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Comprehensive forensic case report case UMFC 39

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COMPREHENSIVE FORENSIC CASE REPORT, CASE UMFC 39

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I reviewed the literature on estimating age from the pubic symphysis and performed a comprehensive analysis of UMFC 39, which is part of the Department of Anthropology's teaching collection. The techniques and methods I used for this analysis are as follows. Methods for estimating sex include visual assessment of the skull, pelvis and coxal bones, pubic bone, scapula, and femur; from measurements of the scapula, clavicle, humerus, femur, tibia, ischium-pubic index, Giles and Elliot metric analysis; and from FORDISC 2.0. Methods for estimating race include visual assessment of the skull, palate shape, palatine suture, and zygomaticomaxillary suture shape; from measurements of the skull, Giles and Elliot discriminant function analysis, FORDISC 2.0, Gill's interorbital features, 21 cranial measurements discriminant function analysis by Seguchi and Oe, from the scapula; and from long bones. Methods for estimating age include suture closure, dental attrition, epiphyses closure, sternal rib ends, vertebral column, auricular surface, and pubic symphysis. Methods for estimating stature and weight include the Trotter and Gleser method, the Genoves method, and the Metropolitan Life Insurance Company chart. Methods for estimating handedness include asymmetry, and from Stewart's method. I also examined the remains for evidence of pathology and trauma.

Based on the application of the methods presented, the evidence is most consistent with a right-handed female of ambiguous ancestry, 50-60 years of age, with a height of about 5 feet 2-1/2 inches and a weight of 161 pounds, who exhibited pathology consistent with aging, and who has no apparent perimortem trauma.

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CASE BACKGROUND

The case that I have chosen to work on is UMFC 39. There is no paperwork related to this case, such as, where it came from and when it arrived at the Physical Anthropology Laboratory at the University of Montana.

Today the remains are housed in the Physical Anthropology Laboratory at the University of Montana – Missoula. They are a part of the collection that is used for educational purposes. The remains are available to students who are currently taking osteology and forensic anthropology classes. The laboratory remains locked; however, several graduate students have access to the laboratory. Since this case is part of the collection, other students have conducted analysis of the remains as well. These reports are a part of the file for this case. The conclusions drawn by other examiners are as follows.

A report by Amy Eaton in March 1994 concluded that "the evidence is most consistent with these remains representing the possibility of two individuals. One of them represents a male, 50-60 years of age, with a height of 5'5 to 5'6"." Another report by Connie Hegel in March 1999 concluded that "the evidence is most consistent with the remains representing a Negroid female with mongoloid admixture, over 50 years of age and approximately 5'1 to 5'3." The other report done, by Trisha Brown in March 2000, concluded that "the evidence is most consistent with the remains representing a male of ambiguous ancestry, over 60 years of age and approximately 5'3" to 5'5"."

My analysis of the remains took place September 2005 thru January 2006. A thorough inventory of the condition of the bones is presented. A complete set of measurements of the remains is appended to the end of my report. The methods used and results deduced from each method are also included in this report.

For my required literature review of a relevant subject, I chose the Todd Method of estimating age from the pubic symphysis. In this literature review I focus on studies that have attempted to test the reliability of the Todd method and I draw conclusions about its overall accuracy.

INTRODUCTION TO THE HUMAN SKELETON

The adult human skeleton is comprised of approximately 206 bones, with a variety of conditions that can add to the number. These bones range in size from small, angular shapes to long, heavy limb bones that tend to be straight or slightly curved. Each bone in the body is named. When describing the skeleton, the standard orientation is anatomical position. This position places the body standing, with the arms arranged along the side and the palms facing forward. In addition the legs are extended straight; with the feet arranged as though flat on the ground (Bass, 1995:3).

According to Seguchi and Skelton (2004:29) the skeleton is divided into two categories: "the axial skeleton (includes the cranium, mandible, hyoid, vertebral column, sternum and ribs) and the appendicular skeleton (includes the limb bones, shoulder girdle and pelvic girdle)."

The axial skeleton consists of the cranium, which includes the frontal bone, the right and left parietal bones, the right and left temporal bones, the right and left auditory ossicles, the occipital bone, the maxillae, the right and left palatine bones, the vomer, the right and left inferior nasal conchae, the ethmoid, the right and left lacrimals, the right and left nasal bones, the right and left zygomatic bones, the sphenoid and the mandible, which make up the cranium. There is some variation in the number of skull bones. Burns (1999:24) notes, "Many of the extra bones are small bones isolated within the skull sutures. They are called wormian bones. An extra suture across the occipital bone can result in a triangular bone at the back of the skull called an Inca bone. Lack of union of the frontal bone results in a retained midline suture: a metopic suture and paired frontal bones." The hyoid bone, the sternum, the vertebral column, which includes seven cervical vertebrae, twelve thoracic vertebrae and five lumbar vertebrae and twelve right and left ribs, all make up the rest of the axial skeleton.

The appendicular skeleton consists of the shoulder girdle which includes the right and left clavicle, the right and left scapula, the right and left humerus, the right and left radius, the right and left ulna, the hand bones made up of the right and left carpal bones, the right and left metacarpal bones, the left and right phalanges of the fingers. The pelvic girdle consists of the sacrum, the coccyx, and the right and left os coxae. The limb bones consist of the right and left femur, the right and left patella, the right and left tibia, the right and fibula, the foot bones made up of the right and left tarsal bones, the right and left metatarsal bones and the right and left phalanges of the toes (Seguchi and Skelton, 2004:32-39).

Chapter 1

LITERATURE REVIEW FOR AGING FROM THE PUBIC SYMPYSIS

The Todd method is a method for estimating age from the pubic symphysis. This method is presented in Todd (1920). Prior to Todd's method, others recognized morphological changes in the os coxae and their relationship to skeletal age. They were Hunter (1761), Aeby (1858), Henle (1872), and Cleland (1889). Most authors were concerned with the pubic symphysis; however, they neglected the epiphyseal areas of the bone as well as specific bone changes and skeletal age.

In 1920, Todd developed a system of symphyseal phases using the Western Reserve Collection. Todd's observations showed that the symphyseal face of the pubic bone undergoes regular changes from puberty to death. Todd identified a succession of ten phases, bony features, such as ridge and furrow patterns, a dorsal margin, a ventral bevel, a ventral rampart, lower and upper extremities, and a rim. The ten phases, with definitions are as follows.

Phase 1:	Age 18-19. Typical adolescent ridge and furrow formation with no sign of margins and ventral beveling.
Phase 2:	Age 20-21. Foreshadowing of ventral beveling with slight indication of dorsal margin.
Phase 3:	Age 22-24. Progressive obliteration of ridge and furrow system with increasing definition of dorsal margin and commencement of ventral rarefaction (beveling).
Phase 4:	Age 25-26. Completion of definite dorsal margin, rapid increase of ventral rarefaction and commencing delimitation of lower extremity.
Phase 5:	Age 27-30. Commencing formation of upper extremity with increasing definition of lower extremity and possible sporadic attempts at formation of ventral

rampart.

Phase 6: Age 30-35. Development and practical completion of ventral rampart with increasing definition of extremities.

Phase 7: Age 35-39. Changes in symphyseal face and ventral aspect of pubis consequent upon diminishing activity, accompanied by bony outgrowths into pelvic attachments of tendons and ligaments.

Phase 8: Age 39-44. Smoothness and inactivity of symphyseal face and ventral aspect of pubis. Oval outline and extremities clearly defined but no "rim" formation or lipping.

Phase 9: Age 45-50. Development of "rim" on symphyseal face with lipping of dorsal and ventral margins.

Phase 10: Age 50 and Upwards. Erosion of and erratic, possibly pathological, osteophytic growth on symphyseal face with breaking down of ventral margins.
(Todd, 1920:313-314).

Todd's method of aging from the pubic symphysis is a reliable technique for age estimation and is widely used when aging unknown individuals. Since his initial research, using pubic changes to evaluate age at death has received much attention.

Hanihara (1952) applied Todd's method on aging from the pubic symphysis on male Japanese pubic bones. Hanihara investigated a series of 135 male cadavers ranging in ages from 17 to over 50. His description of symphyseal metamorphosis follows closely with Todd's; however, his emphasis of certain features demonstrates a slightly different interpretation. Hanihara concludes that, "the changes (referring to the 10 phases) stated by Todd can be used also on Japanese individuals. However, it (symphyseal changes of Japanese pubic bone) does not always coincide with that of Todd in the division of each period," (Hanihara, 1952:255). He also goes on to state that the age changes of the Japanese individuals is 2 to 3 years earlier. Hanihara is unable to say whether these differences are due to racial variation or to difference of opinion among the examiners. Hanihara does find that Todd's phases tend to overage many specimens.

Brooks (1955), felt the age ranges for each stage were too high and tested them on a series of 194 male and 177 female California Indian skeletons and a sample of 103 males and 82 females from the Western reserve Collection (the same sample utilized by Todd). Brooks concluded that for all ages over 20 years the phases consistently yield a higher than actual age and hence should be modified.

McKern and Stewart (1957) used data on 450 male skeletons from the Korean War. Their system focuses on three aspects of the symphyseal face: the dorsal demi-faces, the ventral rampart, and the symphyseal rim. They showed that these components change independently at different rates, and that Todd's method oversimplifies the changes at the expense of accuracy. This is a complex system, requiring the user to rank each component on a scale of 0 to 5, adding the three numerical values to provide a total score that can then be converted to an age estimate. This method is relatively accurate, but is difficult to implement. This method is only applicable to male individuals and if by chance the estimation of sex is incorrect then the age estimation may also be incorrect.

Gilbert and McKern (1973) developed a method for aging the pubic symphysis that is basically the same method as the McKern and Stewart method, but is exclusively for females. Different definitions of stages are used compared to the Mckern and Stewart method and different correlating ages are used as well. The user ranks each component on a scale of 0 to 5, adding the three numerical values to provide a total score that can then be converted to an age estimate. Gilbert and McKern note that the morphological development of females is different from that of males, and that females are subject to trauma from childbirth which may cause an individual female os pubis to appear older than it actually is. As compared to the male os pubis, that of a female of the same age may appear to be ten years younger based upon the ventral rampart, and ten years older based upon the dorsal plateau. This method is as reliable as the McKern and Stewart method.

The Meindl et al. (1985) method is a revision of the Todd method. This method recognizes only 5 phases instead of the 10 phases recognized by Todd. This method is relatively accurate and should be used in conjunction with the Todd method as well as other pubic symphysis aging techniques.

Katz and Suchey (1986) developed a method that combines Todd's stages and correlates different ages with the stages. This method is applicable only to male specimens. The definitions of each stage correspond with those in Todd's method. Katz and Suchey's method has considerable overlap between stages with the mean age still being useful. Katz and Suchey state, "the traditional Todd system and its modified form are found to be the best systems. When implementation is considered, a modified Todd six phase system is recommended," (Katz and Suchey, 1986:427). This method can be accurate because of the broad age ranges that are utilized.

Suchey and Brooks (1990) were able to demonstrate that pubic symphysis differences are due to the sex of an individual but not ancestral group. Other research has shown that 5 year increments used for describing changes in the pubic face are too narrow.

Although the stages vary, all of the above mentioned methods look at the same features originally described by Todd (1920). In conclusion, the Todd method is a relatively reliable indicator of age.

Chapter 2

SKELETAL INVENTORY

Bones Present for Analysis Include:

All of the bones present for analysis exhibit deterioration and extensive staining, possibly due to exposure to natural elements.

The skull is present and complete, except for possible postmortem trauma on the right side. This trauma will be discussed in detail in Chapter 8: Pathology and Trauma. The frontal bone is complete. The right temporal bone is partially complete (60mm x 60mm), with the right zygomatic process missing. The left temporal is complete, with the left zygomatic process present and complete. The right parietal bone is partially complete. The left parietal bone is complete. The occipital bone is complete with a small portion on the right side not present. The palate and maxilla are present and complete. The right and left nasal bones are present and complete. The right and left inferior nasal conchae bones are partially complete. The right and left side of the ethmoid, lacrimal and vomer are present and complete. The right side of the sphenoid is partially complete. The left side of the sphenoid is present and complete.

The right and left maxillae is present, with maxilla dentition being absent. With only tooth sockets present for the right and left first incisors (RI^1, LI^1) and for the right and left second incisors (RI^2, LI^2). Reabsorption of the maxilla is seen, possibly due to antemortem tooth loss.

The mandible is present and complete. Several mandibular teeth are present. The right and left canine (RC_1, LC_1), the right second premolar (RP_2) and the left first premolar (LP_1) are present. Many teeth are absent, with only a tooth socket present for the right first premolar (RP_1) and for the left second premolar (LP_2). Reabsorption of the mandible is seen, possibly due to antemortem tooth loss.

The right clavicle shows signs of deterioration anteriorally, on the sternal articulation and the lateral end. Posteriorally, deterioration is seen on the sternal articulation and on the medial edge of the acromial facet.

The left clavicle shows signs of deterioration anteriorally, on the sternal articulation and on the lateral end. Posteriorally, deterioration is seen on the edge of the sternal articulation, on the edge of the acromial facet and minor deterioration on the conoid tubercle.

The right scapula shows signs of deterioration anteriorally, on the lateral end of the acromion, the superior border, and the superior angle. The right scapula has a small circular defect, anteriorally and dorsally, just below the superior border. The right scapula is missing the coracoid process, the glenoid cavity, the infraspinous and subscapular fossa, the body, the lateral border, the medial border and the inferior angle, possibly due to exposure to soil and weather.

The left scapula shows signs of deterioration on the coracoid process and on the superior angle. The left scapula has a circular defect, anteriorally and posteriorally, (.45mm x .65mm) on the infraspinous fossa. The left scapula has two circular defects, anteriorally and posteriorally, on the subscapular fossa between the oblique ridges, the first is .65mm x .65mm and the second is 23mm x 31mm.

The right humerus shows signs of deterioration anteriorally, on the medial and lateral edges of the capitulum. Posteriorally, deterioration is seen on the medial and lateral edges of the trochlea and in the olecranon fossa. There is a small circular defect (1mm) on the lateral anterior side of the right humerus just below were the greater tubercle should be. The head, the greater tubercle and a potion of the lesser tubercle are missing, possibly due to being exposed to natural elements.

The left humerus shows signs of deterioration anteriorally, on the greater and lesser tubercle and on the lateral edge of the capitulum. Posteriorally, deterioration is seen on the lateral edge of the head, in the olecranon fossa and on the medial and lateral edges of the epicondyles.

The right ulna shows signs of deterioration anteriorally, on the edge of the coronoid process, the semilunar notch and posteriorally on the lateral edge of the olecranon process.

The left ulna shows signs of slight deterioration anteriorally, on the medial edge of the olecranon process, semilunar notch and the coronoid process. Posteriorally, deterioration is seen on the lateral edge of the olecranon process and on the head.

The right radius shows signs of slight deterioration anteriorally, on the lateral edge of the styloid process and posteriorally along the edge of the ulnar notch and along the edge of the head, medially to laterally.

The right first rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left first rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left second rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The right third rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left third rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The right fourth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The right fifth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left fifth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The right sixth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left sixth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The right seventh rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left seventh rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The right eighth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left eighth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The right ninth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left ninth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

The left tenth rib shows signs of deterioration on the head, along the inferior edge, on the sternal ends and on the superior rim.

Four possible rib fragments are present. There are no sternal or vertebral ends; therefore I am unsure as to the number or side of these fragments. The staining appeared to be the same as the other ribs.

The fifth thoracic vertebrae shows signs of deterioration. Superiorly, the transverse process is present, however short due to deterioration. The spinous process is intact, with the body and pedicles missing.

The sixth thoracic vertebrae shows signs of deterioration. Superiorly and inferiorly, deterioration is seen on the body. The right side of the body is missing, as well as the pedicule. The left transverse process is present, shows signs of deterioration and is shorter than normal. Lipping is seen along the edge of the body.

