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Analyzing Ossuary Skeletal Remains: Techniques and Problems

Homes Hogue

In southeastern North Carolina the remains of what could have been ossuary burial practices have been observed since the late 1800s. An ossuary burial is generally defined by Douglas Ubelaker as "the collective, secondary deposit of skeletal material representing individuals initially stored elsewhere" (Ubelaker 1974:8). The primary burial of bones was accomplished in a number of ways. The Choctaws, according to Romans, practiced "bone-cleaning," an act by which the flesh was actually picked from the bones. The Algonquians placed the bodies of the deceased on scaffolds or buried them in the ground until the flesh had decomposed (Ubelaker 1974:8-9). In any event, the bones void of flesh were gathered after a culturally determined length of time and redeposited in one place. This place is what is referred to as an ossuary.

In 1884 J. A. Holmes examined "burial mounds" in Duplin, Sampson, Robeson, Cumberland, and southern Wake counties. He observed that the burial mounds had certain common characteristics.

... they are usually low, rarely rising to more than three feet above the surrounding surface, with circular bases varying in diameter from 15 to 40 feet, and they contain little more than the bones of human (presumably Indian) skeletons arranged in no special order. They have been generally built on somewhat elevated, dry, sandy places, out of a soil similar to that by which they are surrounded In the process of burial, the bones or bodies seem to have been laid on the surface or above and covered with soil taken from the vicinity of the mound. In every case that has come under my own observations charcoal has been found at the bottom of the mound (Holmes 1916).

In describing the mounds, Holmes stated that the bone was in quite a decayed condition and hence little analysis was allowed. All mounds observed in Duplin County appear to have been composed of secondary bundle burials. He gave the following description of Mound No. 1:

The following arrangements of the parts, however, was found to be there of nearly every skeleton exhumed. The bones lay in a horizontal position, or nearly so. Those of the lower limbs were bent upon themselves at the knees, so that the thigh bone (femur) and the bones of the leg (tibia and fibula) lay parallel to one another, the bones of the foot and ankle being found with or near the hip bones. . . . The skulls generally lay directly above or near the hip bones, in a variety of positions; in some cases the side, right or left, while in other cases the top of the skull, the base, or the front, was downward (Holmes 1916).

Holmes stated that since the bone was in a decayed condition, the position of the parts of the individual skeletons could not be determined. Further

analysis of aging and sexing was also thought impossible. Two adult and one subadult craniums, however, were identified out of as many as twenty-one skeletons (Holmes 1916).

Charles Peabody excavated a mound in North Carolina at Hope Mills in Cumberland County in the early 1900s. This mound contained great quantities of human bone, but in poor condition. Peabody estimated perhaps sixty individuals were included in a space of a few cubic feet (largely concentrated in the northern quadrant of the mound), which he inferred as evidence for a secondary burial (Peabody 1910). Oddly enough, the one skull which he could have used for study disappeared while left outside overnight to harden (Peabody 1910).

In 1962 Stanley South excavated what is known as the McFayden Mound in Brunswick County, North Carolina, fifteen miles from Wilmington. The mound was located on a natural sand ridge and was noticed when human bone fragments were seen in disturbed areas (South 1962:2-3). According to South, the McFayden Mound would fit the description of the mound Holmes cited earlier in this paper (South 1962:27-28).

In excavating this site (Bw°67), South acknowledged that evidence of secondary burials does occur. In one instance, Feature One in Square 40L40, the jaw bones of two skulls were located several inches from one cranium, thus supporting evidence for a secondary burial. A second feature in this square contained another concentration of human bones. Loose teeth, long bone fragments, and other bone fragments were observed in this feature. These bones, along with a skull, were oriented slightly in a parallel fashion (South 1962:5-6).

In any event, South stated that no primary burials were located. Furthermore, he described the bone concentrations as being piles of bone fragments of the skull, long bones, jaws, teeth, etc. These bones, it is believed, were simply placed on the mound and then covered with sand. In a few instances the bones exhibited signs of burning and were thought to represent cremation. Few skeletal remains were found below the original surface of the mound (South 1962:26).

One can infer from South's excavation of Bw°67 that it was an ossuary as no articulation of bones was evident which would characterize it as a primary burial. The skeletal remains from this site were inventoried but as yet no analysis has been done.

Another "Indian Mound" was excavated by Howard A. MacCord in the early 1960s. This site was named the McLean Mound (Cd° 1) and was located in Cumberland County, approximately one half mile east of the Cape Fear River. The diameter of the McLean Mound was approximately 60 feet, and the height was measured 30 inches (MacCord 1966:5-8), somewhat larger than the mounds described by Holmes (1916).

