Historical Bone Project – The Forensic Evaluation of Ms. Tuttle

[“A Piece of American History”: in dedication to the memory of Mr. Stanley Barnes]

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Identacode Consulting LLC (abbreviated from final report 2013)

Skeletal Inventory

UNH Independent Study

Advisor- Dr. Heather Coyle

Sample: Guilford History Project

Date of Report: April 14, 2013

Report Written by: Laura Reimer

Description of Items:

Samples were provided for study by an anonymous donor. Skeletal remains were represented as historical in nature. Samples consisted of a partial skeleton, along with commentary of how the remains were found and preserved. Samples were preserved with a shellac coating.

Analyses Performed:

Skeletal inventory was performed. This included itemization of all remains received. This was done using the Arizona State Museum Human Remains Documentation Packet[1] to document each bone that was received. Along with the inventory, each bone was examined for condition and evaluated to determine how complete the bone was.

Dental analyses included photographs taken, along with radiographs taken by Sandy Palumbo, Adrianna Fields and reviewed by Doctor Richard Diotalevi. The dental photographs were analyzed in an attempt to identify ancestry of the remains.

Results obtained:

The table below lists the percent present of each bone that was present from inventory.

Bone Present	**Percentage Present**
Frontal-Left	25-75%
Frontal-Right	25-75%
Mandible-Left	75-100%
Mandible-Right	75-100%
Zygomatic-Left	75-100%
Zygomatic-Right	25-75%

Maxilla-Left	25-75%
Maxilla-Right	25-75%
Nasal-Right	75-100%
Incisors (five present)	75-100%
Canines (three present)	75-100%
Premolars (seven present)	25-75%
Molars (nine present)	25-75%
Thoracic Vertebra 1-9 (nine present)	25-75%
10th Thoracic Vertebra	75-100%
11th Thoracic Vertebra	75-100%
12th Thoracic Vertebra	75-100%
Lumbar Vertebra 1-4 (four present)	75-100%
5th Lumbar Vertebra	75-100%
Sacrum (five present)	75-100%
Scapula-Right	1-25%
Humerus-Left	75-100%
Humerus-Right	75-100%
Radius-Left	75-100%
Radius-Right	75-100%
Ulna-Left	75-100%
Ulna-Right	25-75%
Femur-Left	75-100%
Femur-Right	75-100%
Tibia-Left	75-100%
Tibia-Right	75-100%
Fibula-Left	75-100%
Fibula-Right	25-75%
Ilium-Left	25-75%
Ilium-Right	75-100%
Pubis-Left	75-100%
Pubis-Right	25-75%
Ischium-Left	75-100%
Ischium-Right	75-100%
Acetabulum-Left	75-100%
Acetabulum-Right	75-100%
Patella-Left	75-100%

Additional bones present were nine full ribs, six partial ribs, and sixteen fragmented ribs. There were a total of 48 unknown fragments. The bones that were missing were as follows: the parietal bones, the occipital bone, the temporal bones, the left nasal bones, the lacrimal bones, the palatine bones, the sphenoid bone, the ethmoid bones, the vomer bone, the hyoid bone, the cervical vertebra, the coccyx, the sternum, the left scapula, the right patella, all bones of the wrists, hands, ankles, and feet. Also missing was the proximal epiphysis of both the left and right humerus, the distal epiphysis of the right ulna, the distal epiphysis of the right femur, the proximal epiphysis of the right tibia, and the proximal and distal epiphyses of the right fibula. From this information, this skeleton would be classified as a partial skeleton because only 25-75% of the total skeleton is present.

After the inventory of all bones was completed, each bone was evaluated to see what type of analyses could be done on that specific bone. From this it was determined that the left tibia would be the best bone to use for measurements that could help determine stature. While other metrics could be taken, because of the condition of the bones it would be difficult to get an accurate measurement.

Additionally, from the visual examination of the bones, a large ridge on both femurs was discovered. This is most likely from a muscle insertion, indicating a repeated motion over a long period of time. The muscle that has an insertion at this point is the gluteus maximus.[2] The large ridge that was created on these bones from the consistent movement of the gluteus maximus is consistent with repeated extension and lateral rotation of the hip.

Because the pelvic bones were mostly intact, it was possible to do an assessment of sex. There was a large angle of the sciatic notch, the pelvic inlet was elliptical shaped, and the sacrum had only a slight curve. All of these traits indicate that the remains are that of a female. From the pelvic bones it was also possible to determine that the age at death was likely above 14. This can be said because the pelvic bones have already fused, which happens by age 14.

Another area that can indicate sex is the orbital region. Because the subject has a sharp angle in the orbital, this indicates a female. The frontal bones, specifically the eye regions, were examined under a stereomicroscope to look for any possible pathology. The right orbita had some pores visible, which could be evidence of anemia. However, because of the shellac on the bones it is not possible to say for certain if the marks were natural or postmortem.

The dental radiographs present some helpful information about possible age, and also about health. From the radiographs, the third molar could be seen. This molar was not fully developed. From this, the subject was likely around the age of 15, which is consistent with the analysis from the pelvic bones. The dental health of the subject was poor, as the radiographs showed cavities in multiple teeth. Also, there is evidence that the first, right premolar was lost before death, as there is bone healing in the area. There was also a pulp stone in the first left maxillary molar, which is an indication of inflammation. Along with these problems, there were also two abscesses present, indicating an infection. The abscesses were above the first, left maxillary molar, and below the first, left mandibular molar. The abscess below the mandibular molar was very significant and could have caused sepsis in the brain. The teeth in general had a lot of wear, indicating a high vegetable diet. Because there is significant wear on the teeth, it cannot be said whether the teeth have a shovel shape or not. The shovel shape would indicate someone with Native American ancestry. Unfortunately, it cannot be said whether the subject has this indication or not. Overall dental health was very poor.