The seventh thoracic vertebrae shows signs of deterioration. Superiorly, deterioration is seen on the body. The transverse process and spinous process are intact. Inferiorly, deterioration is seen on the lateral side of the body. Lipping is seen on the body superiorly and inferiorly.

The eighth thoracic vertebrae shows signs of deterioration. Superiorly, the right transverse process is deteriorated. The spinous processes are intact. Lipping is seen on the body superiorly and inferiorly. The body is heavily deteriorated, with porosity seen.

The eleventh thoracic vertebrae shows signs of deterioration. Superiorly, deterioration and lipping is seen on the body. Inferiorly and posteriorally, deterioration is seen on the body. The transverse process, spinous process, and left pedicule show signs of deterioration.

The twelfth thoracic vertebrae shows signs of deterioration. Superiorly, the transverse process and the spinous process show signs of deterioration. Superiorly and inferiorly, the body (center) shows signs of deterioration.

The first lumbar vertebrae shows signs of deterioration. Superiorly, the transverse process, spinous process, and mammillary process are present and deteriorated. Lipping on the body is seen superiorly and inferiorly. Portions of the rim on the body are present.

The second lumbar vertebrae shows signs of deterioration. Superiorly, the transverse process, spinous process, and mammillary process are present and deteriorated. Superiorly, the edges of the body are deteriorated. Lipping on the body is seen superiorly and inferiorly.

The third lumbar vertebrae shows signs of deterioration. Superiorly, deterioration is seen on the lateral portion of the body and on the left pedicule. Superiorly, the transverse process, spinous process, and mammillary process are present and deteriorated. Lipping on the body is seen superiorly and inferiorly.

The fifth lumbar vertebrae shows signs of deterioration. Superiorly, the body (center) is cracked from the anterior to the posterior of the body. Superiorly, the transverse process, spinous process, and mammillary process are present and deteriorated. Lipping on the body is seen superiorly and inferiorly. Inferiorly, the body is deteriorated on the lateral side.

The right coxal bone shows signs of deterioration. Deterioration is seen on the lateral edge of the acetabulum, the medial edge of the pubis, the ischial spine, the anterior of the pubic symphysis, posteriorly-superiorly on the iliac spine, and posteriorly-inferiorly on the ischium. There is a small crack running through the ischio-pubic ramus and on the pubis, possibly due to handling and deterioration.

The left coxal bone shows signs of deterioration and is fragmented. Deterioration is seen on the ischium, anteriorally. The ischio-pubic ramus and the pubis, including the pubic ramus and pubic symphysis, are missing. A portion of the ilium is present (62mm x 100mm) and the iliac fossa is present. The anterior-superior iliac spine is missing, a portion of the auricular surface is missing and a crack (2mm) is in the ilium. A portion of the ischium is present (45mm x 179mm). Deterioration is seen on the anterior-medial auricular surface, the anterior-medial ischial spine, the anterior-lateral ischial spine, and in the acetabulum.

The right femur shows signs of deterioration anteriorally on the medial epicondyle, along the patellar articular surface, and on the lateral edge of the head. Deterioration is seen superiorly on the medial edge of the lateral condyle and the lesser trochanter.

The left femur shows signs of deterioration anteriorally on the medial epicondyle, on the lateral edge of head, on the obturator externus groove, and medially on the greater trochanter. Deterioration is seen superiorly on the lateral edge of head, on the lesser trochanter, and medially on the greater trochanter.

The right patella shows signs of deterioration along the superior edge of the articular surface and along the edge of the inferior edge of the patella.

The right tibia shows signs of deterioration anteriorally on the lateral tibia plateau. Deterioration is seen posteriorally on the medial and lateral tibia plateau and on the edges of the facet for the fibula.

The left tibia shows signs of deterioration anteriorly on the medial and lateral tibial plateau. Deterioration is seen posteriorly on the medial and lateral tibial plateau and on the edges of the facet for the fibula.

The right fibula shows signs of deterioration medially and laterally on the base of the head.

The left fibula shows signs of deterioration medially and laterally on the base of the head and on the medial edges of the facet for the tibia.

The right talus shows signs of deterioration superiorly and laterally.

The right calcaneus shows signs of deterioration superiorly and laterally.

The right navicular shows signs of deterioration superiorly.

The right cuboid shows signs of deterioration superiorly.

The right first metatarsal shows signs of deterioration medially near the base.

The right third metatarsal shows signs of deterioration superiorly on the base, medially and laterally, and on the head, laterally. Deterioration is seen inferiorly, on the head, laterally.

The right fourth metatarsal shows signs of deterioration superiorly on the base, medially and laterally and on head, laterally. Deterioration is seen inferiorly on the head, medially and laterally.

The right fifth metatarsal shows signs of deterioration superiorly on the head, medially. Deterioration is seen inferiorly on the head, medially and laterally.

The right first proximal phalange shows signs of deterioration superiorly on the head, laterally. Deterioration is seen inferiorly on the head, laterally and on the base, medially and laterally.

The left third metatarsal shows signs of deterioration inferiorly on the head, medially and laterally.

The left fourth metatarsal shows signs of deterioration superiorly on the head, medially and laterally. Deterioration is seen inferiorly on the head, medially and laterally.

The left fifth metatarsal shows signs of deterioration superiorly on the base, medially.

After inventorying the skeletal remains for this case, there appears to be one individual present. There are no duplicated bones, and the coloring seems to be consistent throughout. Therefore, I conclude that UMFC 39 represents one individual.

Bones Not Present for Analysis Include:

- The auditory ossicles: the right and left malleus, the right and left incus, and the right and left stapes.
- The dentition: all of the maxilla dentition; the right and left first incisor, the right and left second incisor, the right and left canine, the right and left first premolar, the right and left second premolar, the right and left first molar, the right and left second molar, and the right and left third molar. Mandible dentition; the right and left first incisor, the right and left second incisor, the right first premolar, the left second premolar, the right and left molar, the right and left second molar, and the right and left third molar.
- The sternum.
- The left radius.
- The carpals: the right and left lunate, the right and left triquetral, the right and left hamate, the right and left capitate, the right and left scaphoid, the right and left trapezoid and the right and left trapezium.
- The metacarpals: the right and left first metacarpal, the right and left second metacarpal, the right and left third metacarpal, the right and left fourth metacarpal, the right and left fifth metacarpal.
- The proximal hand phalanges: the right and left first hand phalange, the right and left second hand phalange, the right and left third hand phalange, the right and left fourth hand phalange, the right and left fifth hand

phalange.

- The intermediate hand phalanges: the right and left first hand phalange, the right and left second hand phalange, the right and left third hand phalange, the right and left fourth hand phalange, the right and left fifth hand phalange.
- The distal hand phalanges: the right and left first hand phalange, the right and left second hand phalange, the right and left third hand phalange, the right and left fourth hand phalange, the right and left fifth hand phalange.
- The ribs: the right second rib, the left fourth rib, the right tenth right, the right and left eleventh rib and the right and left twelfth rib.
- The vertebral column: the hyoid, the atlas, the axis, the third cervical vertebrae, the fourth cervical vertebrae, the fifth cervical vertebrae, the sixth cervical vertebrae, the seventh cervical vertebrae, the first thoracic vertebrae, the second thoracic vertebrae, the third thoracic vertebrae, the fourth thoracic vertebrae,.the ninth thoracic vertebrae, the tenth thoracic vertebrae, the fourth lumbar vertebrae, the sacrum and the coccyx.
- The sacrum and coccyx.
- The patella: left side.
- The tarsal bones: the left talus, the left calcaneus, the left cuboid, the left navicular, the right and left medial cuneiform, the right and left intermediate cuneiform and the right and left lateral cuneiform.

- The metatarsals: the left first metatarsal, the right and left second metatarsal.
- The proximal foot phalanges: the left first foot phalange, the right and left second foot phalange, the right and left third foot phalange, the right and left fourth foot phalange, the right and left fifth foot phalange.
- The intermediate foot phalanges: the right and left first foot phalange, the right and left second foot phalange, the right and left third foot phalange, the right and left fourth foot phalange, the right and left fifth foot phalange.
- The distal foot phalanges: the right and left first foot phalange, the right and left second foot phalange, the right and left third foot phalange, the right and left fourth foot phalange, the right and left fifth foot phalange.

Chapter 3

SEX ESTIMATION

The estimation of sex for an individual is an important part of the identification process. The techniques involved are highly accurate because there are limited choices. An examiner has a 50% chance of accurately sexing human remains by chance alone. This accuracy is only achievable with adult skeletal material. Preadolescent children do not exhibit as many clearly diagnostic characteristics. The race of an individual must also be kept in mind while sexing the individual, White (2000:363) states, "Because of such inter-populational differences in size and robusticity, males from one population are sometimes mistaken for females in other populations." The accuracy level for sex estimation depends on what techniques and how many are applied to the unknown individual. The more techniques applied to the individual, the higher the level of accuracy of sex estimation.

The following methods for estimating the sex of an individual are based on both metric and non-metric cranial analysis techniques and metric and non-metric postcranial techniques. Every individual is born with a skull that looks female, in that it is small and not strongly muscle marked. Therefore, sex estimation of an immature skull is not very accurate. According to Skelton (2006:5), male skulls change at puberty and start exhibiting common male characteristics. Since most developmental errors are failures to develop full expressions of sex specific traits, there are some males who retain female skull characteristics but few females who exhibit male characteristics. Therefore, we need to give greater weight to male characteristics in sexing the skull (Seguchi and Skelton, 2004:13).

Sex Estimation from Visual Assessment of the Skull

The first method for estimating the sex of an individual is based on visual assessment of the skull. The criteria upon which the method is based, is found in numerous sources: Seguchi and Skelton (2004), Burns (1999), Bass (1995), etc; therefore it is not necessary to mention all of the methods here. These techniques look at specific characteristics of the skull and the observer must determine if the expressed characteristics are male or female. Bass believes,"the skull is the second best area of the skeleton for determining sex. The estimation of sex is based on the generalization that the male is more robust, rugged, and muscle marked than females. Absolute differences seldom exist, and many intermediate forms are found," (Bass, 1995:85).

Seguchi and Skelton state, "The criteria for sexing from the skull are listed in the order of reliability and should be used with the "3 to 1" rule. This rule states that it takes three or more "less" reliable criteria to overrule one reliable criteria. Remember that we count each male trait as worth 2 female traits," (Seguchi and Skeleton, 2004:12). The common expressions of skull characteristics are as follows.

1. Sunken Nasal Root is seen in males. Although a small number of males lack sunken nasal roots (also prominent glabella), it is extremely rare for females to have a sunken nasal root.
2. Brow Ridges are larger in males.
3. Frontal Bossing is seen in females. The phenomenon is described as a high, unsloping frontal and is characteristic of females. Males typically have sloping foreheads. However, people of African descent have a high degree of frontal bossing,

therefore this criteria is not useful for populations of African origin.

4. Mastoid Size. The mastoid process is larger in males and the crest above it is prominent.
5. Nuchal Rugosity. The nuchal area of the occipital bone is less rugged and less prominent in females. Nuchal rugosity is variable from population to population.
6. Chin Shape. The chin is more square in males and more rounded in females. It is also more common for a male to have a round chin than for a female to have a square chin.
7. Orbit Shape. The orbits tend to be rounder with sharper edges in females and more square with rounded edges in males.
8. Thickness of the Zygomatic Arch. The zygomatic arch tends to be thin in females and thick in males.
9. Zygomatic Bone. The zygomatic bone tends to be smooth in females, but has prominent muscle markings in males.
10. Mandibular Thickness. The mandible tends to be thicker in males at the region of the second molar.
(Seguchi and Skelton, 2004:13).

I applied this method for estimating the sex of UMFC 39. The observed criteria are as follows. This individual exhibited no sunken nasal root, the presence of a slight brow ridge, frontal bossing was seen, the mastoid process is medium in size, slight nuchal rugosity is seen, the chin shape was rounded, the orbit shape was round with sharp edges, thickness of the zygomatic arch was thin and the mandibular thickness was slightly thick. Based on these observations, the remains are most consistent with a female individual.

Sex Estimation from Measurements of the Skull

The next method used for estimating the sex of an individual is based on a technique measuring the skull presented by Giles and Elliot (1963). This technique is based on four measurements of the skull. The measurements are: maximum cranial length (g-op), maximum cranial breadth (eu-eu), facial width (zy-zy), and a mastoid length (po-ms). Once these are obtained, they are then placed in the following formula: 2.184(g-op) +1.000(eu-eu) +6.224(zy-zy) +6.122(po-ms) = [1495.40]70%. If the sum is greater than 1495.40, the skull is male and if the sum is less than 1495.40, the skull is female. This method of sex estimation claims an accuracy of 70%. According to Skelton (2006:6) this method is fairly accurate, however it should be used in conjunction with other techniques.

I applied this method for estimating the sex of UMFC 39. The measurements obtained are as follows: a maximum cranial length of 190mm, a maximum cranial breadth of 135mm, a facial width of 120mm, and a mastoid length of 28mm ([2.184(190)+1.000(135)+6.224(120)+6.122(28)=1468.256]). The overall sum worked out to be 1468.256. The score is less than 1495.40; therefore based on this method, the skeletal remains are most consistent with a female individual. This method can give incorrect estimations due to population differences in cranial measurements and caution should be taken when interpreting the results from this method.

Another method used for estimating the sex of an individual is based on taking cranial measurements and then using FORDISC 2.0, created by S. Ousley and R. Jantz (1996). This computer program takes skeletal measurements (see Appendix A and C) and does an analysis to estimate sex and ancestry. FORDISC 2.0 consists of two databases. The first consists of more than 1,500 modern forensic cases and the second consists of data from W.W. Howell's cranial database, which consists of skull measurements from different populations from around the world.

I applied this method for estimating the sex of UMFC 39. FORDISC 2.0

identified UMFC 39 as a female. The accuracy was estimated at 88.6% however, FORDISC estimated the typicality at .000, indicating that none of the females in its database look like UMFC 39. These results indicate that UMFC 39 is closest to the female average but is not a typical female. I also used FORDISC to determine sex from mandibular measurements. FORDISC identified UMFC 39 as a female. The accuracy was estimated at 79.8% however, FORDISC estimated the typicality at .030, indicating that 3% of the females in the FORDISC database look like UMFC 39.

Sex Estimation from Postcranial Bones

The methods used for estimating the sex of an individual are based on: size and the structure of the human skeleton (male versus female). Male skeletons tend to be more robust, taller, and more rugged than females. Female skeletons are structurally different than males. Since females carry and give birth to children, their pelves are wider than those of males. Several methods can be used for estimating sex of skeletal remains, such as measurements and the shape of certain bones.

Sex Estimation from the Coxal Bones

One of the most reliable methods for estimating sex of an individual is from the shape of the pelvis and coxal bones. According to Bass (1995:216), the common expressions of morphological traits are as follows:

FEMALE	MALE
Pubis - long and square	Pubis - short and rounded
Subpubic angle - wide	Subpubic angle - narrow
Greater sciatic notch - broad	Greater sciatic notch - narrow
Auricular surface - elevated	Auricular surface - flat
Acetabulum - relatively small	Acetabulum - relatively large
Obturator foramen - smaller & triangular	Obturator foramen - larger & oval
Coxal - smaller & less rugged	Coxal - larger and more rugged

I applied this method for estimating the sex of UMFC 39. The observed criteria are as follows: the pubis was long, the subpubic angle was wide, the greater sciatic notch was broad, the auricular surface was elevated, the acetabulum was relatively small, and the obturator foramen was small. Therefore, according to this visual assessment, this individual is female.

Another method for estimating sex of an individual is from visual assessment of the pubic bone. TW Phenice (1969) discovered three characteristics of the pubic bone, which he claimed were highly reliabile for differentiating males from females. These characteristics are: the ventral arc, the subpubic concavity, and the width of the medial aspect of the pubis. Only females have a ventral arc that is separated from the rim of the pubic symphysis, have a subpubic concavity and have a narrow medial aspect of the ischio-pubic ramus. According to Phenice, and others, if the individual is female, then at least one of these three traits will be present and if none of these three traits is clearly female than the individual is probably male.

