shows that similar age-specific biases are common in archaeological skeletal collections (e.g., Masset, 1990). Palaeodemographers, therefore, should be very cautious when attempting to make demographic reconstructions based on poorly preserved skeletal collections. For such collections, the assumption that the age structure of the skeletal collections mirrors that of the burial population may be unwarranted.
SEX BIASES

The belief that sex differences in skeletal preservation are negligible is another assumption implicit in most palaeodemographic reconstructions. There are, however, some reasons to believe that this may not always be true. The skeletons of women often are more gracile than those of men, and the greater susceptibility of women to age-related bone loss is a well-known phenomenon (Raisz, 1982). These differences could influence the rate at which male and female skeletons disintegrate after burial and in this way distort demographic reconstructions.

Again, historically documented collections provide a direct way to test this palaeodemographic assumption. In our Mission La Purisima research we were unable to detect a statistically significant sex difference in preservation (Walker et al., 1988). This initial finding was encouraging since it suggested that the ratio of males to females in archaeological collections is not greatly influenced by differential preservation.

Subsequent analysis of sex differences in the preservation of burials from the crypt of Saint Bride's Church in London, however, suggests that sex differences sometimes can be large enough to significantly bias mortality profiles. In contrast to the La Purisima burials, many of the skeletons from Saint Bride’s are of named individuals whose sex and age at death have been determined based on coffin plate inscriptions and other documentary evidence (see Scheuer and Bowman, this volume). Using this documentation, it is possible to make a detailed analysis of age and sex differences in the preservation of sexually dimorphic skeletal traits such as those of the pubic bone.

Pubic bone morphology is one of the most reliable skeletal age and sex indicators. Pubic bone preservation, therefore, has important implications for the accuracy of palaeodemographic reconstructions. When the pubic bone is not preserved, less reliable sex indicators such as cranial morphology and skeletal robusticity must be used as the basis for sex determinations. If these features are also poorly preserved, or do not give a clear indication of the person’s sex, an osteologist is likely to assign the burial to an “undetermined sex” category (see Milner, 1983:83).

Sex differences in preservation of the pubic bones of the Saint Bride’s burials suggest that this undetermined sex category often contains a disproportionate number of elderly females. I divided the Saint Bride’s burials into a poorly preserved group whose pubic bones could not be used for sex determination and
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a well preserved group whose pubic bones could be scored for sexually dimorphic traits. For the people whose documented age at death is greater than 44 years (n=93), significantly more pubic bones of females (55.3 per cent) than males (32.7 per cent) were so poorly preserved that they could not be used for sex determination($\chi^2=4.7, p=0.030$). The disproportionate number of poorly preserved elderly female skeletons in the Saint Bride's collection suggests that the skeletons of such women may be under-enumerated in demographic studies of some prehistoric cemeteries.

SEXISM IN SEXING

There are nearly always more males than females in skeletal collections from archaeological sites (Weiss, 1972). This is not consistent with what we know about the sex ratios of extant human populations. It can be explained, at least in part, by sex differences in preservation such as those seen in the Saint Bride's collection.

My research on historical collections suggests that the development of “male” cranial features in post-menopausal females also contributes to this apparent excess of males in skeletal collections. The source of this problem can properly be called “sexism in sexing” since the error seems rooted more in a cultural stereotype of “typical” female morphology than in an appreciation for the complex biological reality of human cranial sexual dimorphism. I am not saying that osteologists consciously discriminate against females in their sex determinations, but simply that the cultural ideal of modern western society (male=big and robust, female=youthful and gracile) has made it difficult for osteologists to recognize older, relatively robust, females in skeletal collections.

When using cranial morphology to decide the sex of an adult, most osteologists note the effects of tooth loss and tooth wear on the jaws. Otherwise, they pay little attention to the person’s age. This is reasonable since there is a large craniofacial development literature that views cranial morphology as essentially stable after adolescence (see Behrents, 1985:24-32). However, evidence for age changes in cranial sexual dimorphism from historical collections suggests that this static view of adult cranial morphology is unwarranted. Substantial age changes occur in the cranial features osteologists use for sex determination. A failure to account for this can significantly distort palaeodemographic reconstructions.
I became aware of the complexity of age changes in cranial sexual dimorphism while developing a scoring system for osteologists to use in cranial sex determination (Walker, 1994). As part of this work, I scored the development of the mastoid process, mental eminence, supraorbital area, orbital margin and nuchal crest on more than 300 crania of known age and sex in the collections at Saint Bride’s Church, the Smithsonian Institution and the Cleveland Museum of Natural History.