In the excavation MacCord was primarily concerned with the burials and evidences of mortuary practices (MacCord 1966:12-13). According to

his trait list, MacCord located multiple burials, bundle burials, and cremations during this excavation. The bundle burials were generally incomplete, and charred and uncharred bones were found scattered randomly throughout the mound. MacCord stated that the first burials at the site were made in shallow pits dug into the humus. Later, burial remains were simply placed on the surface and covered with sand (MacCord 1966:35-37) forming, over time, the mound observed.

TABLE ONE

COMPARISON OF CERTAIN BURIAL MOUND TRAITS

TRAITS	Duplin County Mound #1	Duplin County Mound #2	Cumberland County Hope Mills	Brunswick County McFayden Mound	Cumberland County McLean Mound
Circular mound under 25' dia	X	X	X	X	X
over 25' dia	X		X	X	X
On sand ridge	X	X	X	X	X
Submound pits			X	X	X
Multiple burials	X	X	X	X	X
Bundle burials	X	X	X	X	X
Cremations	X		X	X	X
Incomplete burials	X	X	X	X	X

The skeletal material from Cd⁹¹ was analyzed by Dr. T. D. Steward. His techniques of analysis will be discussed later in this paper; however, the following is a general overview of the skeletal analysis. Out of 268 numbered burials, the following can be observed:

- One hundred twenty-eight burials contained parts of more than one individual.
- Twenty-five (9.3%) individuals had been cremated.
- At least 24 burials had been placed in pits before the mound proper was begun.
- Twenty-one (7.9%) burials were accompanied by durable objects.
- Ninety-eight burials were so fragmentary that we can not be sure if they are burials of individuals, or merely the burial of loose bones.

f. No infants were found (under 4 years of age), and this absence may be culturally significant.

g. Both sexes seemed to be equally represented in the burials which could be "sexed" in the field. Dr. Stewart's identifications show 124 males as opposed to 166 females. The remainder were too immature or incomplete to warrant sex determination (MacCord 1966:13-15).

The previous table, derived from MacCord (1966), exhibits certain common traits shared by the mounds mentioned in this paper.

A radiocarbon date of 970 ± 110 or about 1000 A.D. would place the McLean Mound in the Late Woodland Period. The presence of smooth pottery and stone pipes with geometric decorations would suggest a somewhat later date, but MacCord states that not enough is known about the ceramics and pipes to confirm this and is inclined to accept the C-14 date of 1000 A.D. (MacCord 1966:43-44), despite the potential for error.

Having noted similar traits in these particular burial instances, one may ask the question as to who these people were. According to James Mooney, the Cape Fear Indians were thought to be Siouan since there were indications that they had associations and alliances with other known Siouan tribes (Mooney 1894:65). It appears that the name "Cape Fear Indian" was given to any Indian in the vicinity despite cultural and tribal connections (Bushnell 1916:16). The Indians of the lower Cape Fear were also considered to be Congarees who were thought to be a branch of the Old Cheraw (Ashe 1916:25).

From Holmes's analysis of the three skulls from Mound No. 1 and Mound No. 2, the following measurements were derived:

Crania	Length	Breadth	Height	Index	Index	Facial
				of	of	
				Breadth	Height	Angle
A	193 mm	151 mm	144 mm	.746	.746	74°
B	172 mm	133 mm	136 mm	.772	.790	66°
C	180 mm	137 mm	147 mm	.761	.816	63°

(Holmes 1916)

Using equations from Bass (1974:63-65) and Vallios (1965:127-143), the following was derived:

	Cranial Index	Cranial Length- Height Index	Cranial Breadth- Height
A	78.23	74.61	95.36
B	77.32	79.06	102.25
C	76.11	81.66	107.29

From this chart one can infer the following about this small sample of the population: (a) the cranial index was average or medium; (b) the cranial length index gives evidence of average to high skulls; (c) cranial breadth-height are average to high skulls. Skull No. 1 seems to be average all around. Holmes's sample, however, was too small to be considered representative of the prehistoric population of Duplin County.

Stewart's analysis of the skeletal material from the McLean mound in Cumberland County seems to point to a dolichocephalic or a long-headed population. Populations with extreme highheadedness are widespread to the north along the coastal zones of the middle-Atlantic states and are found in a few places in the Piedmont (Stewart 1966:73-74). Unfortunately, these two studies of population samples do not tell us much except that the population of that general Inter-Coastal region ranged from medium to long-headed.

METHODS OF ANALYZING OSSUARY SKELETAL MATERIAL

Because of the uniqueness of a secondary burial, skeletons are seldom articulated as complete. This can create quite a number of problems for the archaeologist and physical anthropologist.



Plate I

Excavation of a secondary burial at the McLean Mound in Cumberland County, North Carolina.

The first problem is bone preservation. If preservation is poor, bone identification will be difficult. In any case, the skeletal material should be treated in the laboratory. After cleaning and drying, one process which could be used in the laboratory is to let the bone soak overnight in 6 parts acetone to 1 part gelva and 1 part "Duco" cement for penetration. The bone is then removed and dipped in a thicker solution to give strength to the outer surface.