I applied this method for estimating the sex of UMFC 39. The observed criteria are as follows: a ventral arc, a subpubic concavity and a narrow medial aspect of the ischio-pubic ramus. Therefore, according to the Phenice method, UMFC 39 is most consistent with a female individual.

Another method for sex estimation of an individual is based on the measurements of the coxal bones and is the ischium-pubic index by Washburn (1948). The index was established as a way of quantifying the longer pubic bone in females when compared with males. Although the ischium-pubic index is fairly accurate for determining sex, the two measurements needed are difficult to obtain. The base point is inside the acetabulum, where the ilium, ischium and pubis fuse and is represented by a raised area. The two measurements are taken by using a sliding caliper on base point, swinging it first to the end of the pubic bone and then swinging it to the bottom of the ischium. Once these measurements are obtained, they are then placed in the following formula:

IP Index = (Pubis Length x 100) / Ischium Length.

I applied this method for estimating the sex of UMFC 39. The measurements obtained are as follows: the pubis length of 102mm and the ischium length of 85mm (102x100/85=120). The sum for the ischium-pubic index is 120mm. The Ischium-Pubic Index aids in sex estimation, according to the following chart (Bass, 1995:200).

Ischium-Pubic Index

WHITES	BLACKS
Below 90 = male	Below 84 = male
90-95 = sex indeterminate	84-88 = sex indeterminate
95 and over = female	88 and over = female

Measurements given in mm.

I applied this method for estimating the sex of UMFC 39. The measurement obtained, places UMFC 39 in the female range. Based on this information, the remains are consistent with those of a female.

Sex Estimation from the Scapula

The next method for estimating sex of an individual is from visual assessment of the scapula. The method for visual assessment of the scapula is presented in Skelton (2004) and comes from unpublished research. According to Skelton (2004), females exhibit a broad scapula, and a deeper glenoid fossa, that is set at a right angle to the axis of the scapular body. Males exhibit a narrow scapula, with a shallow and broad glenoid fossa, and points more superiorly (Seguchi and Skelton, 2004:42). Sex estimation tends not to be reliable when using this method and should be used in conjunction with other methods.

I applied this method for estimating the sex of UMFC 39. The individual exhibits a broad scapula, with a deep glenoid fossa. The glenoid fossa of UMFC 39 was set at a right angle to the axis of the scapular body. Based on these observations, the skeletal remains are most consistent with those of a female individual.

The next method for estimating sex of an individual is based on the measurements of the scapula. The criteria for which the method is based, is found in numerous sources: Bass (1995), Stewart (1979), Krogman (1962), etc; therefore it is not necessary to mention all of the methods here. This method is presented in Bass (1995) and by Dwight (1894b). The measurements are as follows: the maximum scapular length and the length of the glenoid cavity. The measurements according to Dwight (1894b) are then compared to the following chart:

Length of Glenoid Cavity of Scapula

Measurement	Females	Sex?	Males
Scapula Length	<129	140-159	>160
Glenoid Cavity Length	<34	34-36	>37

Measurements given in mm.

I applied this method for estimating the sex of UMFC 39. Only the left scapula was present for analysis. The measurements obtained are: the maximum length is 149mm and the glenoid cavity is 37mm. The measurement obtained for the scapula length based on Dwight's chart, places UMFC 39 in the indeterminate range. The measurement obtained for the glenoid cavity length based on Dwight's chart, places UMFC 39 in the male range. Based on this information, I conclude that the sex for UMFC 39 is indeterminate when using the scapula for sex estimation.

Sex Estimation from the Clavicle

The next method for estimating sex of an individual is based on the measurements of the clavicle. The criteria for which the method is based, is found in Bass (1995). The measurements are as follows: the maximum length and the circumference at the middle bone of the clavicle. Bass states, "the accuracy of estimating an individual's sex based on measurements of the clavicle has met with varying degree's of success," (Bass, 1995:133). Thieme (1957) used clavicle length as one of eight measurements for estimating sex in African Americans. Although this single measurement is not very accurate, Thieme reports the following:

Sex Estimation from Clavicle Length

Measurement	Sex	N	Mean	Standard Deviation
Clavicle Length	M	98	158.24	10
	F	100	140.28	8

After Thieme (1957).
Measurements given in mm.

I applied this method for estimating the sex of UMFC 39. The right and left clavicle were present for analysis. The measurements obtained are: the maximum length for both the right and left clavicle is 160mm; the circumference at the middle bone of both the right and left clavicle is 13mm. Based on the measurements obtained and Thieme's chart, for the right and left clavicle length, UMFC 39 falls into the male category. This method could give an incorrect estimation because the chart used is from an African American sample. Therefore these results could be different for other population groups. Based on this information, the estimation of sex from the clavicle for UMFC 39 is male.

Sex Estimation from the Humerus

The next method for estimating sex of an individual is based on the measurements of the humerus. The criteria for which the method is based, is found in Bass (1995). The measurements are as follows: the maximum length, the diameter of the humeral head, and the epicondylar width. Stewart (1979:100) reported on the vertical diameter of the humeral head for 50 males and 50 females from the Terry Collection. The results are as follows:

Sex Estimation from Diameter of Humeral Head

Measurement	Females	Sex?	Males
Vertical Diameter of Humeral Head	<43	44-46	>47

Stewart (1979:100)
Measurements given in mm.

Thieme (1957:73) reported on the length and epicondylar width of the humerus in 98 males and 100 females in African American Skeletons. The results are as follows:

Sex Estimation using the Humerus of American Negroes

Measurement	Sex	N	Mean	Standard Deviation
Humerus Length	M	98	338.98	18.55
	F	100	305.89	18.66
Epicondylar	M	98	63.89	0.363
Width of humerus	F	100	56.76	0.332

After Thieme (1957:73).
Measurements given in mm.

I applied this method for estimating the sex of UMFC 39. The right and left humerus were present for analysis; however the right humeral head was not present. The measurements obtained are: the maximum length for the right is 324mm and for the left is 315mm, the left diameter of humeral head is 44mm, and the epicondylar width for the right is 59mm and for the left is 60mm.

According to Stewart's chart above, the measurement obtained for the left humeral head, places UMFC 39 in the sex indeterminate range. According to Thieme's chart using African Americans, the measurements obtained for the right and left maximum length and for the right and left epicondylar width, UMFC 39 falls within the female range. This chart could give an incorrect estimation because the chart used is from an African American sample. Therefore these results could be different for other population groups. Based on this information, I conclude the estimation of sex for UMFC 39 is indeterminate.

<u>Sex Estimation from the Femur</u>

The next method for estimating sex of an individual is based on the measurements of the femur. The method is found in Bass (1995). The measurements are as follows: vertical diameter, popliteal length, bicondylar width and trochanteric oblique length. Pearson (1917-1919:56) reported on femur measurements from 17th century bones from London. Therefore, it should be understood that modern populations are larger. The results from Pearson's study are as follows:

Rules for Sexing the Femur

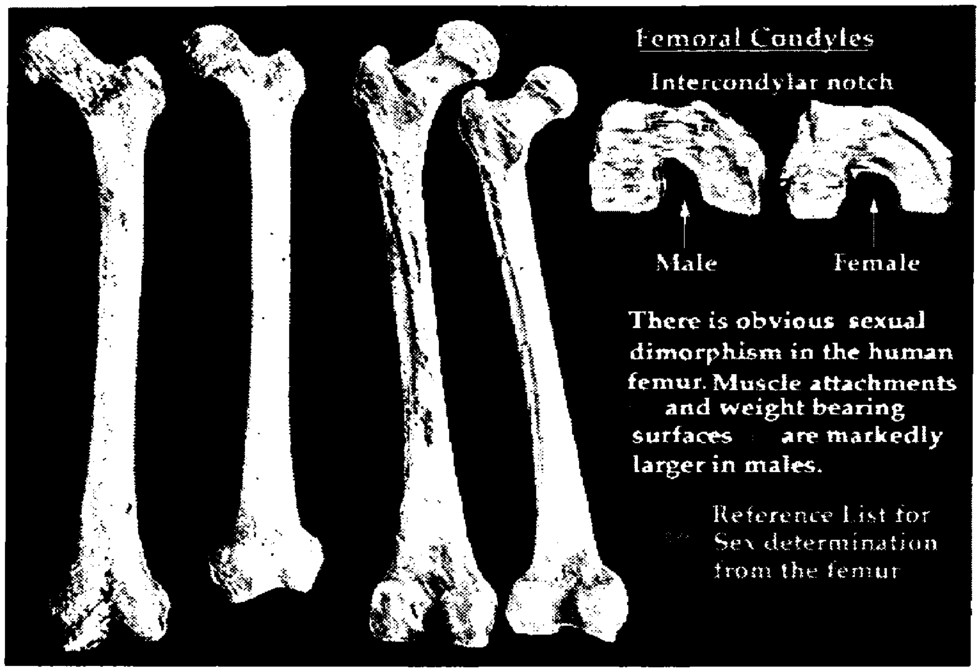
Measurement	Female	Female ?	Sex ?	Male ?	Male
Vertical Diameter	<41.5	41.5-43.5	43.5-44.5	44.5-45.5	>45.5
Popliteal Length	<106	106-114.5	114.5-132	132-145	>145
Bicondylar Width	<72	72-74	74-76	76-78	>78
Trochanteric Oblique Length	<390	390-405	405-430	430-450	>450

After Pearson (1917-1919:Table 27).
Measurements given in mm.

I applied this method for estimating the sex of UMFC 39. The right and left femur were present for analysis. The measurements obtained were: the vertical diameter for the right is 45mm, the left vertical diameter is 43mm, the trochanteric oblique length for the right is 423mm, the left trochanteric oblique length is 430mm, the bicondylar width for both the right and left is 78mm and the popliteal length for the right is 132mm, and the left is 127mm.

According to the chart above, the measurement obtained for the right vertical diameter of the femur, places UMFC 39 in the male? category, and the measurement of the left vertical diameter of the femur, places UMFC 39 in the female? category. The measurement obtained for both the right and left trochanteric oblique lengths, places UMFC 39 in the sex? category. The measurement obtained for both the right and left bicondylar widths, places UMFC 39 in the male? category. The measurement obtained for both the right and left popliteal lengths, places UMFC 39 in the sex? category. Based on this information, I conclude the estimation of sex for UMFC 39 is indeterminate.

Another technique for estimating sex of an individual is from visual assessment of the femur. The technique is discussed (http://medstat.med.utah.edu/kw/osteo/forensics /index.html) under Forensic Anthropology, Introduction to the Field. Three characteristics of the femur are discussed for differentiating females from males. These characteristics are: the posterior muscle attachments, the weight bearing surfaces of the femoral head, and the shape of the intercondylar notch. Males tend to have larger and more pronounced muscle attachments, as well as larger and marked weight bearing surfaces on the femoral head. The intercondylar notch tends to curve, is narrower in males and is wider, more vertical in females (see Figure below).



I applied this technique for estimating the sex of UMFC 39. The right and left femur were present for analysis. The observed criteria are as follows. This individual exhibited muscle attachments that did not appear to be heavily marked, the weight bearing surface of the femoral head did not appear to be heavily marked, and the intercondylar notch exhibited a wider, more vertical appearance in both the right and left femur. Based on these observations, the skeletal remains are most consistent with a female individual.

Sex Estimation from the Tibia

The next method for estimating sex of an individual is based on the measurements of the tibia. The method is found in Bass (1995). The measurements are as follows: the proximal breadth, the distal breadth, and the circumference at the nutrient foramen. Symes and Jantz (1983) used original data for their analysis from the Terry Collection and a postcolonial Arikara burial sample. The results from Symes and Jantz study are as follows:

Univariate Discriminant Function Sectioning Points for Whites, Blacks, and Arikara Indian Tibiae

Group	Proximal Breadth	%	Distal Breadth	%	Circumference at Nutrient Foramen	%
Whites						
Sectioning Point	75.11		49.24		90.16	
Male Mean	79.56		52.23		95.97	
Female Mean	70.66		46.24		84.34	
		88.75		86.25		82.50
Blacks						
Sectioning Point	74.82		48.08		92.76	
Male Mean	79.49		51.04		99.80	
Female Mean	70.14		45.11		85.72	
		91.36		87.65		86.42
Arikara Indians						
Sectioning Point	74.56		50.88		91.21	
Male Mean	79.15		54.18		98.58	
Female Mean	69.97		47.58		83.84	
		96.15		92.31		92.31

From Symes and Jantz (1983).
Measurements given in mm.

I applied this method for estimating the sex of UMFC 39. The right and left tibia were present for analysis. The measurements obtained were: the proximal breadth for the right is 73mm, the left proximal breadth is 75mm, the distal breadth for the right is 53mm, the left distal breadth is 50mm, and the circumference at the nutrient foramen for the right is not present for analysis, the left circumference at the nutrient foramen is 83mm.

According to the chart above, the measurement obtained for both the right and left proximal breadth, places UMFC 39 in the female range (in all 3 racial groups), the measurement for both the right and left distal breadth, places UMFC 39 in the male category (in all 3 racial groups), and the measurement for the left circumference at the nutrient foramen, places UMFC 39 in the female category (in all 3 racial groups). I conclude that the sex for this individual is female when using measurements from the tibia for sex estimation.

Summary

Both the metric and non-metric methods place UMFC 39 in three categories; they are female, sex indeterminate and male. Based on this information, and my observations of the skeletal remains, I conclude that UMFC 39 is most consistent with the features of a female.

Chapter 4

RACE ESTIMATION

Many anthropologists do not agree with the existence of race, however, for proper identification of skeletal remains, law enforcement expect anthropologists to properly estimate race. Therefore, anthropologists attempt to estimate ancestry using a broad category based on three races, Caucasoid, Negroid, and Mongoloid. Caucasoid includes most peoples of Europe or the Middle East. Negroid includes most peoples of Africa. Mongoloid is a grouping which would include most of the peoples of Asia, Pacific Islands, or the Americas. The three categories are poorly named and do not reflect worldwide human variation.

The skull is a part of the skeleton that ancestry or population affinity may be estimated with relative accuracy. This does not mean that the methods correctly identify an individual's racial affinity.

Race Estimation from Visual Assessment of the Skull

A method for estimating the race of an individual is based on visual assessment of the skull. Bass states, "the skull is the only area of the skeleton from which an accurate estimation of racial origin may be obtained," (Bass, 1995:86). The criteria for which the method is based, is a mixture of characteristics found in numerous sources: Morse, et al. (1983), Krogman (1962), El-Najjar and McWilliams (1975), and Shipman, et al. (1985) etc; therefore it is not necessary to mention all of the methods here. These techniques look at specific characteristics of the skull and the observer must determine if the expressed characteristics are Caucasoid, Negroid or Mongoloid. The race with the greatest number of characteristics is the one to which the individual is assigned. The common expressions of skull characteristics are as follows.

TRAIT	CAUCASOID	NEGROID	MONGOLOID
Skull length	long to short	mostly long	long to short
Skull breadth	narrow to broad	narrow	broad
Skull height	high	low	medium
Coronal contour	long to round	long	round
Sagittal contour	round	flat	arched
Frontal bossing	females only	both sexes	females only
Face breadth	narrow	narrow	broad
Face height	high to medium	low to medium	high
Face projection	nose projects	jaws project	not projecting
Zygomatics	strong back taper	strong back taper	weak back taper
Interorbital dist	narrow	wide	medium
Orbit shape	angular to round	rectangular	rounded
Nasal orifice width	narrow (ht=2wd)	wide (ht=wd)	medium
Nasal bones width	narrow	wide	medium
Nasal sill	smooth edge	sharp edge	sharp edge
Palate width	narrow to medium	wide	medium
Ruggedness	Gracile	Rugged	Medium

I applied this method for estimating the race of UMFC 39. The observed criteria are as follows. This individual exhibited a long skull length, a broad skull breadth, a medium skull height, a round coronal contour, an arched sagittal contour, frontal bossing, a medium face breadth, a short face height, face projection in jaws due to reabsorption, a strong back taper of zygomatics, rounded orbit shapes, medium interorbital distance, wide nasal orifice width, small nasal bone width, small with sharp edged nasal sill, wide palate width due to alveolar reabsorption and a medium size for ruggedness. Based on these observations, the remains exhibit characteristics of all races. Therefore, the race of

UMFC 39 is ambiguous.