Conclusions:

Based on the pelvic bones and eye sockets this subject is female. From the pelvic bones and the dental work, the subject is between 14 and 25 years of age. Although a lot of analysis was performed, these are the only conclusions that can be stated at this time. There were many problems that occurred in the examination of this skeleton including the obstruction of the bones by the shellac. Because of the shellac it was hard to be certain of any possible pathology on the bones. Many sicknesses that cause death are visible in some way on the bones, but because of the condition of the bones it was not possible to be certain if any were present.

There were many other analyses that were not performed because the time or equipment was not available. If more time had been available, it would have been possible to finish all of the metrics needed to be able to estimate stature and therefore aid in ancestry determination. Also, radiographs of the bones would have provided more information about the age of the subject. Also, because there is still pulp in the teeth, it may be possible to get a DNA profile, if time and equipment allowed.

Some things that will not be able to be completed because of the condition of the bones include ancestry analysis based on skull, as the back of the skull is not present. Another analysis that cannot be done is mitochondrial DNA from hair because of the lack of hair.

At this point in time ancestry cannot be definitely stated. There are pieces of evidence that point to both Native American ancestry and also European ancestry. The poor health of the teeth points towards someone who is eating a more processed diet, which would be consistent with someone of European ancestry, or someone who is living in contact with those of European ancestry. Without more investigation, these two possibilities, of Native American versus European descent, cannot be distinguished definitively.

End of Report

References:

[1]Arizona State Museum. University of Arizona. Arizona State Museum, Human Remains Documentation Packet. 6/2011.

[2]White, Tim D., Michael T. Black, and Pieter A. Folkens. *Human Osteology*. Third ed. San Diego, California: Elsevier, 2012. 311. Print.

University of New Haven: Independent Study by Jordyn Valoroso
Advisor: Dr. Heather Coyle
Guilford History Project
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Description of the Remains:

The sample was provided for the study by an anonymous donor. The remains were stated to be historical in nature. A study of the remains had occurred in the past conducted by the individual who had discovered them. He had stated he had found the remains in his backyard in Guilford, Connecticut. The founder of the remains had no formal educational background in human anatomy or anthropology. The bones were presented for examination in a wooden box with yellow foam inside. A small metal latch was present to seal the wooden box and a white carrying strap was attached to the wooden box. Within the box all the bones were placed; in addition, two old cigar boxes were in the box. One of the cigar boxes held the mandible and cranial bones which were placed wrapped in paper towel. In the second cigar box the unwired ribs and unknown bone fragments were placed.

The remains appeared to be brownish yellow in color and seemed to be covered in a shellac coating. In some places the shellac pooled and clumped, especially inside the hollowed out bones. Certain areas of the bones appeared darker in color which was most likely due to the amount of shellac on the bone. Chips and nicks appeared in the shellac indicating they were inflicted after the shellac was applied. The postmortem damage present on the bones was most likely a result of the burial conditions or the inefficient storage methods implemented over time. A significant amount of debris appeared to be present on the bones, especially on the teeth.

There were several breaks and fractures present on the bones. All of these breaks and fractures appeared to have occurred postmortem. Putty was also applied to the maxilla, which was most likely meant to take the place of the missing bone. In some places putty was applied in areas it was not needed. When held the bones were very light, this was most likely due to the lack of bone marrow present in the bones. The bones were very fragile, special precautions and storage is required to prevent further destruction of the bones. In order to prevent further chipping of the bones they were wrapped in tissue paper and stored separately in evidence boxes. The bones were separated based on their anatomical position.

Some of the bones were wired back together after initial discovery by owner, specifically the left radius, ulna and humerus, the right ulna and radius and left femur, tibia, patella and fibula. Also a set of ribs, about seven or eight, were wired together. A thick metal rod was drilled into the distal end of the femur and the proximal end of the tibia. The left fibula and tibia were glued together at the midsection of both bones. A thick metal rod was also drilled into the vertebral column. The vertebrae were significantly more fragile than the rest of the bones present. They also appeared to be darker in color, appearing almost black.

The mandible and maxilla appeared to have many teeth missing, some of which were lost postmortem, and others were lost ante mortem. Postmortem refers to damage that occurs after death, ante mortem refers to damage that occurs before death and perimortem refers to damage that occurs at or near time of death.