When working with ossuary material, it is important that each bone be properly labeled identifying its location. This will aid in analyzing bone distribution and breakage prior to the final burial. For example, if fragments of one long bone are located several feet apart in an undisturbed ossuary context, one can infer that this bone breakage occurred before the fragments were placed in the ossuary. The fragments of bone should then be restored wherever possible.

One of the first questions an archaeologist may ask when faced with an ossuary and its skeletal contents is how many individuals are involved. Since ossuaries are secondary burials and disarticulation of the bones has occurred, the listing of the frequencies of each type of bone from the site enables one to determine the minimum numbers of individuals represented (Ubelaker 1974:31). When inventorying the skeletal remains in this manner, a number of attributes should be recorded. One should identify the bone that is being represented and state the following: whether the bone is from the right or left side of the body, whether the bone represents an adult or a subadult, the condition of the bone, how much of the bone is present, and signs of osteosis. All complete and fragmented bones should be examined to provide an accurate count. From this inventory one can prepare a total inventory of both the adult and subadult remains. This total inventory reflects the number of individuals represented. For example, in the adult bone inventory there may be *fifteen* right temporals present, but the minimum number of individuals is reflected in the presence of *eighteen* left femurs. The same procedure holds true for the subadult remains.

The "bone-by-bone" inventory also shows variability in the quantity of the different bones present. In many cases smaller bones such as vertebrae, carpals, metacarpals, tarsals, metatarsals, and phalanges are found in lesser quantities relative to the numbers of long bones and skulls. Douglas Ubelaker suggests that the loss of small bones could be the result of five factors: (a) prior to the secondary burial; (b) during excavation; (c) after excavation; (d) intentional selection was made for certain bones for reburial; or (e) differential preservation in the ground (Ubelaker 1974:33). A sixth factor, post burial disturbance, should be included for sites that have been disturbed or vandalized.

Ubelaker in his analysis of the Juhle site in Maryland suggests that missing bones were, in fact, lost prior to the time of ossuary burial and not during the excavation. From this position Ubelaker infers that the Indians

chose the remains of the deceased individuals which best represented them to be reburied. In the Juhle example, which encompasses two ossuaries, the bone inventory of Ossuary I shows that the greatest number of individuals are represented by long bones, tibias (69) as opposed to mandibles (63). Ubelaker questions this count as he feels that the Indians would have chosen the mandible or maxilla to best represent an individual.

Spacial analysis of bone distribution in an ossuary can also be informative to the archaeologist in respect to mortuary procedures. Ubelaker attempted such an analysis using the skeletal material from the Juhle site in Maryland. The procedure used was first to grid the area into 0.6-meter squares. This grid size was chosen as it was large enough to include a significant quantity of bone yet small enough to enable one to note distribution variation of bone belonging to the same skeleton. The next step was to analyze the bones of each square, independently noting type, sex, and age. The contents of each square could then be compared to determine spacial differences in the distribution of the bones (Ubelaker 1978:280). Ubelaker found three patterns of bone concentration. First, the large bones of both adults and subadults; second, miscellaneous small bones of adults; and third, the miscellaneous small bones of subadults (Ubelaker 1974:39).

From evidence such as the above, one might attempt a number of inferences about mortuary practices and secondary burials. For instance, because of the segregated distribution of the miscellaneous small bones of both adults and subadults, the same pattern of segregation could have existed in charnels or death houses. Further support of segregation between adults and subadults may be found in ethnohistorical materials (Ubelaker 1978:28). In any event, such information could be significant in unscrambling the skeletal remains found in ossuaries.

After inventorying, the next steps would be to age and sex the skeletal material. Accurate identification of a skeleton involves sexing, aging, and health analyses. If these procedures are used to identify every skeleton in a totally sampled cemetery, then data on adult longevity, infant and child mortality rates, sex ratios, natural increase rates, population density, family structure, and microevolutionary selection may be inferred (Angel 1969:427). An ossuary represents the number of individuals which died within a certain time, defleshed or allowed to deflesh, and then the skeletal remains were gathered together for reburial. Therefore, ossuary data may apply to all of the above with the possible exception of family structure.

SEXING

There are a number of factors which create problems in accurately sexing skeletal remains. Sexing of unknown materials depends on the completeness of the skeleton. The entire skeleton of an adult eighteen years of age or over can be sexed accurately in nearly every case. The skull and pelvis of an individual is believed to be ninety-eight percent accurate for

sexing. The pelvis alone gives evidence of being ninety-five percent accurate, and when found with long bones that percentage is increased. The skull alone can be sexed with ninety percent accuracy and with the long bones ninety to ninety-five percent. The adult long bones alone can be sexed with eighty percent accuracy (Krogman 1962:149). Therefore, one can see that with skeletal material from an ossuary, the percentage of accuracy is lessened unless articulation is present.