This method could easily give an inaccurate estimation because the method is based on observations of the skull and introduces human error and misinterpretation. Most skulls provide only vague suggestions of an individual population affinity.

Another method for estimating the race of an individual is based on a set of criteria developed by Gill (1984, 1995). The criteria for which the method is based on the palate shape, palatine suture, and zygomaticomaxillary suture shape. These criteria are as follows.

TRAIT	American Indians	European Origin	African Origin
Palate shape	elliptical	parabolic	hyperbolic
Palatine suture shape	straight	Z-shaped	arched
Zygomaticomaxillary suture shape	angled	jagged or S-shaped	curved or S-shaped

from Gill, 1995

This is a relatively new method that estimates racial affinity based on visual assessments of certain characteristics. It was developed using samples from the Northern plains of North America and may be more accurate for cases from this region. This method is easy to use; you simply compare the cranium and mandible to pictures and a brief description, and choose the best match.

I applied this method for estimating the race of UMFC 39. The observed criteria are as follows.

TRAIT	American Indians	European Origin	African Origin
Palate shape	elliptical		
Palatine suture shape	straight		
Zygomaticomaxillary suture shape		S-shaped	S-shaped

The palate shape seemed to be elliptical, found frequently in American Indians. The palatine suture seemed to be straight, also found in American Indians. The zygomaticomaxillary suture seemed to be "S-shaped", found frequently in African and European ancestry. Based on these observations, UMFC 39 is ambiguous for race.

Race Estimation from Measurements of the Skull

The method used for estimating the ancestry of an individual is based on a technique measuring the skull, presented by Giles and Elliot (1963). This technique is based on eight measurements of the skull. The measurements are: basion-prosthion height (ba-ids), glabello-occip. length (g-op), maximum width (eu-eu), basion-bregma height (ba-b), basion-nasion height (ba-n), maximum diameter bi-zyg. (zy-zy), prosth.-nasion height (n-ids), and nasal width (al-al). According to Skelton (2006), "this method assumes that there are three populations (American White, American Black, and American Indian) into which all the Peoples of the World can be divided. The number of discriminant functions needed to correctly identify the group membership of a person is always one less than the number of possible groups. Therefore, we need two functions to sort people as White, Black, or Indian" (Skelton, 2006:22). The procedure is as follows.

1. Take the measurements necessary to use the discriminant functions. In this case they are g-op, eu-eu, ba-b, ba-n, zy-zy, ba-ids, ids-n, and al-al. Note that you only have to take each measurement once, even though we will be using the

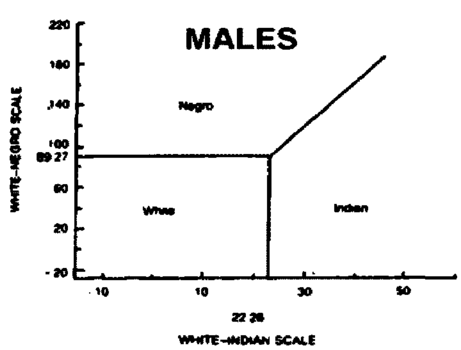
measurements twice. All measurements are in mm.

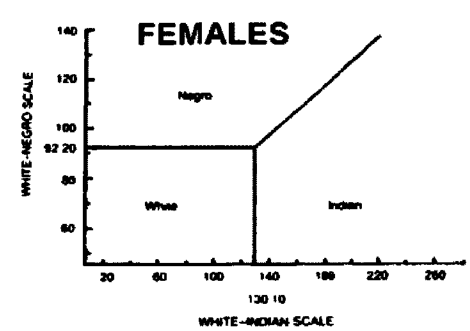
2. Determine by some method whether the individual is female or male.
3. Choose which function or functions to use, based on the sex and possible population affinity of the individual. If the individual could not possibly be American Indian, then use the appropriate function for the sex of the individual to distinguish between American Whites and Blacks. If the Individual could not possibly be Black, then use the appropriate function for the sex of the individual to distinguish between American Whites and American Indians. In all other cases you need to use both functions.
4. Plug your measurements into the functions to get discriminant scores. If you are only using one function, then compare the discriminant score you obtained to the sectioning point to estimate the affinity of the individual.
5. If you are using both functions then plug your measurements into both formulas and record the two discriminant scores. Then, examine the graphs in Bass. Determine where your specimen falls on either the male or the female graph, based on its scores from the White-Black function and the White-Indian function. Assign population affinity to the individual as American Black, American Indian, or American White, depending on which area of the graph the individual falls.
6. See Giles and Elliot's method worksheet below.

Specimen: ______ Date: ______ Measured by: ______

MEASUREMENT		MALE		FEMALE		SEX
		WHT/NEG	WHT/IND	WHT/NEG	WHT/IND	MEAS NO FACTOR
ba-ids Basion–Prosthion Ht	____ x	+3 06 = ____	-0.10 = ____	+1.74 = ____	+3.05 = ____	ba-ids x -1.00 = ____
g-op Glabello–Occip. Ln.	____ x	+1 60 = ____	-0 25 = ____	+1.28 = ____	-1.04 = ____	g-op x +1.16 = ____
eu-eu Maximum Width	____ x	-1.90 = ____	-1.56 - ____	-1 18 = ____	-5.41 = ____	ba-n x +1.66 = ____
ba-b Basion–Bregma Ht.	____ x	-1.79 = ____	+0 73 = ____	-0.14 = ____	+4.29 = ____	zy-zy x +3.98 = ____
ba-n Basion–Nasion Ht.	____ x	-4 41 = ____	-0 29 = ____	-2 34 = ____	-4.02 = ____	n-ids x +1.54 = ____
zy-zy Max Diam. Bi-zyg.	____ x	-0.10 = ____	+1 75 = ____	+0.38 = ____	+5.62 = ____	TOTAL = ____
n-ids Prosth.–Nasion Ht.	____ x	+2.59 = ____	-0 16 = ____	-0 01 = ____	-1.00 = ____	MALE ____ + 891 12
al-al Nasal Width	____ x	+10.56 = ____	-0 84 = ____	+2 45 = ____	-2.19 = ____	FEMALE ____ -
	TOTALS					

*These measurements are used for calculating sex





I applied Giles and Elliot's method to estimate the ancestry of UMFC 39. The measurements obtained are as follows:

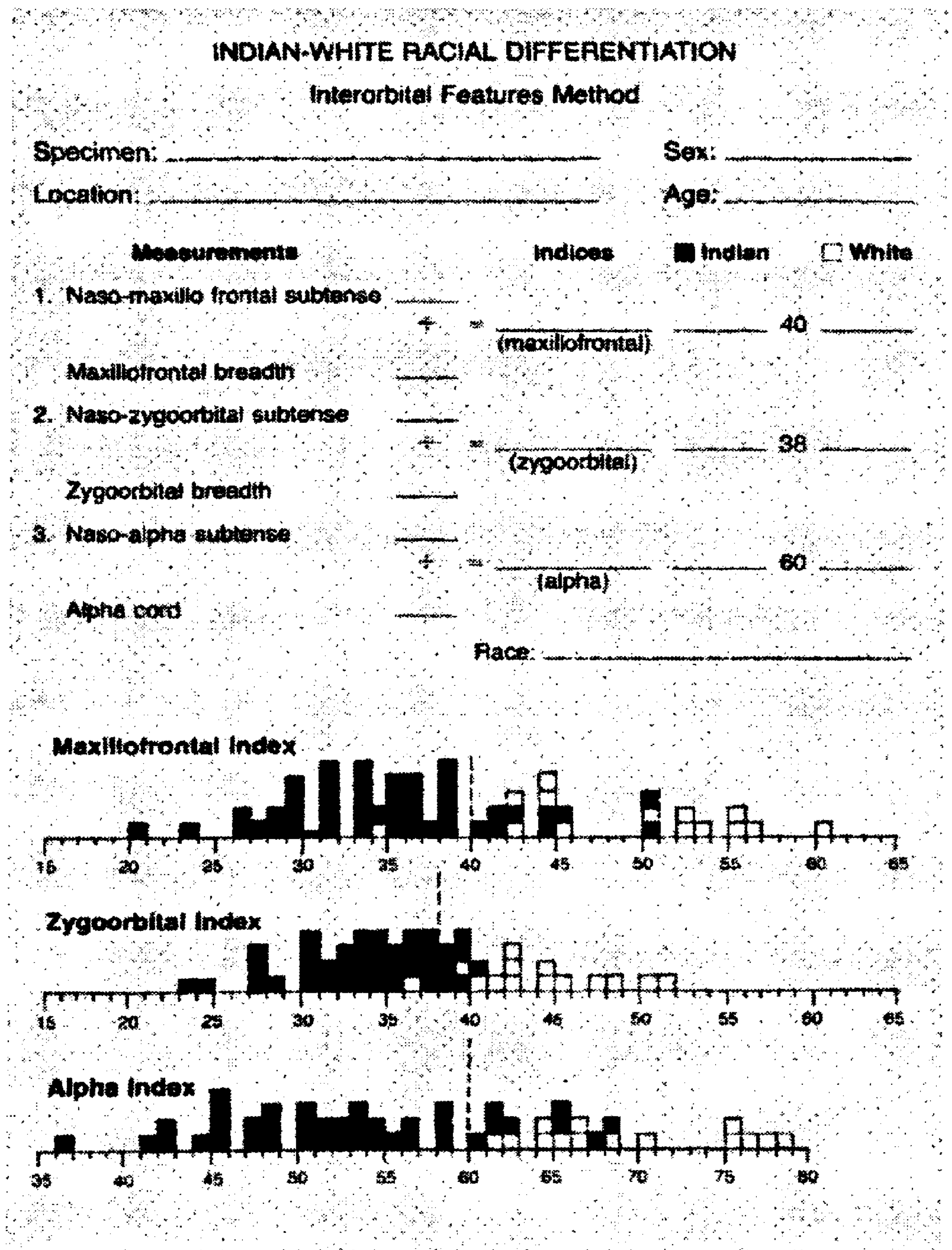
Measurement	mm	Determining Sex	Wht/Neg (Female)	Wht/Ind (Female)
ba-ids	95	95 x -1.00 = -95	95 X 1.74 = 165.3	95 X 3.05 = 289.75
g-op	190	190 x 1.16 = 220.4	190 X 1.28 = 243.2	190 X -1.04 = -197.6
eu-eu	135		135 x -1.18 = -159.3	135 x -5.41 = -730.35
ba-b	125		125 x -0.14 = -17.5	125 x 4.29 = 536.25
ba-n	100	100 x 1.66 = 166	100 x -2.34 = -234	100 x -4.02 = -402
zy-zy	120	120 x 3.98 = 477.6	120 x 0.38 = 45.6	120 x 5.62 = 674.4
n-ids	73	73 x 1.54 = 112.42	73 x -0.01 = -0.73	73 x -1.00 = -73
al-al	27		27 x 2.45 = 66.15	27 x -2.19 = -59.13
		TOTAL: 881.42	**TOTAL: 108.72**	**TOTAL: 38.32**
		Male: 891.12 and over		
		Female: 891.12 and under		

Based on these measurements, UMFC 39 falls within the Negroid range for the estimation of ancestry.

Another method used for estimating the ancestry of an individual is based on a technique measuring indices of the mid-facial region of the skull, presented by Gill (1984). This technique is based on six measurements of the skull. The measurements are: maxillofrontal breadth, naso-maxillo frontal subtense, zygoorbital breadth, naso-zygoorbital substense, alpha cord, and the naso-alpha substense (Bass, 1995:97). The procedure is as follows.

1. Take the measurements necessary to use the discriminant functions. A simometer is required for this method. In this case they are maxillofrontal breadth, naso-maxillo frontal subtense, zygoorbital breadth, naso-zygoorbital substense, alpha cord, and the naso-alpha substense. All measurements are in mm.
2. Plug your measurements into the functions to get the index scores. Then compare the index scores you obtained to the sectioning point to estimate the affinity of the individual.

3. See Interorbital methods worksheet below.



INDIAN-WHITE RACIAL DIFFERENTIATION

Interorbital Features Method

Specimen: ______ Sex: ______

Location: ______ Age: ______

Measurements			Indices	■ Indian		□ White
1. Naso-maxillo frontal subtense	____	÷ =	____ (maxillofrontal)	____	40	____
Maxillofrontal breadth	____					
2. Naso-zygoorbital subtense	____	÷ =	____ (zygoorbital)	____	38	____
Zygoorbital breadth	____					
3. Naso-alpha subtense	____	÷ =	____ (alpha)	____	60	____
Alpha cord	____					

Race: ______

I applied Gill's method to estimate the ancestry of UMFC 39. The maxillofrontal index is 43 (10.0 naso-maxillo frontal subtense / 23.0 maxillofrontal breadth = 43). The zygoorbital index is 40 (20.2 naso-zygoorbital subtense / 50.0 zygoorbital breadth = 40).

The alpha index is 62 (16.1 naso-alpha subtense / 26.0 alpha chord = 62). These indices for UMFC 39 fall within the European range according to Gill's method.

The next method used for estimating the ancestry of an individual is based on a taking cranial and using FORDISC 2.0, created by S. Ousley and R. Jantz (1996). This computer program takes skeletal measurements (see Appendix A) and does an analysis to estimate ancestry. FORDISC 2.0 consists of two databases. The first consists of more than 1,500 modern forensic cases and the second consists of data from W.W. Howell's cranial database, which consists of skull measurements from different populations from around the world.

I applied FORDISC 2.0 to estimate ancestry from the cranial measurements I obtained from UMFC 39. FORDISC identified UMFC 39 as an American Indian female (see Appendix F). The accuracy was estimated at 84.4% however, FORDISC estimated the typicality at .013, indicating that 13% of American Indian females in its database look like UMFC 39.

Another method used for estimating the ancestry of an individual is based on a taking 21 cranial measurements and using a discriminant function program created by Seguchi and Oe (2001). The computer program consists of two programs. They are: DISCR (Seguchi and Oe, 2001) and SCOREPLOT (Seguchi and Oe, 2001). DISCR is a computer program with a database of measurements of more than 8,530 individuals from a variety of populations from around the world. SCOREPLOT is a computer program that uses input data computed by DISCR and generates canonical variate plots. This computer program takes 21 variable measurements (see Appendix H) and performs an analysis to estimate ancestry.

I applied the 21 variable discriminant functions program to estimate ancestry from the cranial measurements I obtained from UMFC 39. The 21 variable discriminant function program identified UMFC 39 closest to East African, as well as Mongol Hunnu (see Appendix I). For East African the posterior probability was estimated at 20.0% with a typicality of 2.3%, indicating that 2.3% of East Africans in its database look like UMFC 39. For Mongol Hunnu the posterior probability was estimated at 20.0% with a typicality of 2.6%, indicating that 2.6% of Mongol Hunnu in its database look like UMFC 39. However, the canonical variates plot indicates that UMFC 39 has features that resemble individuals of Jomon (prehistoric Japanese) and Mid US Archaic Native American ancestry (see Appendix J). These results indicate that UMFC 39 is an individual of ambiguous ancestry.

Race Estimation from the Post-Crania

The following methods for estimating ancestry of an individual are based on postcranial measurements. These methods are relatively new and should be applied with caution and in conjunction with other methods. According to Burns (1999:153), "there is no end to the variation that can be examined, but it is imperative that controls are established on the population to be examined before any method is applied with confidence." In time, these methods could provide more accurate techniques and information for estimating the ancestry of an individual.