Age changes occur in most of these cranial traits. However, they are especially pronounced in the supraorbital area (figs. 3-5). Males younger than 30 years old have much less well-developed supraorbital areas than older men. Males with supraorbital development scores of less than three make up 29 per cent (n=51) of the less-than-30 age group. Only 17 per cent (n=142) of older men have supraorbital ridges this small (Fig. 4). The contrast between young and old males is more pronounced for those with large supraorbital ridges. Only 9 per cent of the young males have supraorbital ridges heavy enough to be assigned scores greater than three. This contrasts markedly with the older males, 45 per cent of whom have brow ridges this well developed. Statistical tests show that this difference between young and old males is highly significant ($X^2=13.5, p=0.001$).

Although females also experience significant age changes in their supraorbital morphology, the timing of the changes is different. Females do not show the
Figure 4
Comparison of the Supraorbital Development Scores (see Fig. 3) for Adults Less than 30 and 30 or More Years Old. Numbers above the Bars are the Number of People with Each Score.

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Figure 5
Comparison of the Supraorbital Development Scores (see, Fig. 3) for Adults Less than 45 and 45 or More Years Old. Numbers above the Bars are the Number of People with Each Score.

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male increase in supraorbital robusticity early in life (Fig. 4). However, females 45 and older have significantly heavier supraorbital ridges than younger women ($\chi^2=9.1$, $p=0.01$). This age difference is not seen in males (Fig. 5).

Overlooking these age changes in cranial morphology can introduce significant biases into mortality profiles based on poorly preserved skeletal collections. The continued development until the age of 30 of sexually dimorphic cranial traits in young males is not widely recognised by osteologists. As a result, when pelvic remains are not well preserved, burials of young men who have not fully developed their cranial secondary sexual characteristics are likely to be misidentified as females or placed in an undetermined sex category. Conversely, the heavier supraorbital development of older women can result in their misidentification as males. This is especially likely since, as I have shown, the pelvic remains of elderly women are often poorly preserved.

LESSONS FOR PALAEODEMOGRAPHERS

What are the lessons in these studies of historical collections for bioarchaeologists interested in prehistoric populations? There are significant age and sex differences in the resistance of human skeletal remains to disintegration that can distort mortality profiles. Using cranial morphology to sex poorly preserved skeletons can introduce additional age-specific biases. Although not insurmountable, these problems are a formidable impediment to palaeodemographic research.

A logical starting point in dealing with the problem of differential preservation is to develop better techniques for assessing the condition of skeletal collections. In view of the biases poor preservation can introduce, it is surprising so little attention has been paid to this in the palaeodemographic literature. If the question of preservation is addressed at all, it is dealt with in a sentence or two that describes the skeletal collection's condition in qualitative terms.

The number of long bones recovered is a crude preservation index that is easily computed from the burial inventory (e.g., Walker et al., 1988). If osteometric data have been collected, the number of measurable long bones or the number of measurements per long bone can serve as more refined preservation indices (Walker and Sneathkamp, 1984). Comparing the weights of the skeletal elements recovered with those of a complete skeleton is another way to determine how well preserved a collection is (Milner, 1983:71-73). Using quantitative measures such as these, a researcher can convincingly show that a skeletal collection is well preserved and thus likely to be representative of the burial population it is
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derived from. If on the other hand, the preservation indices suggest age and sex
differences in preservation, the demographic structure of the population can be
interpreted with this in mind.

In the absence of such quantitative data, published mortality profiles can be
examined for signs of preservation bias. Poor preservation produces a distinctive
age distribution with few children and elderly adults like the one seen in the
Purisima skeletal collection (Fig. 1). This seems in large part to be a result of
systematic changes that occur in skeletal density and mass with increasing age
(Masset, 1990; Walker et al., 1988). These variables in turn influence the probability
disintegration in the ground and archaeological discovery.

One way to detect preservation biases is to compare a collection’s age structure
with a theoretical mortality profile expected with poor preservation. During the
Purisima analysis I produced such a theoretical distribution using skeletal mass
as a weighting factor (Fig. 6). The assumption here is that low skeletal mass is
directly correlated with poor preservation and low archaeological recovery.
Mission records were used to divide the people buried in the Purisima cemetery
into five-year age groups. The number of burials in each age group was then
multiplied by the average skeletal mass (Fig. 2) of that age group.

Weighting the Purisima burial population’s age distribution in this way
transforms it into an inverted “U” similar to the one seen in the poorly preserved
Purisima skeletal collection (Fig. 1). The main effect of the skeletal mass correction
is to reduce dramatically the number of newborns and infants from 23.7 per cent
to 1.8 per cent of the total population and to increase the number of young
adults.