In subadults there is a fifty-fifty chance of sexing skeletal remains accurately. However, if the pelvis remains are present, the percentage of accuracy improves to seventy-five to eighty percent (Krogman 1962:149).

A second problem is that estimates are based on morphology (description) and morphometry (dimensions and proportions). Statistical data does not seem to raise the average of accuracy, but it does make evidence more convincing (Krogman 1962:149).

Third, the population samples involved in a study may require different standards of measuring morphological and morphometric sex differences. This is usually the case as averages and ranges differ between population samples. The best rule for alleviating this problem is to use standards drawn and based on the group to which the sample belongs (Krogman 1962:149-150).

Sexual differences begin to develop in the skeleton before an individual is born. In sexing an infant, one can refer to the sciatic notch of the pelvis as it increases faster in females during fetal growth. Through time, as the individual matures, sex can be determined from a number of skeletal areas and thus with more accuracy. In determining the sex of subadult skeletal material, it is important to remember that the female grows faster and matures earlier than the male and age must be considered (Ubelaker 1978:41).

The sex of subadults may also be estimated by comparing the stage of dental calcification with the degree of maturity of the post-cranial skeleton. Since females mature more rapidly than males and the rate of calcification of the teeth remains the same in both sexes, then one can compare the maturity level of the teeth with that of the post cranial remains. This is accomplished by aging the dental calcification and post-cranial remains independently of one another. A standard male sample is then used to compare with the calcification maturity. If the degree of growth is similar to the standard, the skeleton is male; but if there is a large deviation when compared, the skeleton is considered to be a female (Ubelaker 1978:41). The sexing of subadults in ossuary remains can prove to be quite difficult, however, as sufficient skeletal materials are rarely articulated or known to be from the same individuals. The dental and post-cranial method was tested using radiographs of living children and found to be seventy-three percent effective for two year olds, seventy-six percent effective for five year olds and eighty-one percent accurate for eight year olds (Ubelaker 1978:42). Therefore, because of the fragmented and incomplete condition

of skeletal remains from ossuary sites, it is best to limit identification of sex to adult remains.

In examining adult skeletal remains, it is desirable to consider the morphology of the entire skeleton. However, the pelvis is considered the most accurate single part at ninety percent to ninety-five percent for sexing skeletal remains. An adult is considered to be eighteen or over with reliable sexual distinctions. The significant distinctions include size and shape related to function. Generally, male bones are longer, robust, and more rugged than the female bones in the same population (Ubelaker 1978:42). However, in comparing a male and a female from different populations, the reverse could be the case.

As mentioned earlier, the pelvis provides the most accurate information for the sex information of skeleton remains. Male and female differences are well marked and much research has been done to confirm this. There are seven characteristics in the pelvis which can lead to its sexual assessment. First, the form of the female pelvis is usually broader than the males even though the males may be heavier and more robust. Second, the sciatic notch located at the junction of the upper flat portion of the pelvis and the lower portion of the pelvis is wider in females forming an angle of about sixty degrees. In males the sciatic notch is somewhat narrower, forming an angle of approximately thirty degrees. Third, the auricular area tends to be flatter in males than in females. Another feature of the pelvis which rarely occurs in the male pelvis is the pre-auricular sulcus. This feature is a groove between the sciatic notch and auricular, which when seen on a male pelvis is considerably shallower compared to the female. The fifth characteristic is the acetabulum, which is a socket-like depression that holds the head of the femur. In males it is larger than in females. The sixth trait of the pelvis which shows sexual dimorphism is the pubis. The pubis is longer in females than in males and the subpubic angle is wider (Ubelaker 1978:42). A last characteristics that varies between male and female is seen in the obturator foramen. In males it is larger and more oval, while in the female it is smaller and triangular in shape (Bass 1974:162).

Discriminatory analysis is often used in sexing skeletal remains. The idea assigns an individual to a sample classified into two or more groups. These groups are based on a number of variables which are characteristics of the individual use in the sample. This allows the individual to be assigned to one group, male or female, according to the information available (Giles and Elliot 1963:55).