The method used for estimating the ancestry of an individual from postcranial measurements, uses FORDISC 2.0, created by Ousley and Jantz (1996). This computer program takes skeletal measurements (see Appendix C) and performs an analysis to estimate ancestry. FORDISC 2.0 consists of two databases. The first consists of more than 1,500 modern forensic cases and the second consists of data from W.W. Howell's cranial database, which consists of skull measurements from different populations from around the world.

I applied FORDISC 2.0 to estimate ancestry from postcranial measurements I obtained from UMFC 39. FORDISC identified UMFC 39 as a white female (see Appendix G). The accuracy was estimated at 100.0% however, FORDISC estimated the typicality at .000, indicating that none of the white females in its database look like UMFC 39. These results indicate that UMFC 39 is closest to the white female average but is not a typical white female.

Race Estimation from the Scapula

The method used for estimating the ancestry of an individual is based on a measurements and indices of the scapula, presented by Hrdlicka (1942). This technique is based on simple measurements of the adult scapula. This procedure is simple, but is not very accurate. With considerable overlap between groups makes this method inadequate and it should be used only in support of other methods. Differences in dimensions of the scapula were seen in those of environmental groups and not true races.

I applied this method for estimating the sex of UMFC 39. The left scapula was present for analysis. The measurements obtained were: a length of 149mm, a breadth of 101mm, and a scapular index of 68mm. The measurement for length placed UMFC 39 closest to Fuegian, Finn, and US White. The measurement for breadth is over what is listed in the chart (Bass, 1995:127), however is still closest to Lenape Indian, and Pima and Pueblo Indian. The measurement for scapular index placed UMFC 39 closest to Egyptian, African Black and Melanesian. I then used the chart presented on page 128 from Bass (1995). The measurement for length placed UMFC 39 closest to all Whites, and American Negro. The measurement for breadth placed UMFC 39 closest to American Negro. The measurement for scapular index placed UMFC 39 closest to all Whites, and American Negro. However, with the ranges listed, UMFC 39 could belong to any of the groups listed. Therefore, this method did not yield useful results for UMFC 39.

Summary

The methods described above seem to randomly place UMFC 39 in Negroid, Mongoloid and European ancestry. Based on this information, and my observations of the skeletal remains, I conclude that race for UMFC 39 is ambiguous.

Some methods for race estimation could not be applied to this case for various reasons. Race from the sacrum could not be estimated because it was not present for analysis. Race from the teeth could not be applied because of tooth wear and absence of many of the teeth. Race estimation from the femur could not be applied because they required tools needed for this method were not available to me.

Chapter 5

AGE ESTIMATION

Age estimation is concerned with the age of an individual at their time of death, not the time since death. There are many different methods available to estimate that age of an individual from skeletal remains. Several different bones and teeth can be utilized to determine age, and some are better to use than other. Estimating an individual's age at death can be complicated and imprecise process.

Age Estimation from Cranial Sutures

Todd and Lyon (1924) developed a method for estimating the age of an individual based on endocranial and ectocranial sutures. "Ectocranial sutures are those visible from the outside of the skull and endocranial sutures are visible from the inside of the skull," (Skelton, 2006:7-8). Endocranial sutures are considered to be more reliable than ectocranial sutures, but still not very good. "Most people feel that age estimations based on these sutures are unreliable, but Meindl and Lovejoy (1985) believe that they are not too bad," (Skelton, 2006:7). Todd and Lyon's method is presented below.

	Ectocranial		Endocranial	
Suture	Commencement	Termination	Commencement	Termination
Sagittal	20.0	29.0	22.0	35.0
Coronal	26.0	50.0	24.0	41.0
Lambdoidal	26.0	31.0	26.0	47.0
Masto-occipital	28.0	32.0	30.0	81.0
Spheno-temporal	36.0	never	30.0	67.0

(from Skelton, 2006:9-10)

The method is to score the 5 cranial sutures based on being open, commenced, or terminated for both ectocranial and endocranial sutures. Skelton recommends following these steps:

1. For open sutures, score the age as younger than the age listed in the "commencement" column.
2. For commenced sutures, score the age as older than the age in the "commencement" column, and younger than the age in the "Termination" column.
3. For terminated sutures, score the age as older than the age in the "termination" column.
4. Take the information from each suture into account by combining the ages from the 10 sutures to make the most logical pattern. It is very common for the sutures to give inconsistent results.
(Skelton, 2006:7-8).

I applied this method for estimating the age of UMFC 39. The observed criteria are as follows.

Suture	Ectocranial			Endocranial		
Sagittal	Termination	over	29.0	Termination	over	35.0
Coronal	Termination	over	50.0	Termination	over	41.0
Lambdoidal	Termination	over	31.0	Termination	over	47.0
Masto-Occipital	Termination	over	32.0	Termination	over	81.0
Spheno-Temporal	Termination	over	never	Termination	over	67.0

Based on Todd and Lyon's method, UMFC 39 is approximately over 50 years of age.

Another method developed for estimating age from cranial suture closure, was developed by Baker (1984). Skelton states, "the Baker technique is similar to that for endocranial and ectocranial suture closure by the Todd and Lyon method," (Skelton, 2006:8). Baker's method is presented below.

Suture	Open	Commenced	Terminated
Sagittal Endocranial	<36	19 - 79	>25
Sagittal Ectocranial	<88	19 - 83	>33
Lambdoid Endocranial	<71	19 - 74	>22
Lambdoid Ectocranial	<85	24 - 84	>22
Coronal Endocranial	<71	22 - 79	>25
Coronal Ectocranial	<85	24 - 89	>35

(from Skelton, 2006:10)

I applied this method for estimating the age of UMFC 39. The observed criteria are as follows.

Suture		
Sagittal Endocranial	Termination	>25
Sagittal Ectocranial	Termination	>33
Lambdoid Endocranial	Termination	>22
Lambdoid Ectocranial	Termination	>22
Coronal Endocranial	Termination	>25
Coronal Ectocranial	Termination	>35

Based on Baker's method, UMFC 39 is approximately over 35 years of age.

The next method used for estimating the age of an individual from cranial suture closure is the suture site method and was developed by Meindl and Lovejoy (1985). This method is based a series of 1cm segments of ten suture sites and scored on a scale (0) open, (1) minimum closure, (2) significant closure, and (3) completely obliterated. The scores are summed for sites 1-7 and for sites 6-10 to obtain a "vault" suture age. Meindl and Lovejoy's sites, description, composite scores and age correlates are below.

Site Name	Description
1. Midlambdoid	Midpoint of left lambdoid suture
2. Lambd	Intersection of sagittal and lambdoidal sutures
3. Obelion	At obelion
4. Anterior Sagittal	One-third the distance from bregma to lambda
5. Bregma	At bregma
6. Midcoronal	Midpoint of left coronal suture
7. Pterion	Usually where the parietosphenoid suture meets the frontal
8. Sphenofrontal	Midpoint of left sphenofrontal suture
9. Inferior Sphenotemporal	Intersection between left sphenotemporal suture and line between articular tubercles of the temporomandibular joint
10. Sperior Sphenotemporal	On left sphenotemporal suture 2cm below junction with parietal

(from White, 2005:371)

Meindl and Lovejoy (1985) "vault" sutural ages (add scores for sites 1-7)

Composite Score	Mean Age	Standard Deviation
0	-	-
1-2	30.5	9.6
3-6	34.7	7.8
7-11	39.4	9.1
12-15	45.2	12.6
16-18	48.8	10.5
19-20	51.5	12.6
21	-	-

(from White, 2005:370)

Meindl and Lovejoy (1985) "vault" sutural ages (add scores for sites 6-10)

Composite Score	Mean Age	Standard Deviation
0	-	-
1	32.0	8.3
2	36.2	6.2
3-5	41.1	10.0
6	43.4	10.7
7-8	45.5	8.9
9-10	51.9	12.5
11-14	56.2	8.5
15	-	-

(from White, 2005:370)

I applied this method for estimating the age of UMFC 39. The observed criteria are as follows.

Site	Score
1. Midlambdoid	2
2. Lambd	3
3. Obelion	3
4. Anterior Sagittal	3
5. Bregma	3
6. Midcoronal	3
7. Pterion	3
8. Sphenofrontal	3
9. Inferior Sphenotemporal	2
10. Sperior Sphenotemporal	2

The sum for the "vault" sutures sites 1-7 is 20, which correlates with a mean age of 51.5 years and with a standard deviation of 12.6 years. The sum for the "vault" sutures sites 6-10 is 13, which correlates with a mean age of 56.2 years and a standard deviation of 8.5 years. Based on Meindl and Lovejoy's method, UMFC 39 is approximately 32.8-53.9 years of age (standard deviation of 10.6 years), with a mean age of 43.3 years.

Age Estimation from Dental Attrition

A method for estimating the age of an individual from the teeth was developed by Lovejoy et al. (1985). Their samples were taken from teeth of a prehistoric Native American population from Libben, Ohio. Lovejoy found that, "on the populational level, that dental wear was very regular in form and rate. Lovejoy and his colleagues concluded that dental wear is the best single indicator for determining age of death in a skeletal populations and they found dental wear as an age indicator to be accurate and consistent without bias," (White, 2005:367). However, assessing age from dental wear for a single individual allows only for an approximation of age. Their dental wear method is based on visual assessment of tooth wear patterns, and is divided into phases for the right maxillary and left mandibular dentitions (White, 2005:369).

I applied this method for estimating the age of UMFC 39 and based on Lovejoy's method for aging from dental wear, UMFC 39 is approximately 45-55 years of age.

The next method for estimating the age of an individual from the teeth was developed by Skelton (2006). According to Skelton, "this method is a way to estimate how old an individual is by the extent of dental attrition, or wear on their teeth. Dental attrition aging is fairly reliable within a population, after the rate of dental attrition has been calculated for that population," (Skelton, 2006: 10). This method is broken up into two parts. The first part is scoring the amount of dental attrition seen for each tooth present for analysis. The second part is interpreting the score obtained and determining the age that best fits with the dental score. The dental attrition scoring system that is used here was taken from Skeleton's Advanced Forensic Anthropology Manual (2006). Several teeth were used for this method and the ages standards used were, a Montana population, adapted and reworked from Tromly (1996). The right and left canine (RC_1, LC_1), the right second premolar (RP_2) and the left first premolar (LP_1) were used. The right and left canine (RC_1, LC_1) both scored a 6, which indicated that the rim of the enamel had been breached on the side of heaviest wear. A score of 6 for canines indicated an age of 38 years and older. The right second premolar (RP_2) and the left first premolar (LP_1) both scored a 6, which indicated that the shape of dentine exposure is oval and the rim of enamel is still complete. A score of 6 indicated an age of 40 years and older. Based on Skelton's method for aging from dental attrition, UMFC 39 is over 38 years of age.

Age Estimation from Epiphysis Closure

A method for estimating the age of an individual is based on examining epiphysis closure, by McKern and Stewart (1957) and Johnston (1962). This method is particularly useful for estimating age of adolescents, however, all it can tell us for adult skeletal remains is that the epiphyses of all the bones are fused and at what age they fuse.

I applied this method for estimating the age of UMFC 39. All epiphyses of the bones present exhibited signs of being fused. Based on the epiphysis closure method, UMFC 39 is over 23 years of age. This method is not useful in estimating the age of adults; it only gives a possible minimum age of an adult.

Age Estimation from the Sternal Rib Ends

Iscan et al. (1985) developed a method for estimating the age of an individual from examining the sternal rib ends of the 4th rib. Their method is based on visual assessment of the sternal end of the 4th rib, and placing the visual assessment into one of the nine stages they developed. Like the rest of the skeleton, the ribs under go changes with age. According to Burns, "the sternal rib end is connected to the sternum by cartilage. As the bone-cartilage interface is subjected to normal stresses of life, the bone responds by steadily remodeling and ossifying and the pattern of change is predictable," (Burns, 1999:56).

I applied this method for estimating the age of UMFC 39. The right fourth rib was present for analysis and exhibited signs of a cup-shaped center. Based on the sternal rib method, UMFC 39 is approximately 35-55 years of age.

Age Estimation from the Vertebral Column

Albert and Maples (1995) developed a method for estimating the age of an individual from examining the vertebral body. Their method is based on, "visually assessing the advancement of epiphyseal ring fusion and assessing the development of osteoarthritic lipping at the edges of vertebral disks," (Burns, 1999:64). Like the rest of the skeleton, the ribs vertebrae under go changes with age.

I applied this method for estimating the age of UMFC 39. Some vertebrae were available for analysis and exhibited lipping, and the vertebral body is porous and deteriorating. Based on the vertebral column method, UMFC 39 is over 30 years of age.

Age Estimation from Long Bone Length

A method for estimating age of an individual is based on measurements of the long bones. This method is found in Seguchi and Skelton (2004:73, 74) and was developed by Krogman (1962) and Krogman and Iscan (1986) to estimate age for subadults. The measurements needed are the length of the humerus, length of the radius, length of the femur, and length of the tibia, with or without attached epiphyses.

I was unable to apply this method to UMFC 39 because this method is for determining age from long bone of subadults, and UMFC 39 is an adult.

Age Estimation from the Auricular Surface of the Ilium

Another method for estimating the age of individual is based on the visual assessment of the auricular surface of the ilium, developed by Lovejoy et al. (1985). This method is based on the premises that the auricular surface changes continuously with age, and that these changes can be seen on the bone. An eight phase scoring system is utilized with this method and the phase that is most consistent with the skeletal remains should be chosen. Descriptions of the eight phases of the auricular surface are as follows.

1	Age 20-24	This stage exhibits billowing and very fine granularity.
2	Age 25-29	This stage exhibits reduction, but not loss of billowing.
3	Age 30-34	This stage exhibits general loss of billowing, with replacement by striae, and distinct coarsening of the surface.
4	Age 35-39	During this stage the surface is uniformly coarse grained.
5	Age 40-44	During this stage the texture of the surface begins to change from coarse to dense. The surface is still mostly coarse grained, but islands of dense bone appear.
6	Age 45-49	During this stage, the coarse grained surface is replaced by dense bone.
7	Age 50-59	In this stage the auricular surface is dense and irregular, with rugged topography. Macropores may be present.
8	Age 60+	During this stage, degeneration causes breakdown and increased irregularity of the surface. Macropores may be present.

(from Skelton, 2006:33-35)

This method is somewhat unreliable and should not be used only as a primary factor in the estimation of age of an individual, unless no other methods are available. "Degenerative change in the auricular surface is much too variable across individuals to be used as a single criterion for age estimation," (Murray and Murray, 1991:1168).

I applied this method for estimating the age of UMFC 39. The observations of the auricular surface are as follows. The surface texture is dense and irregular, with rugged topography. There are marked degenerative changes, marked porosity and irregularity of the retro-auricular area and macropores are present. The margins are beginning to exhibit irregularity and lipping. Based on these observations, UMFC 39 is most consistent with a combination of phases 7 and 8; these phases have a corresponding range of 50 years to over 60 years of age.

Age Estimation from the Pubic Symphysis

The first method for estimating the age of an individual is based on visual assessment of the pubic symphysis. The criteria for which the method is based, was developed by Todd (1920). He observed how the symphyseal face of the pubic bone under goes regular changes from puberty to death. Todd identified a succession of ten phases, bony features, such as ridge and furrow patterns, a dorsal margin, a ventral bevel, a ventral rampart, lower and upper extremities, and a rim. The ten phases, with definitions are as follows.

Phase 1: Age 18-19. Typical adolescent ridge and furrow formation with no sign of margins and ventral beveling.

Phase 2: Age 20-21. Foreshadowing of ventral beveling with slight indication of dorsal margin.

Phase 3: Age 22-24. Progressive obliteration of ridge and furrow system with increasing definition of dorsal margin and commencement of ventral rarefaction (beveling).

Phase 4: Age 25-26. Completion of definite dorsal margin, rapid increase of ventral rarefaction and commencing delimitation of lower extremity.