Processes Performed:

- ***Skeletal Inventory:*** Is the process in which remains are examined in order to determine the number of bones present and the condition in which they appear. The Arizona State Museum Human Remains Document was used as a guide to perform this analysis; this document was provided by Dr. Gary Aronsen who assisted us during the project. Bones present were documented and a note was recorded indicating how much of the bones were present. A specific code was used which is present on the Arizona form, f indicates approximately 1 to 25% of the bone is present, p indicates approximately 25 to 75% of the bone is present and c indicates approximately 75 to 100% of the bone is present. When a bone was not present an X or 0 was used to indicate its absence. The number of teeth and vertebra were also recorded; a further more detailed analysis of the teeth was performed using a comparison microscope and radiological methods. Also, the dental section of the Arizona sheet was filled out.
- ***Metrics:*** The pelvis, femurs, tibias, fibulas, humerus, radius and ulnas were examined in order to determine if any beneficial measurements could be taken that would help to determine stature, ancestry and gender. Measurement(s) obtained using the pelvis is beneficial in determining the gender of the individual. The pelvis differs significantly between males and females. Females tend to have a wider pelvis in order to facilitate child birth. Measurements obtained from the femurs, tibias, fibulas, humerus, radius and ulnas can be used to help determine the stature of an individual. These measurements can also be compared to known standards collected from different ancestral groups: Negro (African American), Caucasian (European), Hispanic (Mexican) or Mongoloid (Native American). Gender can also be determined; males tend to have larger bones than females.
- ***Determination of MNI:*** Is the process in which bones are examined to determine how many individuals are present based on class characteristics and differences found on the bones (it's best to compare "like" bones, ex: left and right femurs, right and left humerus).
- ***Biological Profile:*** Is the process in which class characteristics are determined. Class characteristics are sex, age, stature, race/ancestry, human vs. nonhuman.
- ***Dental Photography:*** Dental photographs were obtained using a comparison microscope which was linked up to a camera and computer. This provided a closer look at the dental morphologies present on the remains.
- ***Dental Radiology:*** Dental radiographs were obtained at the University of New Haven's Dental Clinic, located at 419 Boston Post Road West Haven, Connecticut on November 8th, 2012. Both Dr. Coyle and I were present at the examination of the teeth, maxilla and mandible. The radiographs were taken by Dr. Richard Diotalevi, a professional associate working with the University and Sandra Palumbo, an associate professor and the interim program director of UNH's Dental Clinic. A radiograph is a special type of photograph obtained using different kinds of radiation other than visible light. They are beneficial for visualizing the internal structures of the teeth, allowing for an examination of the tooth roots, cavities, and bone and tooth health.

Results Obtained:

The skeletal inventory showed the skeleton was about 65 to 70% complete at the time of analysis. The bones present have been completely itemized on the inventory sheet, which has been included with the report. The inventory sheet can be seen on page two of the Arizona Human Remains document. The third page of the Arizona Human Remains document also has a color coded diagram which shows the bones that were present during the initial examination of the remains.

The cranium or the skull was presented to us in a small cigar box along with the mandible; both were wrapped in paper towel. Eight bones make up the cranium; the occipital bone (1), the parietal bones (2), the frontal bone (1), the temporal bones (2), the sphenoid bone (1) and the ethmoid (1). Out of the eight cranium bones only the frontal bone was partially present. Based on our examination of the remains we determined it was approximately 25 to 75% present. The face is made up of fourteen bones, the maxillary bones (2), the palatine bones (2), the nasal bones (2), the inferior nasal conchae (2), the zygomatic bones (2), the lacrimal bones (2), the vomer (1) and the mandible (1). Out of the fourteen facial bones there were six bones present. The mandible was present in its entirety, the right nasal along with the right and left zygomatic bones and right and left maxillary bones were partially present. Because the cranium wasn't present in its entirety a facial reconstruction is unable to be obtained and facial measurements are not possible. In addition, there are areas of the skull that were glued and puttied together and as a result of incorrect reconstruction present at other locations on the skeleton we are unsure also how accurate the facial reconstruction is for measurements.

Twenty four vertebrae; make up the spinal column. The spinal column is divided into three types of vertebrae, the cervical vertebrae (7), the thoracic vertebrae (12) and the lumbar vertebrae (5), in addition to the sacral and the coccygeal vertebrae. Examining the spinal column that's been articulated, we determined no cervical vertebrae were present. In the spinal column, the cervical vertebrae are the first seven. The first cervical vertebra is present at the base of the skull. Directly after seven cervical vertebrae, comes the twelve thoracic vertebrae. Next comes the five lumbar vertebrae, then the sacrum and the coccygeal or coccyx. We were able to determine none of the seven cervical vertebrae were present with the remains, all nine of the thoracic vertebrae were present and the five lumbar vertebrae were present. The 5th lumbar vertebra was not articulated with the rest of the spinal column instead it had been glued to the sacrum. The coccyx was not present with the remains. The vertebrae are very fragile, and appear to be broken and chipped. None of them appear to be whole. The sacrum also appears to be chipped and broken in places.

The pelvis of the individual has been glued back together along with the 5th lumbar vertebra and the sacrum. There are three bones that make up the pelvis, the ischium, the ilium and the pubis. Part of the left iliac crest is missing. Bone appears to be missing from the right and left iliac fossa, both the iliac fossa and iliac crest are part of the ilium. The distal end of the right and left ischium are missing along with the most of the right and left pubic tubercle. A piece of unidentified bone has been glued to the right pubis at the site where the pubic tubercle would be located. This bone appears to be different in color from the rest of the pelvis and obviously it was glued after the shellac was applied. However, just because the bone is a different color doesn't mean the bone is misplaced. We determined its misplacement based on its shape. We compared it to the partial left pubic tubercle present, which was also glued back, to the right. Based on the differences we believe the bone does not belong there.