Discriminatory analysis was used by Giles and Elliot in sexing a known collection of skulls from the Terry Collection at Washington University and the Todd Collection at Western Reserve University (Giles and Elliot 1963:55). Sex estimates made from the skull are not quite as accurate as those derived from the pelvis; however, a specialist can identify a skull with eighty to ninety percent accuracy (Ubelaker 1978:42). Four hundred and

eight skulls were used; one hundred and eight white males, seventy-nine white females, one hundred and thirteen Negro males, and one hundred and eight Negro females. Seventy-five specimens from each group were chosen randomly and measured for eleven variables. The other sample was reserved for checking. The eleven measurements of the crania used were the glabello-occipital length, the maximum width, the basion-bregma height, the maximum diameter of the bi-zygomatic, the prosthion-nasion height, the basion-nasion distance, the basion-prosthion distance, the nasal breadth, the palate external breadth, the opisthion (or forehead length), and the mastoid length. The means and standard deviations of each measurement were computed with the age and sex combination. In every measurement for both races, the dimensions of the male skull are significantly larger than those of the female. There was also seen a difference between the populations. The white female measurements were lower in most traits than the black female (Giles and Elliot 1963:55-56). Given that the individuals within the ossuary all represent the same population, this type of analysis may be utilized. But it is important to keep the measurements within the population being studied.

Eugene Giles used discriminatory function analysis with just the mandible and found it accurate to eighty-five percent. He too used a controlled sample but suggests that a large independent scale would have been more desirable. Furthermore, he reinforces the need to keep the sample within the population (Giles 1964:133-134).

Another technique for determining the sex of skeletal remains is by examining the long bones. Generally the bones of males are larger and more rugged than the female in the same population. However, the accuracy of sex identification using this standard is reduced by the overlap of males and females within the same population and varies between populations. The maximum diameter of the head of the femur is a good indicator of the sex of the remains. If the head measures over forty-five millimeters, there is a good chance it is a male, while those measuring less than forty-two millimeters are probably female. The humerus can be measured in the same way with measurements less than forty-three millimeters suggesting females and over forty-eight millimeters suggesting males (Ubelaker 1978:42). A definite problem here is that the epiphyses are many times fragmented as a result of erosion, soil condition, etc.

In summary, sexing of archaeological skeletal remains is limited by the condition of the bone to determine what bones are to be used as a base. For example, if within the entire populations found more mandibles existed over the other remains, then they should be used to determine the sex ratio of the population. However, the pelvis is seen as the most reliable source followed by the skull and the long bones.

TABLE TWO

STAGES OF METAMORPHIC CHANGE IN THE OS PUBIS (FEMALE)

(Adapted from Gilbert and McKern 1973)

COMPONENT I—THE DORSAL DEMI-FACE

	AGE RANGE	AGE MEAN
0—Ridges and furrows distinct	14-24	18.00
1—Ridges begin to flatten/ furrows fill in/ flat dorsal margin begins in demi-face	13-25	20.04
2—Dorsal demi-face spreads ventrally/ becomes wider as flattening continues/ dorsal margin extends	18-40	29.81
3—Dorsal demi-face is quite smooth/ margin may be narrow or indistinct from face	22-40	31.00
4—Demi-face becomes complete and unbroken/ broad and very fine grained	28-59	40.00
5—Demi-face becomes pitted and irregular through rarefaction	33-59	48.00

COMPONENT II—THE VENTRAL RAMPART

0—Ridges and furrows very distinct/ entire demi-face is beveled up toward the dorsal demi-face	13-22	18.63
1—Beginning inferiorly, the furrows of the ventral demi-face begin to fill in, forming an expanding beveled rampart	16-40	22.52
2—Furrows now filled in and expansion of demi-face continues from superior and inferior ends	18-40	29.64
3—Two thirds of the ventral demi-face is filled in with fine grained bone	27-57	38.77
4—Ventral rampart presents a complete fine grained surface from the pubic rest to the inferior ramus	21-58	40.90
5—Ventral rampart may begin to break down assuming a very pelted appearance through rarefaction	36-59	48.50

COMPONENT III—THE SYMPHYSEAL RIM

0—Rim is absent	13-25	20.23
1—Rim begins in the mid-third on the dorsal surface	18-34	25.75
2—Dorsal part of the symphyseal rim is complete	22-40	32.00
3—Rim extends from the superior and inferior ends of the symphysis until all but about 1/3 of the ventral aspect is complete	22-57	35.60
4—Symphyseal rim is complete	21-58	39.90
5—Ventral margin of dorsal demi-face may break down so that gaps appear in the rim	36-59	49.40

AGING

Aging of skeletal remains involves a number of steps. One must first observe the morphological features in the skeletal remains and compare them with those changes observed in recent populations of known ages. The variability which exists between the two populations must be estimated. This third step is seldom discussed in osteological studies, but is an important element (Ubelaker 1978:45).

To estimate age, it is important to utilize what is known about chronological changes which take place in the skeleton. Estimates of age at death must be relevant to the maturity of the individual as changes occur at different rates and times. For instance, dentition may be a useful criterion for measuring the age of a six or eight year old, but after the age of thirty-five it is virtually useless. Thus, it is important to determine first whether the specimen is an infant, child, adolescent or adult so that the best aging criteria can be utilized (Ubelaker 1978: 45-46).