Phase 5: Age 27-30. Commencing formation of upper extremity with increasing definition of lower extremity and possible sporadic attempts at formation of ventral rampart.

Phase 6: Age 30-35. Development and practical completion of ventral rampart with increasing definition of extremities.

Phase 7: Age 35-39. Changes in symphyseal face and ventral aspect of pubis consequent upon diminishing activity, accompanied by bony outgrowths into pelvic attachments of tendons and ligaments.

Phase 8: Age 39-44. Smoothness and inactivity of symphyseal face and ventral aspect of pubis. Oval outline and extremities clearly defined but no "rim" formation or lipping.

Phase 9: Age 45-50. Development of "rim" on symphyseal face with lipping of dorsal and ventral margins.

Phase 10: Age 50 and Upwards. Erosion of and erratic, possibly pathological, osteophytic growth on symphyseal face with breaking down of ventral margins.
(Todd, 1920:313-314).

Todd's method of aging from the pubic symphysis is a reliable technique for age estimation and is widely used when aging unknown individuals. However, an examiner must note that this aging method is based on the male pubic symphysis.

I applied this method for estimating the age of UMFC 39. The observed criteria are as follows. This individual exhibited erosion of the symphyseal face with a breakdown of the ventral margins. Based on these observations, UMFC 39 is most consistent with an age older than 50 years.

The next method for estimating the age of an individual is based on a revision of Todd's method, by Meindl et al. (1985). The method is presented in Skeleton (2006). The Meindl et al. method is a revision of Todd's method and recognizes only 5 phases instead of Todd's ten phases. The five phase definitions are as follows.

1. <u>Pre-epiphyseal stage:</u> (Todd stages I-V) younger than 29 years. There seem to be two sub-phases here, which overlap to some extent.
   a) < 25. Pronounced billowing. Little or no rampart formation on the ventral side. Little or no definition of lower extremity. No significant difference between the appearance

of the dorsal and ventral halves of the symphysis ("demi-faces").
   b) 24-29. Beveling of the ventral margin. At least some definition of the lower extremity. Substantially reduced billowing (but billowing may persist into the 40's). Differences in the appearance of the dorsal and ventral demi-faces usually present.
2. Active epiphyseal stage: (Todd stage VI) 30 to 35 years. Formation and completion of the ventral rampart. Frequently, the rampart never forms completely and gaps are left along its length. [Also note that Todd defined this stage by completion of the dorsal margin and upper extremity, giving an oval outline to the symphyseal face. Many people have found this to be a reliable characteristic]
3. Immediate post-epiphyseal stage: (Todd stage VII) 36 to 40 years. The texture of the surface changes from grainy to fine-grained (or smooth) and dense. Ventral rampart formation is usually complete before this stage, but traces of beveling in the form of a sulcus (groove) beneath the rampart can occasionally be found.
4. Maturing stage: (Todd stage VIII) 40 to 44 years. The surface is smooth (dense) with no degenerative changes. All ramparts should be completed (ignore gaps).
5. Degenerative stage: (Todd stages IX and X) older than 45 years. Degenerative changes are present. These may include bone loss, formation of bony spurs or spikes, and the formation of an elevated "rim" around the margins of the symphysis. The timing of the onset of degenerative changes is variable, and depends partly on body size. Smaller individuals (therefore females) tend to show degenerative changes sooner.
   (Skelton, 2006:30-31).

This method is relatively accurate and should be used in conjunction with the Todd method, as well as other pubic symphysis aging techniques to ensure a rounded estimation. Also, an examiner must note that this aging method is based on the male pubic symphysis.

I applied this method for estimating the age of UMFC 39. The observed criteria are as follows. This individual exhibited bone loss, lipping and the formation of an elevated "rim" around the margins. Based on these observations, UMFC 39 is most consistent with an age older than 45 years.

The next method for estimating the age of an individual is based on visual assessment of the female pubic symphysis, developed by Gilbert and McKern (1973). Their method describes the morphological changes of the female os pubis. Their developmental stages and age relations are presented in terms of formula scores that closely follow the method of McKern and Stewart (1957). The pubic symphysis is assessed based on the three components developed by Gilbert and McKern and then given a score (stage) of 0-5.

The scores are summed for each component to obtain a mean age. Gilbert and McKern's components, stages, description, composite scores and age correlates are below.

Component I - The dorsal demi-face.

Stage	Description of metamorphic changes for stages 0-5.
0	Ridges and furrows very distinct, ridges billowed, margin undefined
1	Ridges begin to flatten, furrows fill-in, margin begins to flatten
2	Dorsal demi-face becomes wider as flattening continues
3	Dorsal demi-face is smooth, margin may be narrow or indistinct
4	Demi-face becomes complete, unbroken, is broad and fine grained
5	Demi-face becomes pitted and irregular

(from Gilbert and McKern, 1973:33-34)

Component II - The ventral rampart.

Stage	Description of metamorphic changes for stages 0-5.
0	Ridges and furrows very distinct, beveled up towards dorsal demi-face
1	Furrows begin to fill-in, forming an expanding beveled rampart
2	Fill in of furrows and expansion of demi-face continue, rampart spreads laterally
3	Dorsal demi-face is smooth, margin may be narrow or indistinct
4	All but 1/3 of demi-face is filled in with fine grained bone
5	Ventral rampart may begin to break down, assuming a very pitted appearance

(from Gilbert and McKern, 1973:33-34)

Component III - The symphyseal rim.

Stage	Description of metamorphic changes for stages 0-5.
0	The rim is absent
1	The rim begins in the mid-third of dorsal surface
2	The dorsal part of symphyseal rim is complete
3	The rim extends until all but 1/3 of the ventral aspect is complete
4	The symphyseal rim is complete
5	Ventral margin may have gaps in rim, or may round off with no clear dividing line

(from Gilbert and McKern, 1973:33-34)

Component I

Stage	Age Range	Mean
0	14-24	18.00
1	13-25	20.04
2	18-40	29.81
3	22-40	31.00
4	28-59	40.80
5	33-59	48.00

Component II

Stage	Age Range	Mean
0	13-22	18.63
1	16-40	22.52
2	18-40	29.64
3	27-57	38.77
4	21-58	40.90
5	36-59	49

Component III

Stage	Age Range	Mean
0	13-25	20.23
1	18-34	25.75
2	22-40	32.00
3	22-57	35.60
4	21-58	39.90
5	36-59	49.40

(from Gilbert and McKern, 1973:34)

Calculated mean age from
total scores for Components I-III

Total Score	Age Range	Mean	S.D. +/-
0	14-18	16.00	2.00
1	13-24	19.80	2.76
2	16-25	20.15	4.97
3	18-25	21.50	5.36
4-5	22-29	26.00	5.70
6	25-36	29.62	6.86
7-8	23-39	32.00	5.54
9	22-40	33.00	9.00
10-11	30-47	36.90	7.73
12	32-52	39.00	8.54
13	44-54	47.75	7.57
14-15	52-59	55.71	8.07

(from Gilbert and McKern, 1973:34)

I applied this method for estimating the age of UMFC 39. The observed criteria are as follows.

Component	Score
Component I - The dorsal demi-face.	5
Component II - The ventral rampart.	5
Component III - The symphyseal rim.	5

The sum for components I-III is 15, which correlates with a mean age of 55.71 years and a standard deviation of 8.07 years. Based on Gilbert and McKern's method, UMFC 39 is approximately 52-59 years of age, with a mean age of 55.71 years.

This method is relatively accurate and is based on the female os pubis. This method should be in conjunction with other pubic symphysis aging techniques to ensure a rounded estimation.

The next method for estimating the age of an individual is based on a revision of Todd's method, by Katz and Suchey (1986). The method is presented in Burns (1999) and is a revision of Todd's method. Katz and Suchey recognize only 6 phases instead of Todd's ten phases. The five phase definitions are as follows.

Phase 1: (Todd stages I-III) 15 to 23 years. Completely ridged surface.

- Early: completely ridged surface, no nodules, no beveling, no symphyseal rim, no lipping
- Late: ossified nodules begin to form as ridges slowly disappear

Phase 2: (Todd stages IV-V) 19 to 35 years. Ossified nodules.

- Ossified nodules obvious
- Dorsal plateau formed
- Ventral beveling begins

Phase 3: (Todd stage VI) 22 to 43 years. Ventral rampart.

- Ossified nodules obvious
- Dorsal plateau formed
- Ventral beveling begins

Phase 4: (Todd stages VII-VIII) 23 to 59 years. Oval outline.

- Smoother symphyseal face
- Oval outline almost complete
- No symphyseal rim, no lipping

Phase 5: (Todd stage IX) 28 to 78 years. Symphyseal rim.

- Marked symphyseal rim
- Dorsal margin lipped
- Ventral margin irregularly lipped

Phase 6: (Todd stage X) 36 to 87 years. Erratic ossification.

- Eroded erratic ossification
- Irregular lipping
- Broken down ventral border

(Burns, 1999:88-89).

This method is relatively accurate and should be used in conjunction with the Todd method, as well as other pubic symphysis aging techniques to ensure a rounded estimation. This aging method is also based on the male pubic symphysis.

I applied this method for estimating the age of UMFC 39. The observed criteria are as follows. This individual exhibited eroded and erratic ossification, irregular lipping and a broken down ventral border. Based on these observations, UMFC 39 is most consistent with an age range of 36 to 87 years, with a mean of 61.5 years.

Summary

The methods used for estimating the age of an individual yielded the following results. The age of UMFC 39 falls within a broad range of 38-87 years, with a narrow range of 50-60 years. The narrow range can be suggested based on the age results obtained by a variety of methods. These age ranges were constructed on the most reliable methods. A chart of the methods, age ranges, and weight I gave to each, follows.

Method		Age	Weight
Suture Closure			
	Meindl and Lovejoy	32.8 - 53.9	medium
	Todd and Lyon	50 - up	low
	Baker Method	35 - up	low
Dental Attrition			
	Lovejoy	45 - 55	medium
	Skelton & Tromly	38 - up	medium
Epiphysis Closure			
	Bass	26.3 - 51.5	medium
	McKern & Stewart	29 - up	medium
	Medial Clavicle	22 - up	medium
Sternal Rib Ends			
	Iscan et al.	35 - 55	low
Vertebral Column			
	Albert & Maple	30 - up	medium
Auricular Surface			
	Meindl et al.	50 - 59	medium
Pubic Symphysis			
	Todd	50 - up	high
	Gilbert & McKern	52 - 59	high
	Katz & Suchey	36 - 87	high
	Meindl et al.	45 - up	high

Chapter 6

STATURE AND WEIGHT ESTIMATION

Stature Estimation

Stature may be estimated from measuring long bones and comparing them to a stature table. White (2000:372) states that the stature of skeletal remains correlates with limb bone lengths from all ages and allow osteologists to reconstruct an individual's height.

The method for estimating the stature of an individual is based on measurements of the long bones. The method is found in Burns (1999:155-156), and is based on Trotter and Gleser's (1952, 1977), and Genoves's (1967) research. Not all of the long bones need to be present to estimate stature, however if the long bones are present, it is best to use them. This method utilizes a chart as well as regression formulas. For this method, race and sex of the individual must be determined before estimation of stature can be performed.

European Female

	Right	Left	Average	Formula(cm)	(cm)	S.D.+/-	Avg. (ft)	Min. (ft)	Max (ft)
humerus	32.40	31.50	31.95	3.36(humerus)+57.97=	165.32	4.45	5.42	5.28	5.57
radius	23.70		23.70	4.74(radius)+54.93=	167.27	4.24	5.49	5.35	5.63
ulna	25.70	25.50	25.60	4.27(ulna)+57.76=	167.07	4.30	5.48	5.34	5.62
femur	42.30	43.00	42.65	2.47(femur)+54.10=	159.45	3.72	5.23	5.11	5.35
tibia	33.80	33.70	33.75	2.90(tibia)+61.53=	159.41	3.66	5.23	5.11	5.35
fibula	33.40	33.80	33.60	2.93(fibula)+59.61=	158.06	3.57	5.19	5.07	5.30
				Average	**162.76**		**5'-4"**	**5'-2-1/2"**	**5'-5-1/2"**

African Female

	Right	Left	Average	Formula(cm)	(cm)	S.D.+/-	Avg. (ft)	Min. (ft)	Max. (ft)
humerus	32.40	31.50	31.95	3.08(humerus)+64.67=	163.08	4.25	5.35	5.21	5.49
radius	23.70		23.70	3.67(radius)+71.79=	158.77	4.59	5.21	5.06	5.36
ulna	25.70	25.50	25.60	3.31(ulna)+75.38=	160.12	4.83	5.25	5.09	5.41
femur	42.30	43.00	42.65	2.28(femur)+59.76=	157.00	3.41	5.15	5.04	5.26
tibia	33.80	33.70	33.75	2.45(tibia)+72.65=	155.34	3.70	5.10	4.97	5.22
fibula	33.40	33.80	33.60	2.49(fibula)+70.90=	154.56	3.80	5.07	4.95	5.20
				Average	**158.14**		**5'-2"**	**5'-0"**	**5'-3-3/4"**

Mexican Female

	Right	Left	Average	Formula(cm)	(cm)	S.D.+/-	Avg. (ft)	Min. (ft)	Max. (ft)
femur	42.30	43.00	42.65	2.59(femur)+49.74=	160.20	3.82	5.26	5.13	5.38
tibia	33.80	33.70	33.75	2.72(tibia)+63.78=	155.58	3.51	5.10	4.99	5.22
				Average	**157.89**		**5'-2"**	**5'-0"**	**5'-3-3/4"**

I applied this method to UMFC 39 and the results are as follows. This stature estimate is based on a combination of the African Female chart, European Female chart and Mexican Female chart. I choose to do this based on UMFC 39's admixture of ancestry. Based on the formula analysis, the skeletal remains are most consistent with a 5'0" – 5'5" individual.

Weight Estimation

The method for estimating weight of an individual is presented in Skeleton (2006). This method uses a height and weight chart form the Metropolitan Life Insurance Company (see below). Estimating weight is difficult because it is so variable from individual to individual. The height and weight tables suggest what a person should weigh, not what they do weigh. "Recent studies have shown that these charts underestimate ideal weights for people in modern western society by about 20%," Skelton (2006:37). Skeleton suggests adding 20% to the numbers for industrial-aged populations and for either sex over age 50, add 15% to the total. These recommendations are rules of thumb and may not be suitable for the population you are working with.

HEIGHT/WEIGHT TABLE

FOR FEMALES:

STATURE Ft/in	cm	GRACILE	MEDIUM	ROBUST
4'10"	147	95±14	101±15	111±17
4'11"	150	97±15	104±16	114±17
5'0"	152	100±15	107±16	117±18
5'1"	155	103±15	117±18	120±18
5'2"	157	106±16	113±17	123±18
5'3"	160	109±16	117±18	127±19
5'4"	163	112±17	120±18	130±20
5'5"	165	115±17	123±18	133±20
5'6"	168	119±18	127±19	136±20
5'7"	170	123±18	131±20	140±21
5'8"	173	127±19	135±20	144±22
5'9"	175	131±20	139±21	148±22
5'10"	178	135±20	143±21	153±23
5'11"	180	140±21	147±22	158±24
6'0"	183	145±22	152±23	163±24

For statures less than 4'10" (147cm) subtract 2 pounds per inch (2.54cm) less than 4'10".
For statures greater than 6'0" (183cm) add 5 pounds per inch greater than 6'0".

Determining robusticity is also another complicating factor. The Metropolitan Life Insurance Company table is arranged with columns for gracile, medium, and robust people; however, there is no accepted method for estimating skeletal robusticity. The best method is to estimate how robust the individual is, look at the stature you've determined and look at the corresponding weight.

I applied this method to UMFC 39 and the results are as follows. I estimated the weight of UMFC 39 based on the Metropolitan Life Insurance Company table, as being between 132-190 pounds, allowing 20% for industrialized populations, 15% for individuals over 50, and for a medium build.