There are twenty four ribs that make up the rib cage. Nine of the ribs found to be present with the remains were articulated. In addition to the nine whole ribs we found six partial ribs and sixteen fragments we believed to be ribs. The unarticulated and fragmented ribs were placed and stored in a second old cigar box. Because of our lack of expertise we were personally unable to determine which ribs were part of the right side of the rib cage and which ribs were parts of the left side. In addition to the ribs found in the second cigar box we counted 48 unknown fragments. Later one of the bone fragments was identified as a deer or sheep bone, we were unable to determine which species of animal by morphology. However, we are certain the phalange-like bone is not human in origin. Also I believe one of the unknown bone fragments present in the box was identified to be part of a clavicle or collarbone. The clavicle we found to be present was present in its entirety; however, it was broken down the middle. Unlike many of the other bones present, the clavicle was not glued back together. The unarticulated ribs and fragment bones present in the second cigar box did not appear to have been shellacked. We also located a fragment of the right scapula. The sternum was not identified with the remains.

With the remains both ulna, humerus and radius bones were present. These three bones make up the arm. The right humerus, ulna and radius were articulated, while only the left radius and ulna were articulated. The left humerus remained unattached. The right and left humerus both appeared to be missing the humeral head. They also were broken and glued back together. The left ulna and radius appeared to be completely present, but both bones were broken and glued back together. The right ulna was broken in half and missing the distal end of the bone. In addition, the remaining portion of the bone present appeared to have been glued back together. The right radius was determined to be complete, but like the other bones it was broken and glued back together. None of the sixteen carpal bones, ten metacarpal bones or twenty eight phalanges that make up the hands and wrists were present with the remains.

Both right and left femurs, tibias and fibulas were identified with the remains. Like the right humerus, radius and ulna, the left femur, tibia, patella and fibula were articulated. The femur was missing the medial condyle, otherwise it appeared to be complete except for some wear and bone chipping. The left tibia and fibula appeared to be complete, but both were broken and glued back together. The fibula was actually glued to the tibia; as a result it would be very difficult to take these bones apart without further damaging them. The right femur is missing the distal end of the bone and the right tibia is missing the proximal portion of the bone. The right fibula is missing both the proximal and distal end of the bone. Only the left patella is present and is present in full. The left femur, tibia and fibula were broken and glued back together. None of the fourteen tarsal bones, ten metacarpals or twenty eight phalanges that make up the ankles and feet were present with the remains.

The teeth were also inventoried. Out of thirty two teeth we found twenty four to be present with the remains. Below I've included two easy to read tables. Table 1 names the teeth identified with the remains and the immediate observations. Table 2 identifies the teeth not present with the remains and states whether the teeth were lost post or ante mortem. The way it is determined if a tooth is ante or postmortem depends on whether a "hole" is present in the actually bone. If the “hole” has closed up then the tooth was lost perimortem, this is because the bone has had time to heal/ fuse together. If the “hole” is present then the tooth was lost postmortem, after death all the cells of the body die which prevents the bone from repairing itself.

Table 1: Teeth Identified with the Remains and Observations

Tooth Number	*Tooth Name*	*Observations*
2	2nd Molar	-----
3	1st Molar	Wear line present.
4	2nd Bicuspid	-----
6	Cuspid or Canine	Has been placed in the wrong spot. The canine in the 6th tooth position is actually the 11th tooth.
9	Central Incisor	-----
10	Lateral Incisor	-----
12	1st Bicuspid or 1st Premolar	The tooth appears to be mostly incomplete.
13	2nd Bicuspid or 2nd Premolar	-----
14	1st Molar	Wear line present.
15	2nd Molar	-----
18	2nd Molar	A small hole is present on the tooth.
19	1st Molar	Half of the tooth appears to have rotted away.
20	2nd Bicuspid or 2nd Premolar	------
21	1st Bicuspid or 1st Premolar	-----
22	Cuspid or Canine	-----
23	Lateral Incisor	-----
25	Central Incisor	-----
26	Lateral Incisor	-----
27	Cuspid or Canine	-----
28	1st Bicuspid or 1st	-----

	Premolar	
29	2^{nd} Bicuspid or 2^{nd} Premolar	-----
30	1^{st} Molar	-----
31	2^{nd} Molar	-----
32	3^{rd} Molar or Wisdom Tooth	The tooth has not completely grown in.

Table 2: Teeth Identified as Missing

Tooth Number	***Tooth Name***	***When lost: Ante, Post or Perimortem***
1	3^{rd} Molar or Wisdom Tooth	Unable to determine.
5	1^{st} Bicuspid or 1^{st} Premolar	Ante mortem.
6/11	Cuspid or Canine	Postmortem – tooth 11 was misplaced in tooth 6's position.
7	Lateral Incisor	Ante mortem.
8	Central Incisor	Ante mortem.
16	3^{rd} Molar or Wisdom Tooth	Postmortem.
17	3^{rd} Molar or Wisdom Tooth	Unable to determine.
24	Central Incisor	Postmortem.

There are several beneficial measurements that can be collected from bones; however, in order to obtain these measurements complete bones or mostly complete bones are needed. We specifically looked at the long bones (femurs, tibias, fibulas, humerus, radius and ulnas) and the pelvis. In addition these bones can be used for age determination, based on the epiphyseal fusion sites. For example, the compound distal epiphysis fuses to the shaft of the humerus between the ages of 11 and 15. If when the humerus is examined and the compound epiphysis appears to have fused it can be determined the specimen is no younger than 11, since the bone does not usually fuse earlier. The maximum age of the specimen cannot be determined without looking at other markers, such as other epiphyseal fusion sites. Because of the shellac applied to the bones, the epiphyseal fusion sites could not be observed without the help of radiographs or x-rays. Due to scheduling issues and lack of radiology training we were unable to radiograph the bones/remains.