Stewart in his analysis of the McLean Mound utilized the teeth, skull fragments, pubic fragments and long bones with one or both epiphyses (Steward 1966:67).

Subadult age, below eighteen, can be estimated by using three traits: dental development, epiphyses union, and length of bones. The first, dental development, is considered to be the most reliable in determining chronological age (Ubelaker 1978:47).

Studies have shown that dental development is determined by genetic factors with little environmental influence. Some diseases such as hypo-

TABLE THREE
MEAN AGE, STANDARD DEVIATION, AND AGE RANGES
(Adapted from Gilbert and McKern 1973, Ubelaker 1978:59)

TOTAL SCORE	AGE RANGE	MEAN AGE	STANDARD DEVIATION
0	14-18	16.00	2.82
1	13-24	19.80	2.62
2	16-25	20.15	2.19
3	18-25	21.50	3.10
4-5	22-29	26.00	2.61
6	25-36	29.62	4.43
7-8	23-39	32.00	4.55
9	22-40	33.00	7.75
10-11	30-47	36.90	4.94
12	35-52	39.00	6.09
13	44-54	47.75	3.59
14-15	52-59	55.71	3.24

pituitarism and syphilis can effect tooth development, but most have little or no effects. By examining dental development in living populations, one can get a good idea of its correspondence with age. Classification of age in American Indian populations has shown that tooth development occurs earlier than in white populations. Age is determined by deciduous tooth loss and the eruption of permanent teeth, which is completed around age twenty-one. Age after twenty-one is based on the wear of the teeth (Ubelaker 1978:46).

Ubelaker derived a dental age chart from non-Indian populations to be applied to American Indian skeletal remains. Each stage of development has a plus-or-minus factor due to variability reported in studies. However, an estimate may be off as much as five years (Ubelaker 1978:46).

Union of epiphyses is also used to age subadult remains especially between the age of ten and twenty. The method is based on three stages of epiphyses union. First, the proximal end of a bone is separated from the head of the epiphyses. Second, the epiphyses unite with the proximal end of the bone, creating a visible line. Third, when bone growth is complete, the line disappears. Ages of epiphyses union vary between populations. Usually union will begin earlier in females than in males, but in both sexes there can be a variation up to six years between individuals. Union occurs earliest in the ankle and hip, then takes place in the knee and elbow, and finally in the shoulder and waist (Ubelaker 1978:52-53). As mentioned earlier, epiphyses may be fragmented in ossuary material; so this procedure may prove futile.

Using long bones to determine age in subadults is limited and not very exact. Environment is quite important in determining bone length and must be taken into consideration. Many archaeological remains have been aged by using dentition and comparing long bone growth rate with these data. Errors were found to occur in the use of long bones when compared with ages on dental development and union of the epiphyses (Ubelaker 1978:46-47).

The best method for aging adults is to examine the symphyseal face of the pelvis or the surface where one pubis joins another. In early adulthood this area is quite rough with ridges and furrows, but with time these furrows fill to produce a smooth surface. While this is occurring, a ridge forms on the outer surface of the face, followed by the formation of a rim of bone along the outer circumference of the face. Then the symphyseal face finally begins to decompose (Ubelaker 1978:53).

A closer examination of this process can be seen in Table One composed by using information derived from Gilbert and McKerns's study of the age correspondence with metamorphic changes in the symphyseal face of the os pubis in females (Gilbert and McKern 1973:33-34). The procedure for this method consists of determining which stage the os pubis is in for each component. The score is then added up and compared with Table Two, which indicates the age range, mean age and standard deviation (Ubelaker

1978:59). The study was based on one hundred and three individual male remains ranging in age from thirteen to ninety-seven years. No apparent change in the symphyseal face was seen in individuals over fifty-five (Gilbert and McKern 1973:34), therefore limiting its use.

It is important when using this method to have the remains sex determined. In females the pubis undergoes flattening faster than males. Hence a female pubis aged twenty-five has the same appearance as a male pubis aged thirty-five (Gilbert and McKern 1973:35-36).

Other aspects which need to be considered in using this method include the effect the environment might have on development such as nutrition. Birth traumas can prevent aging of the pubic symphysis and need to be recognized (Gilbert and McKern 1973:37).

A second method of aging adults is to look at suture closures. If the skull is the only part found, examination of suture closures is the best procedure (Krogman 1962:89). Sutures are the joints between the twenty-two bones forming the skull. They are clearly visible in young adults, but as the individual becomes older they begin to close, usually after age seventeen (Bass 1964:33). Much variability occurs between individuals. Ranges up to twenty-one years have been examined between two individuals exhibiting similar suture closures (Johnston and Snow 1961:242). Closure usually occurs endocranially first, and these closures should take precedence over ectocranial closures due to lapsed union (Krogman 1962:89). Therefore, using suture closures to determine the age at death should be approached with much skepticism. However, if no other bones remain, it is certainly a useful method for gathering estimates.