Summary

Based on the methods for estimating the stature and weight of an individual, UMFC 39 is most consistent with an individual with a height between 5 feet 0 inches and 5 feet 5 inches; with an average of 5 feet 2-1/2 inches and a weight between 132-190 pounds; with an average of 161 pounds.

Chapter 7

HANDEDNESS ESTIMATION

The hand an individual prefers is in part genetic, but the precise ways in which genes affect handedness are not known. The methods used for recognizing handedness in skeletal remains is imprecise. It is generally accepted among anthropologists that the dominant arm tends to be larger. The scapula and humeri are the main bones of interest.

Handedness from Asymmetry

A method used for estimating the handedness of an individual is based on a visual assessment of the humeri, is presented by Burns (1999). This method has two parts. The first part is based on the length of the humeri, for it is believe that the dominant arm tends to be longer. The second is based on the morphology of the humeri. According to Burns, "the two humeri can be compared for differences in the muscle attachment areas, particularly the deltoid tuberosity. The dominant side is expected to show slightly larger attachment areas. The humeri can also be compared at the elbow area where differences in osteoarthritic changes may indicate increased use on one side over the other," (Burns, 1999:157). This method can give some idea of what hand the individual used most often. However, this method can not predict handedness accurately. Methods for recognizing handedness in skeletal remains is imprecise.

I applied this method for estimating the handedness of UMFC 39 and the observations are as follows. The right humerus (324mm) is slightly longer than the left humerus (315mm). There is a slightly more pronounced muscle attachment on the right humerus, located at the deltoid tuberosity and the bone in this area is slightly thicker than the left humerus. Therefore, these results indicate that UMFC 39 has a higher probability of being right handed.

Handedness from Stewart's Method

Another method used for estimating the handedness of an individual is based on visual assessment of the glenoid fossa of the scapula, presented in Burns (1999). This method is based on the premise that beveling of the glenoid fossa occurs with more, heavy use. Burns states, "on the dominant side, the glenoid fossa is more likely to demonstrate a dorsal bevel. This is probably the result of repeated reaching and wearing of the glenoid rim," (Burns, 1999:157). This method is not very reliable but it does give insight to which hand was most likely used most.

I applied this method for estimating the handedness of UMFC 39 and the observations are as follows. The right scapula was not available for analysis. The left scapula was present and did not show signs of a beveled rim. Therefore, based on this observation, UMFC 39 had a high probability of being right handed.

Summary

Based on the methods for estimating handedness an individual, UMFC 39 is most consistent with being right handed. However, this estimate is not very reliable and should be considered only as a probability.

Chapter 8

PATHOLOGY AND TRAUMA

UMFC 39 exhibited both premortem and postmortem defects, however no obvious perimortem abnormalities were observed. Defects were found on the cranium and on the post-crania. These defects are described below.

The cranium of UMFC 39 exhibited thinning bone throughout, which is consistent with osteoporosis (Ortner, 2003). There are areas of porosity on the inferior areas of the cranium that are possibly related to degenerative joint disease. The right posterior medial area of the zygomatic bone shows evidence of swelling and drainage, which is consistent with osteomyelitis.

The maxilla dentition are absent. The right first premolar (RPM_1) shows signs of an abscess. Most inflammatory conditions or abscess, are triggered by bacteria that enter the pulp chamber through cavities, attrition or fractures of the teeth (Hillson, 1996).

UMFC 39 exhibits antemortem tooth loss both in the maxilla and mandible. It is detected by the distorted and unequal appearance of the alveolar bone (Bass, 1995: 290-291). Antemortem tooth loss is usually the result of injury, caries, abscesses or periodontal disease (Ortner, 2003:589-608).

There was some postmortem trauma of the skull. A linear defect, which measured 30mm, was present on the right parietal bone, just superior of the squamosal suture. This defect probably occurred during the excavation of the remains. The color of the bone along the broken edges is consistent with postmortem trauma. Many of the skeletal remains exhibit discoloration due to weathering of the bones.

The skeletal remains of UMFC 39 were extremely light weight, which is most consistent with osteoporosis. There is a small circular defect (1mm) on the lateral anterior side of the right humerus just below were the greater tubercle would be. The vertebrae of UMFC 39 exhibited lipping, porosity, and bony projections, which are most consistent with advanced age. The lumbar vertebrae exhibit extreme porosity, deterioration, and lesioning. A number of the ribs exhibit edges that are elongated and rugged, with the center being porous and irregular. UMFC 39 exhibited apparent lipping on the articulating ends of the femur, the ulna, and the exposure of cancellous bone on the proximal and distal ends of most of the bones. Osteoarthritis also shows up in porous lesions on the popliteal surface of the femur and with the erosion of the acetabulum of the coxal bones.

There seems to be no obvious signs of perimortem trauma suffered by UMFC 39, however, postmortem trauma is present and seen throughout the skeleton. The postmortem trauma was presented in the inventory and a description of each bone present for analysis; therefore it is not necessary to restate them here.

Chapter 9
CONCLUSION

Summary of Analysis

Based on the application of the methods presented, the evidence is most consistent with UMFC 39 representing a right-handed female of ambiguous ancestry, 50-60 years of age, with a height of about 5 feet 2-1/2 inches, and a weight of 161 pounds, who exhibited pathology consistent with aging, and who has no apparent perimortem trauma.

Summary of Sex

Visual assessment suggests that UMFC 39 is female. The common female characters observed include the following. On the cranium: no sunken nasal root, the presence of a slight brow ridge, frontal bossing was seen, the mastoid process medium sized, slight nuchal rugosity was seen, the chin shape was rounded, the orbit shape was round with sharp edges, thickness of the zygomatic arch was thin and the mandibular thickness was slightly thick. On the pelvis: the pubis was long, the subpubic angle was wide, the greater sciatic notch was broad, the auricular surface is elevated, the acetabulum was relatively small, and the obturator foramen was small. Postcranial: the scapula is broad, and with a deep glenoid fossa, set at a right angle to the axis of the scapular body. Metric methods (measurements of the scapula, clavicle, humerus, coxal bones, femur, tibia, discriminant function and FORDISC 2.0) place UMFC into different categories, they are: female, indeterminate, and male.

Summary of Race

Visual assessment suggests that UMFC 39 is of ambiguous ancestry. The characteristics observed include the following. On the cranium: a long skull length, a broad skull breadth, a medium skull height, a round coronal contour, an arched sagittal contour, frontal bossing, a medium face breadth, a short face height, face projection in jaws due to reabsorption, a strong back taper of zygomatics, rounded orbit shapes, medium interorbital dist., wide nasal orifice width, small nasal bone width, small with sharp edged nasal sill, wide palate width due to alveolar reabsorption, medium size for ruggedness, an elliptical palate shape, a straight palatine suture, and an "S-shaped" zygomaticomaxillary suture. Metric methods (measurements of the scapula, postcranial remains, interorbital features, discriminant function and FORDISC 2.0) place UMFC into contradictory categories as well.

Summary of Age

Visual assessment suggests that UMFC 39 is 50-60 years of age. The common features observed include the following. On the cranium: the cranial sutures are completely obliterated, and the dental attrition exhibits heavy wear. On the pelvis: the pubic symphysis exhibits bone loss, bony spurs, an elevated "rim", and a broken down ventral border. Postcranial: the epiphyses are fused, the fourth rib exhibited signs of deterioration and a cup-shaped center, the vertebrae exhibited lipping, and the vertebral body is porous and deteriorating, the auricular surface is dense, irregular, with marked porosity and irregularity of the retro-auricular area,

Summary of Stature and Weight

Stature for UMFC 39 was calculated from measurements of the long bones present, using a combination of the African Female chart, European Female chart and Mexican Female chart. Based on the formula analysis, the skeletal remains are most consistent with a 5'0" to 5'5" individual. Weight for UMFC 39 was calculated using the Metropolitan Life Insurance Company standards. Based on the standards and adjusting for age, robusticity, and industrialism, the skeletal remains are most consistent with an average of 161 pounds.

Appendix A

CRANIAL MEASUREMENTS

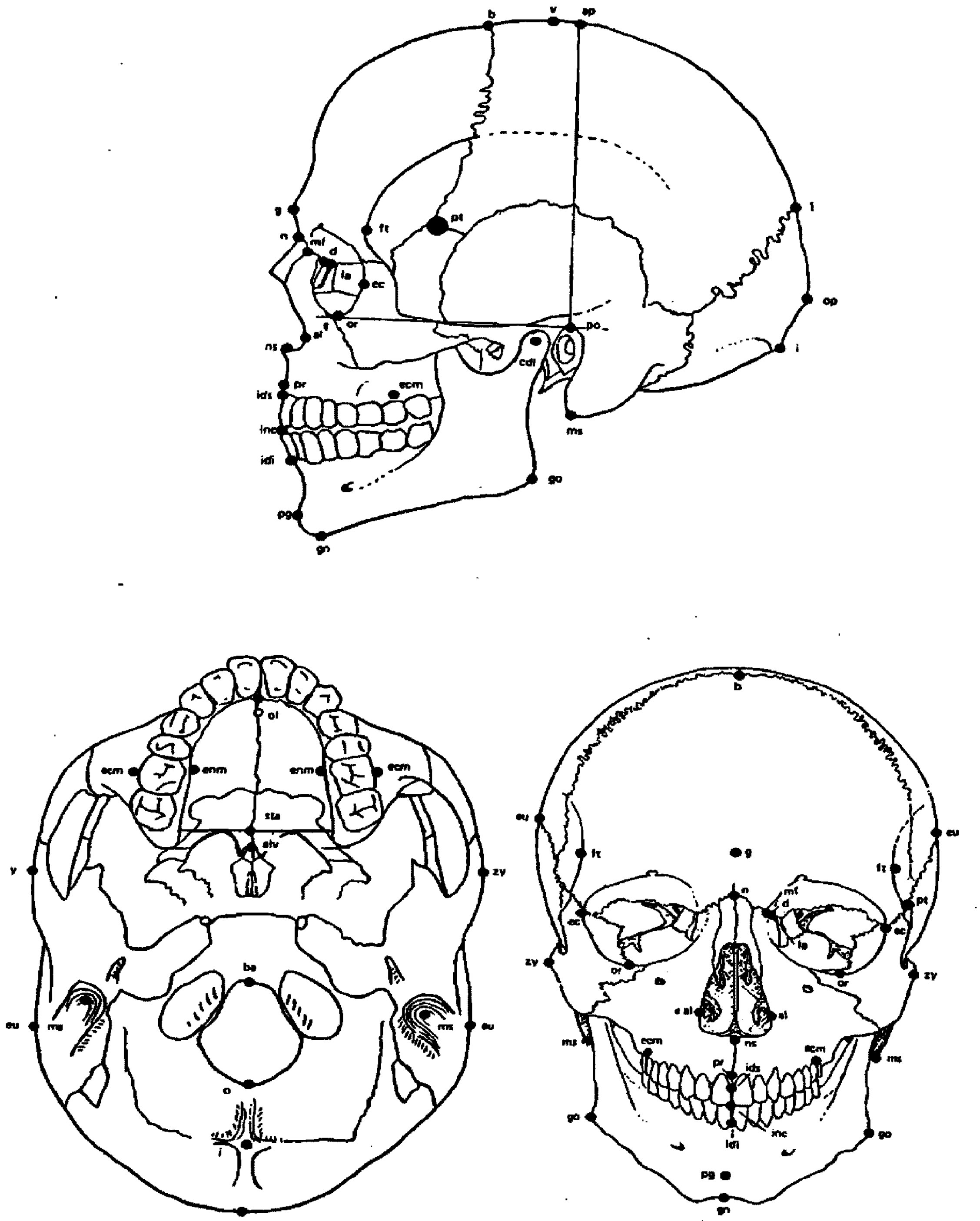
* ALL MEASUREMENTS ARE IN MILLIMETERS

Maximum Cranial Length (g-op):	190
Maximum Cranial Breadth (eu-eu):	135
Bizygomatic Breadth (zy-zy):	120
Cranial Base Length (ba-n):	100
Basion - Bregma Height (ba-b):	125
Basion - Prosthion Height (ba-pr):	95
Minimum Frontal Breadth (ft-ft):	83
Upper Facial Height (n-ids):	73
Upper Facial Breadth (fmt-fmt):	103
Nasal Height (n-ns):	54
Nasal Breadth (al-al):	27
Orbit Height (obh):	34
Orbit Breadth (mf-ec):	38
Biorbital Breadth (ec-ec):	101
Interorbital Breadth (d-d):	21
Foramen Magnum Length (ba-o):	36
Maxilloalveolar Length (pr-alv):	51
Maxilloalveolar Breadth (ecm-ecm):	54
Bicondylar Breadth (cdl-cdl):	119
Bigonial Breadth (go-go):	96
Mastoid Length (po-ms):	28
Height of Ascending Ramus (go-cdl):	70
Chin Height:	23

Ramus Breadth:	35
Body Height at Mental Foramen:	22
Body Thickness at Mental Foramen:	11

<u>*Appendix B*</u>

ANTHROPOMETRIC LANDMARKS OF THE SKULL



(From Bass 1995:69-71)

Appendix C

POSTCRANIAL MEASUREMENTS

* ALL MEASUREMENTS ARE IN MILLIMETERS
* NP = Not Present for Analysis

CLAVICLE	RIGHT	LEFT
• Maximum Length	160	160
• Anterior – Posterior Diameter at Midshaft	13	13

SCAPULA	RIGHT	LEFT
• Maximum Length	NP	149
• Maximum Breadth	NP	101
• Length of Spine	NP	129
• Glenoid Cavity	NP	37
• Scapular Index	NP	68

STERNUM NP

HUMERUS	RIGHT	LEFT
• Maximum Length	324	315
• Maximum Diameter at Midshaft	20	21
• Minimum Diameter at Midshaft	23	23
• Maximum Diameter of Head	NP	44
• Epicondylar Width	59	60
• Articular Width	43	44
• Circumference at Nutrient Foramen	7	6.5

RADIUS	RIGHT	LEFT
• Maximum Length	237	NP
• Anterior – Posterior Diameter at Midshaft	12	NP

ULNA	RIGHT	LEFT
• Maximum Length	257	255
• Physiological Length	227	225

SACRUM NP

OS COXAE	RIGHT	LEFT
• Maximum Height	213	NP
• Maximum Breadth	139	NP
• Length of Pubis	102	NP
• Length of Ischium	85	NP
• Ischium – Pubis Index	120	NP
• Depth of Acetabulum	NP	NP

FEMUR	RIGHT	LEFT
• Maximum Length (Trochanteric Oblique)	423	430
• Bicondylar (Oblique) Length	431	436
• Maximum Diameter of Head	45	43
• Anterior – Posterior Diameter at Midshaft	26	27
• Medio - Lateral Diameter at Midshaft	26	28
• SubTrochantric Anterior – Posterior Diameter	27	27
• Sub Trochantric Medio – Lateral Diamter	33	31
• Bicondylar Width	78	78
• Popliteal Length	132	127

TIBIA	RIGHT	LEFT
• Maximum Length	338	337
• Anterior – Posterior Diameter at Midshaft	32	30
• Medio – Lateral Diameter at Nutrient Foramen	NP	20
• Proximal Breadth	73	75
• Distal Breadth	53	50
• Circumference at Nutrient Foramen	NP	83

FIBULA	RIGHT	LEFT
• Maximum Length	334	338

CALCANEOUS	RIGHT	LEFT
• Maximum Length	76	NP

Appendix D

SEX ESTIMATION FROM CRANIAL MEASUREMENTS

FORDISC 2.0 Analysis of

Reference group classification using 24 variables:

GOL XCB ZYB BBH BNL BPL MAB MAL UFHT WFB UFBR NLH
NLB OBB OBH EKB DKB FOL GNI HMF TMF GOG CDL WRB

From Group	Into Group M	Into Group F	Total Counts	Percent Correct
M	74	9	83	89.2 %
F	7	50	57	87.7 %
Totals:	124		140	88.6 %