There are eight measurements that can be obtained using the humerus, as long as the bones are complete or mostly complete. These measurements are:

1. The Maximum Humeral Length
2. The Humeral Biomechanical Length
3. The Biocondylar Length
4. The Humeral Midshaft Circumference
5. The Vertical Head Diameter
6. The Humeral Torsion
7. The Maximum Midshaft Diameter
8. The Minimum Midshaft Diameter

The maximum humeral length is obtained by measuring the distance between the top of the humeral head and the most distant point of the distal humerus. Distal refers to the direction pointing away from the point of attachment or origin, whereas, proximal refers to the direction towards the point of attachment or origin. The biochemical length is obtained by measuring the distance between the top of the humeral head and the distant most point on the lateral lip of the trochlea. Lateral specifically refers to the side of the body. Trochlea is a "spool-shaped" medial portion of the condyle of the humerus, and a condyle is a rounded articular projection present on the surface of a bone. Medial means towards the midline of the body. The humeral biocondylar breadth measurement measures the greatest distance between the medial and lateral epicondyles. The humeral midshaft circumference can be taken in combination with the radial biochemical length using a flexible cloth type. The vertical head diameter measures the distance between the margins head in a "paracornal plane". The humeral torsion measure is taken by placing the bone parallel to the table top, and using a protractor the angle between the tabletop and the mid humeral axis can be obtained. The maximum midshaft diameter is taken using a caliper which determines the largest cross sectional dimension of the bone. Lastly a minimum midshaft diameter is obtained; it measures the smallest cross-section dimension of the midshaft.

After looking at both the right and left humerus, it is apparent that most of the measurements could be successfully taken. We were able to determine the humeral biocondylar breadth, the humeral midshaft diameter, the humeral torsion, and the maximum and minimum midshaft diameters could be obtained. The vertical head diameter, the maximum humeral length and the humeral biomechanical length of the left humerus would not be able to be obtained because the humeral head of the humerus was missing. We believe the humeral biocondylar breadth, humeral midshaft circumference, humeral torsion, maximum and minimum midshaft diameter of the right humerus could be obtained. Unlike the right humerus, the left humerus was missing part of the humeral head. Because part of the humeral head was missing the maximum humeral length, the humeral biomechanical length and the vertical head diameter measurements are not able to be obtained. It should also be noted that a break in the humerus was glued back together, this could influence the measurements obtained. Measurements taken from the humerus would be the most useful for estimating the stature of the individual out of the three arm bones.

There are six measurements that can be obtained using the radius. These measurements are:

1. The Maximum Radial Length
2. The Radial Biomechanical Length
3. The Radial Head Anteroposterior Diameter
4. The Radial Midshaft Circumference
5. The Radial Anteroposterior Midshaft Diameter
6. The Radial Mediolateral Midshaft Diameter

The maximum radial length measures the distance between the head of the radius and the distal most tip of the styloid process. The radial biomechanical length measures the distance between the center of the radial head and the deepest point of the carpal articular surface. Carpal refers to the bones that make up the wrist. There are eight bones that make up each wrist; the trapezium, trapezoid, capitates, hamate, pisiform, triquetrum, lunate and scaphoid, none which were identified as present with the remains. The radial head anteroposterior diameter measures the largest diameter of the head of the radius. The radial midshaft circumference is measured using the cloth tape minimum circumference in addition to the measurement obtained from the radial biomechanical length. The radial anteroposterior midshaft diameter measures the anteroposterior diameter using the measurement obtained from the biomechanical length. The radial mediolateral midshaft diameter measures the mediolateral diameter using the measurement obtained from the biomechanical length.

After looking at both the left and right radius it was determined that all six measurements could possibly be taken from both radius bones. However, it should be noted that both the left and right radius bones have been glued back together. The reconstruction of these bones could affect the measurements taken from these bones even though they appear to be complete.

There are also six measurements that can be using from the ulna. These measurements are:

1. The Maximum Ulna Length
2. The Ulnar Biomechanical Length
3. The Ulnar Physiological Length
4. The Maximum Anteroposterior Diameter
5. The Maximum Mediolateral Diameter
6. The Ulnar Minimum Circumference

The maximum ulna length measures the olecranon distance to the distal most point of the styloid process. While the ulnar biomechanical length measures the distance between the proximodistal midpoint of the trochlear notch and the center point of the distal head. The ulnar physiological length measures the distance between the most distal point of the trochlear notch and the most proximal point of the ulnar notch. The maximum anteroposterior diameter is used to determine the point in which the shaft interosseous crest has the greatest development by measuring the diameter of the bone. The maximum mediolateral diameter measures the mediolateral diameter using the anteroposterior diameter measurement. The ulnar minimum circumference uses flexible cloth tape to measure the circumference of the diaphysis. Diaphysis refers to the shaft of the long bones.

The right ulna was broken in half which prevents us from retrieving any useful measurements. More specifically the distal end of the bone is absent, while the remaining portion of the bone had been glued together. The left ulna is present in its entirety, meaning all six of the possible measurements can be successfully taken. It should be noted, however, like the other bones examined, this one has been glued back together and this could result in potential error.