As in the aging of subadults, epiphyseal union of bones can be utilized to determine age for adults. The medial extremity of the clavicle begins fusing around age eighteen. This fusion normally ends between ages twenty-seven and thirty. Retardation of the union can, however, occur and fusion may not begin until age twenty-five (Genoves 1970:448). It is obvious that this method is limited in its age range from eighteen to thirty.

Dentition can also be used to age adult skeletal remains at time of death. As mentioned earlier in this paper, dental development is virtually useless for aging after age thirty-five. Dental attrition has been used to indicate age, as wear caused by chewing occurs continuously during a life. Five states of dental wear have been established for American aborigines. At the beginning of adult life, wear signs occur on the tips of cusps. The cusps of the molars are worn off around ages twenty-six to thirty-three. Between the ages of thirty-five and fifty, the enamel is worn off of the masticating surfaces of teeth and in the next two decades the crowns are noticeably worn down. The crowns are worn off completely around age sixty-five and up. (Ubelaker 1978:64).

There are problems which arise from using this method. First, teeth erupt at different ages in individuals within the same population, causing

some teeth to be exposed to more wear. The environment plays a significant part in dental wear. If food contains grit, then wear will occur much more rapidly. Occlusion, morphology and using teeth as tools are also factors which need to be considered when analyzing dental attrition (Ubelaker 1978:64).

In conclusion, traditional methods of determining age at death are limited by the condition of the remains. The most useful remains for aging an individual are rarely found or in a condition often fragmented, eroded or incomplete (Kerley 1965:149). It is also important when aging an individual to be aware of the variabilities that exist within and between populations. Furthermore, the greater the experience of the examiner, the more accurate the age estimate especially when working with the remains of older individuals (Kerley 1965:149).

Perhaps the most accurate method for aging skeletal material is by an osteon count. The process of osteon formation occurs throughout an individual's life; thus the number within a long bone increases with age (Ubelaker 1978:64). Four features are observed in osteon formation. They include the number of whole osteons, the number of old osteons represented as fragments, the amount of circumferential lamellar bone remaining and the number of non-Haversian canals which are formed by the inclusion of small blood vessels in the bone (Kerley 1965:152).

One major problem with using this method is the equipment necessary: a microscope with 100-power magnification and instruments for cutting useful cross section of the bone. However, Ubelaker was able to utilize this method in analyzing materials from the Juhle site with more accuracy than observing pubis metamorphosis (Ubelaker 1974:54-57).

CULTURAL AND PATHOLOGICAL ALTERATIONS

Cultural and pathological alterations are also significant when analyzing skeletal remains. Cultural influences which should be noted include cranial deformation and dental mutilation. Head deformation could be one of five types devised by T. D. Stewart. These include vertico-occipital, lambdoid, frontal, fronto-occipital, and circular. Such deformations usually are the result of the head of a subadult or infant being tightly bound or subjected to a hard surface such as a cradle board (Ubelaker 1978:64).

Dental mutilation may include occlusal grooves caused by pulling thin strings through the teeth, filing and chipping (Ubelaker 1978:71-72).

The surface of buried bone may exhibit changes similar to the following: (a) marking due to disease, (b) deliberate marking due to man, (c) post-mortem marking due to erosion, roots, earth pressure, animals, teeth, etc. (Stewart 1966:76). In examining ossuary skeletal remains, de-fleshing of the bones may be noted by cut marks on the distal or proximal ends of the long bones (Ubelaker 1978:76-77). Such markings should not be confused with tooth marks left by gnawing rodents (Stewart 1966:77). Trephination,

as well, should not be confused with rodent tooth action as seen in Stewart's skeletal sample from the McLean Mound (Stewart 1966:77). Another problem is post-mortem deterioration which may be mistaken for pathology. It is important then that the soil and aspects of the context of the ossuary are considered before making a final analysis on pathology (Ubelaker 1978:75). If the skeletal material is fragmented, as is generally the case when poorly preserved, fractures and disease information may be easily overlooked (Stewart 1966:79). In general, there are ten categories of disorders which affect the bone and should be considered when analyzing archaeological remains. These categories include (a) arthritis, (b) fractures, (c) infections, (d) congenital disorders, (e) circulatory disturbances, (f) tumors, (g) metabolic disorders, (h) endocrine disorders, (i) diseases of blood-forming tissue, and (j) miscellaneous diseases such as dental pathologies (Ubelaker 1978:78).

BURNED BONE

Burned bone is often found in ossuaries (Ubelaker 1974, McCord 1966, South 1962, Holmes 1884). Whether or not such burned bone represents a cremation is questionable, but careful examination of the bone should be incorporated in one's study. Information on whether or not individuals were burned where they were found or elsewhere, whether the burned bone represents an adult or subadult and whether the bone was burned "green" or in a skeletal state could give evidence of custom patterns (Stewart 1966:70).