Weighting the burial record age distribution by skeletal mass also results in
a large increase in the ratio of males to females from 0.96 to 1.43. The size of this
theoretical effect suggests that poor preservation can alter sex ratios significantly.
Cultural practices, such as the maintenance of military cemeteries and so on, can
also skew sex ratios. Nevertheless, a predominance of males in a collection
should be taken as a warning sign of possible preservation bias.

Sex differences in preservation do not have to be large to significantly distort
paleodemographic reconstructions. The pubic bone is fragile and likely to
disintegrate before other skeletal elements. As the Saint Bride’s data show, the
pubic bones of elderly women are more likely to be poorly preserved than those
of men. When poor preservation makes it impossible to make a pelvic sex
determination, less reliable sexing criteria such as cranial morphology must be
used instead.

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Figure 6
Observed and expected mortality profiles of the Mission La Purisima burial population. The graph is based on mission burial records (Walker et al., 1988: Table 1).

The lower graph shows the expected recovery of burials based on the assumption that preservation is directly proportional to the skeletal mass. This distribution was produced by multiplying the burial record values by the bone mass values illustrated in Fig. 2.
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As I have shown, the age changes that occur in cranial sexual dimorphism can produce their own systematic age-related sexing errors. Reliance on cranial sex determinations distorts palaeodemographic reconstructions in two ways. The cranial morphology of men younger than 30 is effeminate in comparison to that of older men (Fig. 4). This results in a tendency for young males to be misclassified as females. The cranial morphology of women, in contrast, becomes more masculine in appearance after the age of 45 (Fig. 5). This results in a tendency for skulls of elderly women to be misclassified as male.

These age-related sexing errors provide an alternative explanation for a conspicuous feature of many mortality profiles based on skeletal collections. Many young women in their late teens and early twenties are frequently identified in such collections. This is typically interpreted as indicating high birth-related mortality among primiparous mothers (e.g., Blakely and Walker, 1968). It cannot be denied that mortality rates are sometimes higher in young women than in young men (see Fig 6, Walker and Johnson, 1994). However, the misidentification of young men, whose cranial features have not fully developed, as females is a likely contributing factor to this apparent excess female mortality.

The misidentification of older women, with masculine appearing cranial features, as men is a much more serious palaeodemographic problem. Such women can be a significant part of a burial population. Because of postmenopausal bone loss, the pelvic remains of older women are likely to be poorly preserved. As a result, cranial morphology is often an important consideration in deciding their sex. It is not uncommon in such cases for the cranial material also to be poorly preserved or sexually ambiguous. Osteologists, therefore, are likely to place such individuals in their undetermined sex category. In either case, the demographic result is to reduce the apparent number of adult females in the population.

The under-enumeration of women owing to these sex determination problems provides a plausible explanation for two of the most consistent and puzzling findings of palaeodemographers. The first is the nearly universal, yet demographically unlikely, discovery that skeletal collections contain more males than females (Weiss, 1972). The second is the conclusion that, in most prehistoric populations, men lived longer than women. This view is succinctly expressed by Aczél and Nemeskéri (1970:184): "The longer male expectation of life in various prehistoric periods appears as general feature. The differences are so characteristic that this must doubtless be interpreted as a rule of mortality manifest under given socio-economic conditions."

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What practicable solutions are there to these problems of differential preservation and sex biases in sexing? One stopgap approach is to focus research on interpreting demographic patterns that are unlikely to be explained by such biases (Walker et al., 1988). For example, collections containing many young males or elderly females would be especially interesting since this is not the pattern preservation biases tend to produce (e.g., Larsen, 1992). The explanation for such a pattern is more likely to lie in the underlying demographic structure of the population or cultural practices such as use of age- and sex-specific burial areas than it is in problems of preservation.

Considerable progress could be made if palaeodemographers simply gave more detailed information on the empirical basis for their age and sex determinations. Often all that is included on this crucial topic is a formulaic paragraph citing ageing and sexing techniques described in standard osteology texts followed by a statement that sexes were determined using pelvic material "whenever possible." With this limited information, it is impossible to evaluate the possible effects of preservation biases such as those I have described. To be convincing, palaeodemographic reconstructions need to be supported by data on the number and ages of people sexed based on pelvic material, cranial remains, long bone robusticity and so on.

Clearly, studies of historically documented collections have an important contribution to make in resolving these methodological problems. Research on the causes and consequences of preservation biases is in its infancy. Although the patterns I have described characterise many collections, there are also many exceptions. Studies of historical collections have an important role to play in helping us to understand the factors responsible for this variation and its anthropological significance.
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