Two Group Discriminant Function Results

Group	Classified into	Distance from	Posterior Probabilities	Typicality Probabilities
M		111.2	.002	.000
F	** F **	99.0	.998	.000

Two Group Discriminant Function Coefficients

		M 83	F 57	D.F. Weight	Relative Weights
GOL	190	186.82	178.23	.044	2.9 %
XCB	135	139.05	132.81	.110	5.2 %
ZYB	120	130.17	122.35	.278	16.4 %
BBH	125	137.93	130.33	.006	0.4 %
BNL	100	104.35	97.75	.313	15.6 %
BPL	95	99.84	95.72	-.254	7.9 %
MAB	54	63.84	60.44	.090	2.3 %
MAL	51	56.07	53.16	.260	5.7 %
UFHT	73	72.51	66.84	-.005	0.2 %
WFB	83	97.10	93.05	.001	0.0 %
UFBR	103	106.20	100.84	-.079	3.2 %
NLH	54	51.78	47.91	.106	3.1 %
NLB	27	24.49	23.81	-.297	1.5 %
OBB	38	40.69	38.63	.187	2.9 %
OBH	34	33.76	33.75	-.352	0.0 %
EKB	101	98.70	94.33	-.179	5.9 %
DKB	21	22.20	21.40	.259	1.6 %
FOL	36	37.05	34.60	.264	4.9 %
GNI	23	34.40	31.40	-.088	2.0 %
HMF	22	31.78	29.04	.433	9.0 %
TMF	11	11.54	10.67	-.040	0.3 %
GOG	96	97.67	90.04	.066	3.8 %
CDL	119	116.92	110.47	-.005	0.2 %
WRB	35	32.23	30.09	.303	4.9 %
Constant				-93.575	
Scores		3.800	-3.800	-6.101	
		(Class means)		(Unknown)	

D square = 7.600

Appendix E

SEX ESTIMATION FROM MANDIBULAR MEASUREMENTS

FORDISC 2.0 Analysis of

Reference group classification using 6 variables:
GNI HMF TMF GOG CDL WRB

From Group	Into Group M	Into Group F	Total Counts	Percent Correct
M	144	30	174	82.8 %
F	29	89	118	75.4 %
Totals:	233		292	79.8 %

Two Group Discriminant Function Results

Group	Classified into	Distance from	Posterior Probabilities	Typicality Probabilities
M		15.5	.322	.017
F	** F **	14.0	.678	.030

Two Group Discriminant Function Coefficients

		M 174	F 118	D.F. Weight	Relative Weights
GNI	23	34.19	31.10	.173	18.5 %
HMF	22	31.37	28.75	.045	4.1 %
TMF	11	11.36	10.51	.022	0.6 %
GOG	96	97.27	89.48	.175	47.9 %
CDL	119	116.72	110.83	.120	24.5 %
WRB	35	32.34	30.12	.056	4.3 %
Constant				-39.049	
Scores		1.443	-1.443	-.744	
		(Class means)		(Unknown)	

D square = 2.887

Appendix F

RACE ESTIMATION FROM CRANIAL MEASUREMENTS

FORDISC 2.0 Analysis of

Discriminant function results using 13 variables:
GOL XCB ZYB BBH BNL BPL MAB UFHT WFB NLH NLB OBB OBH

Group	Total Number	Into Group WF	BF	AF	JF	Percent Correct
WF	137	128	1	0	8	93.4 %
BF	107	6	89	3	9	83.2 %
AF	28	1	1	23	3	82.1 %
JF	100	6	10	10	74	74.0 %
Total:	372		Correct:	314		84.4 %

Multigroup Classification of

Group	Classified into	Distance from	Probabilities Posterior	Typicality
WF		31.9	.067	.002
BF		32.7	.044	.002
AF	** AF **	26.9	.835	.013
JF		32.4	.053	.002

is closest to AFs

		Group Means WF 137	BF 107	AF 28	JF 100
GOL	190	177.8	178.5	177.6	171.7
XCB	135	135.9	133.6	137.9	136.4
ZYB	120	120.8	122.7	132.5	125.1
BBH	125	133.5	127.5	129.4	131.7
BNL	100	98.5	96.9	99.8	95.5
BPL	95	90.9	98.4	96.9	94.3
MAB	54	57.9	63.2	63.2	61.5
UFHT	73	66.9	68.0	71.0	65.8
WFB	83	93.5	93.8	92.1	89.7
NLH	54	49.4	48.0	51.9	48.7
NLB	27	22.2	24.8	25.5	24.8
OBB	38	38.3	37.7	41.0	38.1
OBH	34	33.2	34.4	35.1	34.2

Appendix G

RACE AND SEX ESTIMATION FROM POST-CRANIAL MEASUREMENTS

FORDISC 2.0 Analysis of

Reference group classification using 26 variables:
CLAXLN CLAAPD SCAPHT SCAPBR HUMXLN HUMEBR HUMHDD HUMMXD
HUMMWD RADXLN RADAPD ULNXLN ULNPHL INNOHT ILIABR PUBCLN
ISCHLN FEMXLN FEMBLN FEMHDD FEMSAP FEMMAP TIBXLN TIBCIR
FIBXLN CALCXL

From Group	Into Group WF	Into Group BF	Total Counts	Percent Correct
WF	30	0	30	100.0 %
BF	0	20	20	100.0 %
Totals:	50		50	100.0 %

Two Group Discrimihant Function Results

Group	Classified into	Distance from	Posterior Probabilities	Typicality Probabilities
WF	** WF **	277.2	.893	.000
BF		281.4	.107	.000

Two Group Discriminant Function Coefficients

	WF 30	BF 20	D.F. Weight	Relative Weights
CLAXLN 160	139.23	143.35	-.169	1.2 %
CLAAPD 13	10.60	11.35	-.405	0.5 %
SCAPHT 149	141.00	139.90	-.085	0.2 %
SCAPBR 101	95.23	95.75	-.124	0.1 %
HUMXLN 315	308.27	311.70	.587	3.4 %
HUMEBR 59	55.00	55.55	.143	0.1 %
HUMHDD 44	42.47	40.65	1.084	3.4 %
HUMMXD 20	19.63	20.30	-.901	1.0 %
HUMMWD 23	15.17	16.00	-1.247	1.8 %
RADXLN 237	228.43	241.65	-.481	10.8 %
RADAPD 12	10.13	11.30	-.959	1.9 %
ULNXLN 255	244.40	258.85	-1.018	25.0 %
ULNPHL 225	216.83	231.00	1.031	24.8 %
INNOHT 213	199.23	186.80	.170	3.6 %
ILIABR 139	156.03	148.50	.426	5.5 %
PUBCLN 102	83.43	74.10	.413	6.6 %
ISCHLN 85	82.43	79.00	.153	0.9 %
FEMXLN 423	438.17	442.80	-.268	2.1 %
FEMBLN 431	434.43	437.50	.214	1.1 %
FEMHDD 43	41.93	41.65	-1.215	0.6 %
FEMSAP 27	25.30	25.10	.180	0.1 %
FEMMAP 26	27.17	27.40	1.844	0.7 %
TIBXLN 337	359.43	366.95	-.051	0.7 %
TIBCIR 80	83.70	87.25	-.246	1.5 %
FIBXLN 334	353.20	360.35	-.198	2.4 %
CALCXL 76	77.07	76.95	.152	0.0 %
Constant			-19.929	
Scores	11.158	-11.158	2.121	
	(Class means)		(Unknown)	

D square = 22.315

Appendix H

CRANIOFACIAL MEASUREMENTS

* ALL MEASUREMENTS ARE IN MILLIMETERS

Nasal Height (n-ns):	54.55
Nasal Bone Height:	32.01
Piriform Aperture Height:	29.77
Nasion Prosthion Length:	73.01
Nasion Basion:	100.0
Basion Prosthion:	95.0
Superior Nasal Bone Width:	9.04
Simotic Width:	18.5
Inferior Nasal Bone Width:	8.90
Nasal Breadth:	27.48
Simotic Subtense:	2.73
Inferior Simotic Subtense:	7.53
Frontal-Orbital Width (FOW):	16.21
Mid-Orbital Width (MOW):	17.43
Bizygomatic Breadth:	119.87
Glabella Opisthocranion:	189.0
Maximum Cranial Breadth:	135.0
Basion Bregma:	125.0
Basion Rhinion:	102.0
Width at FOW:	104.0
Width at MOW:	49.22
Inner Orbital Subtense at Nasion:	13.01
Medial Fronto-Orbital Width:	96.0

Appendix I

ANCESTRY FROM CRANIOFACIAL MEASUREMENTS

29			
	1	Jom	Jomon
	2	Ain	Ainu
	3	Pol	Polynesia
	4	Sep	Sepik River Papua New Guiena
	5	Aus	Australia
	6	Afr	West Africa
	7	SAs	South Asia (India)
	8	SNu	East Africa
	9	OJB	Great Lakes Native Americans
	10	Cha	Mongolian Bronze age (sh
	11	MoH	Mongol Hunnu
	12	NAr	Northern Archaic Native Americans
	13	MAr	Mid US Archaic Native Americans
	14	Kur	Crimea Bronze (Kurgan)
	15	EUP	European Upper Paleolithic
	16	NEu	Northern Europe
	17	WEu	Western Europe
	18	EEu	Eastern Europe
	19	Jap	Japanese
	20	Tha	Thai
	21	Mon	Mongol
	22	Bur	Burma
	23	Aty	Atyal
	24	SCN	South China
	25	NCh	Northern China
	26	CBr	China Bronze
	27	CNe	China Neolithic
	28	Bri	Briat
	29	Chu	Chukchi

***	Posterior	Probability	Matrix	for	each	obs	***																						
row.names	Jom	Ain	Pol	Sep	Aus	Afr	SAs	SNu	OJB	Cha	MoH	NAr	MAr	Kur	EUP	NEu	WEu	EEu	Jap	Tha	Mon	Bur	Aty	SCN	NCh	CBr	CNe	Bri	Chu	PredGroup
umfc39	0	0	0.008	0.001	0.006	0.002	0.001	0.202	0.061	0.074	0.208	0	0	0.006	0	0.101	0.001	0	0.091	0.002	0.051	0	0.004	0.021	0.016	0.009	0.012	0.092	0.028	MoH

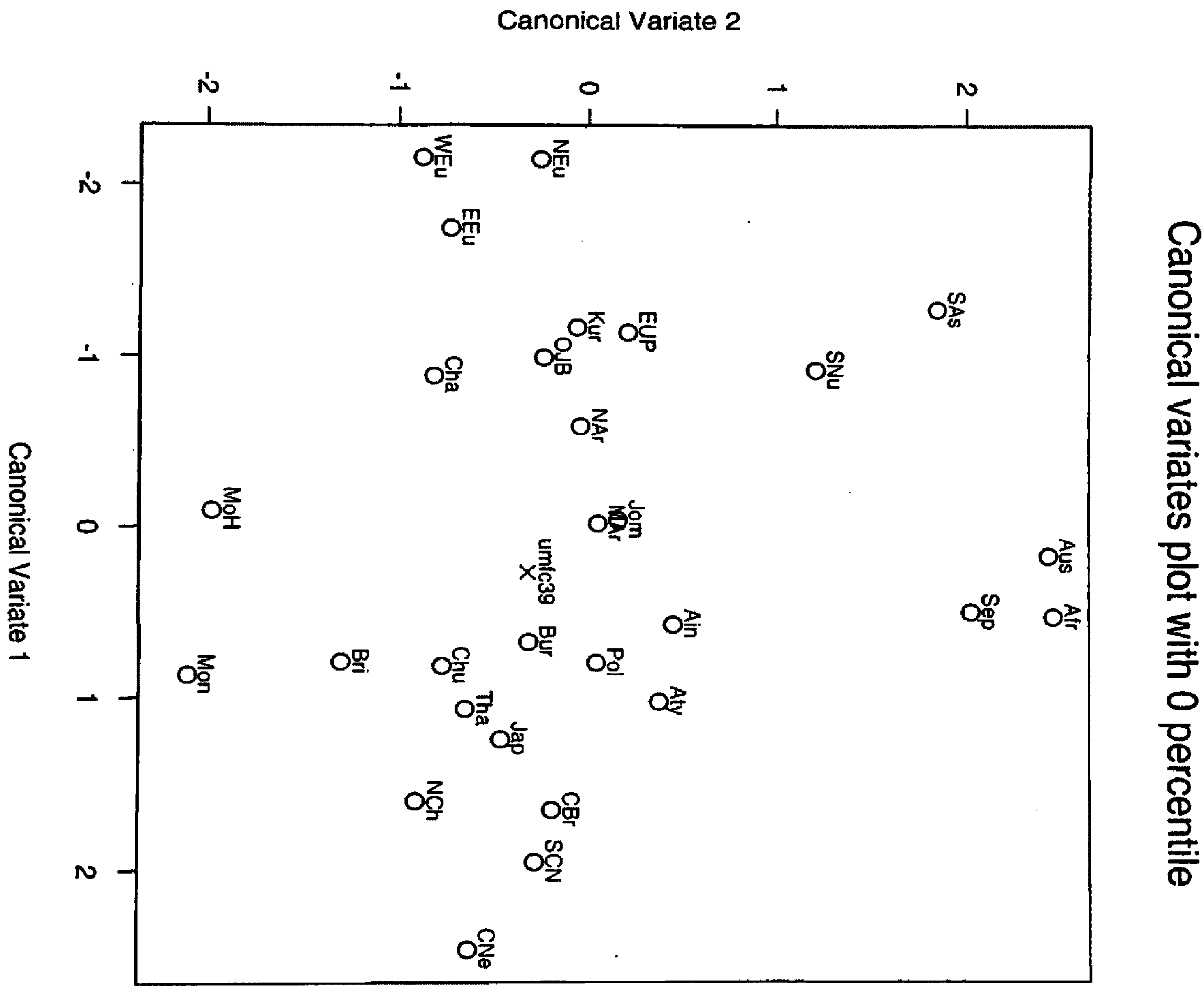
***	Typicality	Prob.	for	each	obs	(Chi)	***																					
row.names	Jom	Ain	Pol	Sep	Aus	Afr	SAs	SNu	OJB	Cha	MoH	NAr	MAr	Kur	EUP	NEu	WEu	EEu	Jap	Tha	Mon	Bur	Aty	SCN	NCh	CBr	CNe	Bri	Chu
umfc39	0	0	0.003	0.002	0.003	0.001	0.001	0.023	0.012	0.013	0.026	0	0	0.004	0	0.014	0.001	0.001	0.013	0.002	0.011	0.001	0.003	0.006	0.005	0.004	0.005	0.019	0.012

***	Typicality	Prob.	for	each	obs	(F)	***																					
row.names	Jom	Ain	Pol	Sep	Aus	Afr	SAs	SNu	OJB	Cha	MoH	NAr	MAr	Kur	EUP	NEu	WEu	EEu	Jap	Tha	Mon	Bur	Aty	SCN	NCh	CBr	CNe	Bri	Chu
umfc39	0	0	0.004	0.005	0.004	0.002	0.002	0.03	0.017	0.018	0.036	0	0	0.006	0.001	0.018	0.001	0.001	0.017	0.003	0.015	0.001	0.005	0.008	0.006	0.006	0.008	0.03	0.023

***	SQUARED	Mahalanobis	Distance	***																								
row.names	Jom	Ain	Pol	Sep	Aus	Afr	SAs	SNu	OJB	Cha	MoH	NAr	MAr	Kur	EUP	NEu	WEu	EEu	Jap	Tha	Mon	Bur	Aty	SCN	NCh	CBr	CNe	Bri	Chu
umfc39	63.834	51.261	42.957	44.801	43.12	45.776	46.465	35.842	38.23	37.868	35.399	51.763	56.306	42.398	55.868	37.597	47.669	48.902	37.865	44.964	38.692	48.925	43.237	40.631	41.396	42.241	41.246	38.568	38.222

Appendix J

CANONICAL VARIATES PLOT



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