Ubelaker suggests four goals in excavating and analyzing burned bone. They are:

- (a) to identify and remove all fragments of bone
 - (b) to record the position of every fragment
 - (c) to establish whether the remains were burned on the spot or were burned elsewhere and redeposited
 - (d) to observe details relevant to reconstructing the firing procedure
- (Ubelaker 1978:33)

The identification of cremated remains usually presents a problem in that they are generally fragmented and distorted as a result of firing. Shrinking does not occur until the temperature reaches 700 degrees centigrade and can be noted by color changes from black to gray and then to white. Shrinkage may occur from 1 to 25 percent (Ubelaker 1978:34), and for this reason size as an indicator of sex can be misleading (Stewart 1966:70). Aging may also be a problem. If the skeletal remains were burned elsewhere before being deposited in a secondary burial, then the surrounding soil would not show evidence of burning (Ubelaker 1974:30-31). One should be careful to observe and record instances of burned bone by using photographs and complete descriptions of the area. If cremation occurred soon after death, articulation of foot and skull bones may still exist

(Ubelaker 1978:34).

Fracture patterns in burned bone can indicate whether it was burned with the flesh present or in skeletal condition. Burning dry bone causes cracking or splitting which is longitudinal but warping usually does not occur. On the other hand, when flesh-covered bone is burned, the bone fractures transversely and significant warping can be seen (Ubelaker 1978:35-36).

Another problem the archaeologist is faced with is whether the bone was intentionally cremated or if while in the process of defleshing the remains were set too close to a fire. Unless actual evidence appears in the ossuary that the bone was cremated in the area or unless a significant quantity of burned remains are found, one can merely speculate. A few burned bones can not give much information, but they should be studied.

Cremations are not useful for demographic profiles as aging and sexing are difficult. However, from the description above, one can derive information concerning when bone was burned and whether in the ossuary or elsewhere.

DEMOGRAPHIC RECONSTRUCTION

Although individuals may have died away from a village or their bones may have been lost prior to an ossuary burial and may not have been counted, the information gathered from an ossuary may be useful in reconstructing the demographic and population profiles of a village. In



Plate II

Excavation of a simple pit ossuary in New Hanover County, North Carolina.

order to complete these reconstructions successfully, three requirements should be met. The first is that the skeletal sample should be complete. Secondly, the age at death should be accurately determined; and third, the size of the living population and their death rates should have remained constant in the ossuary. Using this information, mortality curves, survivorship curves, and life tables for the population can be constructed (Ubelaker 1974:59). For the purpose of this paper, only mortality curves will be discussed.

In assembling demographic reconstruction, the first step is to divide the individuals into categories according to their age at death. Ubelaker suggests using five-year intervals as it allows for error yet allows patterns to be recognized. It is important that all individuals represented in the ossuary be put in an age category in order to reflect the sample in its entirety. If possible, the age categories should be divided into male and females. The number of individuals found in each category is then translated into the percentage of the population, which will be used in the reconstruction (Ubelaker 1978:92-93).

To form a mortality curve, the percentage of the sample is plotted relative to the age category it represents. The points are then connected illustrating the mortality rate of the population. It is important to use the most accurate method for aging individuals, and Ubelaker suggests that the microscopic method is best since it gives a more reliable age of adults and



Plate III

Identifying and restoring bone from a North Carolina ossuary.

long bones usually represents more individuals in an ossuary than the symphyseal face of the pubis (Ubelaker 1978:93).

In prehistoric populations infant mortality ratios are often as high as five to ten (5:10) or even eight to ten (8:10). These early deaths are less important to paleodemographers than the effect of adult death and the number of healthy children. At age ten the child death ratio is a good measure of child health, especially if the skeletal growth and dental development are studied (Angel 1973:430).

Paleodemography relies on accurate individual identification (sex and age) and an accurate sample of such individuals collected by "metricular excavation techniques" (Angel 1973:434). However, the true key to success in accomplishing the above is the collaboration of the archaeologist and the physical anthropologist.

In conclusion, one is presented with quite a few problems when analyzing ossuary skeletal remains. Condition of the bone can limit aging and sexing techniques. Disarticulation of the bones along with their spacial distribution can also limit the identification of individuals represented in an ossuary. Perhaps the best procedure when dealing with such material is to divide crania (including dental analysis), long bones, and innominates into the age groups utilized by Ubelaker rather than by specific ages. Sexing should also use the same skeletal remains when available. When morphological traits are compared to determine sex, it is best to use the population being studied if such data are available; otherwise bones from a similar population may prove quite helpful. In any event, the archaeologist should reflect upon each situation carefully in order to obtain the most information possible by utilizing the necessary maximum accurate procedures.

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