There are seven measurements that can be taken from the femur. These measurements are:

1. The Maximum Femoral Length
2. The Femoral Biomechanical Length
3. The Femoral Bicondylar Length
4. The Femoral Midshaft Circumference
5. The Femoral Epicondylar Breadth
6. The Femoral Torsion
7. The Femoral Anteroposterior Midshaft Diameter

The maximum femoral length measures the distance between the top of the femoral head and the bottom of the farthest condyle. This measurement is taken using an osteometric board. An osteometric board is used to obtain precise measurements of the long bones. The femoral biomechanical length is taken using a large sliding caliper. The caliper is then placed on the inferior most point of the superior femoral neck and measures the distances to the distal most point of the medial and lateral condyles. The average of the two distances is then taken which gives you the biomechanical length. Superior means above in regards to the anatomical position of structures. Inferior is the opposite of superior, it means below in reference to the anatomical position of structures. The osteometric board is also needed to obtain the femoral biocondylar length. The condyles are placed against the stationary end of the osteometric board while keeping the femur parallel to the surface of the board. The distance to the furthest point of the femoral head can then be measured. The femoral midshaft circumference is obtained using flexible cloth tape to measure the minimum circumference at the midshaft. The location of the midshaft is determined by taking half of the femoral biomechanical length. The femoral epicondylar breadth can be taken using a sliding caliper or the osteometric board. It measures the distance between the medial most and lateral most points of the epicondyles. The femoral torsion measures the angle formed between the longitudinal axis of the femoral neck of the bone and the table it's placed on. Lastly the femoral anteroposterior midshaft diameter is taken by using half the length on the femoral biomechanical length to determine the location of the midshaft. After determining the midshaft location of the bone, a sliding caliper can be used to determine the diameter at this calculated point.

The left femur has been articulated to the tibia and fibula. We believe the maximum femoral length can be taken. We also can assume or estimate the location of the midshaft in order to determine the femoral midshaft circumference. If the midshaft is estimated then the femoral anteroposterior midshaft diameter can be determined. It should be noted that the estimation of the midshaft location would result in error when taking the femoral midshaft circumference and the femoral anteroposterior midshaft. Because the femur has been articulated to the tibia and fibula, the measurements would be hard to take appropriately. In order to get the most accurate measurements of these three bones, they would have to be taken apart in which permission would have to be granted. Also the medial condyle is missing on the proximal portion of the bone and there is some chipping present on the femoral head of the bone; this would prevent the other four measurements from successfully being taken. The bone also appears to have been broken at the center and seems to have been glued back together. The distal end of the right femur is completely missing so no measurements can be taken from the bone. It also appears the bone has been broken towards the distal end and appears to have been glued back together.

There are eleven measurements that can be taken from the tibias. These measurements include:

1. The Maximum Tibial Length
2. The Tibial Biomechanical Length
3. The Tibial Maximum Proximal Epiphyseal Breadth
4. The Tibial Maximum Distal Epiphyseal Breadth
5. The Tibial Midshaft Circumference
6. The Tibial circumference at Nutrient Foramen
7. The Tibial Anteroposterior Midshaft Diameter
8. The Tibial Mediolateral Midshaft Diameter
9. The Tibial Maximum Shaft Diameter at Nutrient Foramen
10. The Mediolateral Shaft Diameter Shaft Diameter at the Nutrient Foramen
11. The Platycemic Index

The maximum tibial length measures the distance between the top of the intercondylar eminence and the bottom of the medial malleolus. This measurement is taken using an osteometric board, which produces a highly accurate measurement. The tibial biomechanical length is measured using a sliding caliper. It measures the distance between the talar articular surface of the bone and the center point of the lateral and medial condyles. The two measurements are then averaged to obtain the measurement of the biomechanical length. The tibial maximum proximal epiphyseal breadth is measured by determining the distance between the most medial and lateral points of the tibial plateau. An osteometric board and sliding caliper can be used to obtain this measurement. The tibial maximum distal epiphyseal breadth is used to determine the maximum distance between the medial most point if both the medial malleolus and the lateral most point present on the distal epiphysis. Again a sliding caliper and osteometric board is used to obtain the measurement. The tibial midshaft circumference is used to determine the minimum circumference at the midshaft, which is located by taking half the tibial biomechanical length. The tibial circumference at the nutrient foramen is used to measure the minimum circumference present at the level of the nutrient foramen. The tibial anteroposterior midshaft diameter is used to determine the anteroposterior diameter at the midshaft of the tibia. Like with the other measurements pertaining to circumference, half the tibial biomechanical length is used. The tibial mediolateral midshaft diameter is used to determine the location of the midshaft in order to determine the mediolateral diameter at the location of the midshaft. The tibial maximum shaft diameter at the nutrient foramen is used to measure the greatest distance from the anterior border to the posterior surface at the level of the nutrient foramen. The tibial mediolateral shaft diameter at the nutrient foramen measures the maximum mediolateral width of the shaft at the level of the nutrient foramen. The Platycemic index is actually an equation, specifically the mediolateral shaft diameter at the nutrient foramen divided by the maximum diameter at the nutrient foramen multiplied by one hundred.

After looking at the left tibia, it was obvious that all of the eleven measurements we would be able to take. However, the tibia is broken and has been glued back together like the other bones. This could introduce error into the measurements. All of the measurements requiring the nutrient foramen would only be possible if the nutrient foramen is visible through the shellac coating. We determined the left tibia would be the best bone to use in order to obtain accurate measurements for stature estimates. As stated above the best way to obtain these measurements would be to take the bones apart. The only measurement we believe that can be taken from the right tibia is the maximum distal epiphyseal breadth. All the other measurements are not possible because the proximal end of the tibia is missing along with the nutrient foramen.

There are three measurements that can be taken from the fibula. These measurements are:

1. The Maximum Fibular Length
2. The Maximum Fibular Midshaft Diameter
3. The Fibular Midshaft Circumference

The maximum fibular length measures the distance between the top of the styloid process and the bottom of the lateral malleolus. This measurement is obtained by using the osteometric board. The maximum fibular midshaft diameter is used to determine the largest diameter of the shaft at the midshaft of the bone. In order to obtain this measurement the midshaft location needs to be located. In order to get the midshaft location half the maximum length is taken. Lastly the fibular midshaft circumference is used to determine the minimum circumference at the midshaft location of the bone. Like the maximum fibular midshaft diameter half the maximum fibular length is needed.

We determined all three measurements could be taken from the left fibula. However, it is broken near the center of the bone. It, like the other broken bones, has been glued back together and has been glued to the tibia. As with the other bones, this would result in error. The right fibula was missing both the proximal and distal end of the bone which would prevent any useful measurements from being taken.

There are five measurements that can be taken from the pelvis. These measurements are:

1. The Ischium Pubis Index
2. The Subpubic Angle
3. Sacral Index
4. The Acetabular Depth
5. The Acetabular Height

The pelvis is made up of three bones, the pubis, the ischium and the ilium. The ischium pubis index is the ratio measured by the length of pubis divided by the length of the ischium and multiplied by 100. This measurement can help to determine the sex of an individual; if the index appears to be greater than 90 then the individual is female. If the calculated index is less than 90 then the remains are male. The subpubic angle is the angle formed below the pubic symphysis, which is the articulation site of the right and left ischium bones. Like with the ischium pubis index, if the angle is less than 90 degrees then it indicates male, if the angle is greater than 90 degrees it indicates female. The sacral index is the ratio measured by the breadth of the sacrum divided by its length multiplied by 100. The acetabular depth and acetabular height is obtained by measuring the acetabulum which is the articulation site of the femoral head to the pelvis.

Based on our analysis of the remains we determined only two of the five measurements could be obtained from the remains, the acetabular depth and height. Neither the ischium pubis index nor the subpubic angle can be calculated because both the right and left ischium are incomplete. Also the sacral index cannot be calculated because the sacrum appears to be chipped and incomplete.

After itemizing the bones present and determining which measurements could be taken, we set out to determine if all the bones presented with the specimen belonged to one or multiple individuals. This process is known as MNI; an explanation can be found above in the *Processes Preformed*, section of the report. Upon our first examination of the remains we believed all the bones indicated the presence of one individual. After further examination we were unsure of our original conclusion because we identified more defined ridges on the shafts of one humerus and one femur. We compared the two femurs and two humerus against each other to insure all four bones came from the same individual. Besides the defined ridges the bones appeared to be consistent with each other again indicating one individual.

We believe the defined ridges are occupational stress makers or OSM. Occupational stress markers are defining morphological and pathological alterations that develop on the bones of an individual as a result of continuous physical activity or excessive muscular use. We believe the occupational stress markers observed on the femur and humerus are the result of musculoskeletal stress, which is the most common stress marker observed. Musculoskeletal stress is caused by the significant development of muscles at the insertion sites, which indicates an intense use of the musculature. The location of these occupational makers on the bone is often times indicative of the physical activity performed by the individual on a regular basis throughout life. The bone at these locations appears to be enlarged and rugged because of the increased strength needed from the manifestation of the muscular hypertrophy. Muscular hypertrophy is simply an increase in skeletal muscle.

Both of the defined ridges found on the remains appeared to be present at important muscle attachment sites. The occupational stress marker found on the femur is located at the pectineal line, which is present on the shaft of the femur. At this site the pectineus muscle is present, which is the muscle that attaches to the pectineal line which is inferior or below the lesser trochanter of the femur. The muscle originates from the superior ramus of the pubis bone. This muscle is responsible for the flexion, medial rotation and adduction of the hip. Flexion refers to movement in the anterior-posterior plane. This movement specifically decreases the angle between the articulating bones, in this case the femoral head and the acetabulum of the pubis bone. Adduction refers to the movement of returning structures to their anatomical position. An example would be bringing the fingers or toes back together as opposed to spreading them apart. Medial rotation is responsible for moving the anterior surface of the structure turning it outward toward the long axis of the trunk. The occupational stress maker found on the humerus is located on the shaft of the bone. At the site of this occupational marker we believe is the insertion site of the deltoid muscle. The deltoid muscle originates from the clavicle and the scapula. The whole muscle is responsible for abduction at the shoulder. The anterior part of the muscle is responsible for flexion and medial rotation of the shoulder. The posterior portion of the muscle is responsible for extension and lateral rotation of the shoulder. Abduction refers to movement away from the longitudinal axis of the body which occurs in the frontal plane. An example of abduction would be swinging a limb to the side. Extension is the opposite of flexion, it refers to increasing the angle between articulating bones.

There are several differences between the male and female skeletal structure (Table 3). The bones that offer the most differentiation between the sexes are the skull and the pelvis. We focused on the pelvis in determining the sex of the skeleton; however, we also looked at the humerus and skull of the specimen to support our findings. The skull was not presented to us in its entirety and was reconstructed using glue and putty. So, unlike the pelvis, we were unable to look for all the characteristics that differentiate between male and female. In addition to the long bones, skull and pelvis, the sternum, scapula and metacarpal bones can be used for sex determination. However, the scapulas, sternum and metacarpals were not present with the remains. According to research, sex determination using the pelvis alone offers a 95% accuracy rate. When the skull is used alone the accuracy rate is about 90%. The long bones offer approximately an 80% accuracy rate. When both the skull and the pelvis are used to determine the sex of a skeleton, the accuracy rate is 98%. It should be noted that the sex of an infant or juvenile cannot be determined. The skeleton of individuals before puberty resembles that of a female. It isn't until after puberty is reached that the sexual dimorphism used to determine male or female can be observed.

Table 3: Features of the Male and Female Pelvis

Feature of the Pelvis	***Males***	***Females***
In General	Narrow, robust and rough	Broader, lighter and smoother
Pelvic Inlet	Heart-Shaped	Oval-Shaped
Iliac Fossa	Deeper	Shallower
Greater Sciatic Notch	Deep and Narrow	Broad and Shallow
Ilium	More Vertical	Less Vertical
Angle of the Inferior Pubis Symphysis	Less than 90°	More than 90°
Sun Pub Arch	Inverted V-Shaped	Inverted U-Shaped
Acetabulum	Lateral	Faces slightly anteriorly as well as laterally

Obturator Foramen	Oval-Shaped	Triangularly-Shaped
Ischial Spine	Points Medially	Points Posteriorly
Body of the Pubis	Triangularly-Shaped	Quadrangularly-Shaped
Sacro Iliac Joint	Large	Small
Sacrum	Long, narrow and triangular with a pronounced sacral curvature	Broad, short and triangular with less of a curvature
Coccyx	Points anteriorly	Points inferiorly

The pelvic girdle or pelvis is the most sexually dimorphic part of the human skeleton. All of the sexual dimorphism shown in "Table 3: Features of the Male and Female Pelvis" are based off the anatomical measurements that are obtained from the pelvis. Specifically there are five features that indicate sex in the pubic region of an individual:

1. *The Width of the Sciatic Notch* – Tends to be small and deep in males and wider and shallow in females
2. *The Subpubic Angle* – Is generally wider in females than in males. Usually the angle in females is greater than 90° and in males it's less than 90°.
3. *The Ventral Arc* – This is very commonly observed in females, however, it is almost never observed in males. The vertical arc is more specifically, the curved ridge of the pelvis present on the anterior surface of the pubic bone.
4. *The Isohio-Pubic Ramus* – In females the ischio-pubic ramus usually appears to be a ridge, typically a narrow surface.
5. *The Acetabulum Diameter*

Since the entire pelvis was not present with the remains we were unable to look at all of the five features listed above. Because we could not look at all five features, all of the features shown in Table 3 could not be observed. When conducting our analysis of the pelvis, we specifically looked at the pelvic inlet and the sacrum. Based on our analysis and observations we believe the pelvis indicates the specimen is female. The sciatic notch we believe shows the individual is female because the angle is larger than that which is observed in males. In order to determine this, we used the finger test. The finger test is where the individual examining the bone places their index finger into the sciatic notch. If there is little to no space present it is assumed the specimen is male. But if there is a significant amount of room then the specimen is considered female. This test alone has a 75% accuracy rate because individuals differ, for example someone could have fatter fingers for measurements so it is an approximation. Next we looked at the sacrum; the curvature present on the bone appeared to be less than that of what a male's would be. Lastly we focused our attention on the pelvic inlet which seemed to be oval shaped rather than heart shaped, this also pointed towards a female. We compared the sacrum, the pelvic inlet and the sciatic notch to images of known male and female pelvises in order to help visualize the differences in pelvic structure between the sexes. The three markers we looked at seemed to be consistent with a female. The Ischium-Pubis Index we determined could not be calculated accurately because of the damage present on the ischium and pubis bone. We also determined the ventral arc could not be determined because part of the pubis bone is missing.

Next we looked at the skull of the individual to support our findings with the pelvis. There are nine features present on the skull that indicate the sex of an individual:

1. General Appearance
2. Supra Orbital Ridges
3. Orbits
4. Glabella
5. Zygomatic Arches
6. Mastoid Processes
7. External Occipital Protuberance
8. Mandible
9. Palate

In general, the skull of a male tends to be larger, heavier and rougher. The skull of females tends to be smaller, lighter and smoother. The supra orbital ridges specifically refer to the brow ridge of the individual. In males, the brow ridge is usually more pronounced than in females. However, it is possible for females to have a pronounced brow ridge. In females the orbital shape tends to be roundish with sharp ridges, while in males they appear square in shape with round like margins. The forehead is also examined, in males it seems to be slanted while in females is seems more vertical and rounded. The glabella in males usually is well-developed, while in females it seems to be ill-developed. The zygomatic arches can also indicate male or female. In females, the zygomatic arch appears to be less pronounced. It also has a tendency not to extend posteriorly beyond the external auditory meatus. Unlike in females, in males the zygomatic arch tends to be more pronounced. It also seems to extend beyond the posteriorly external auditory meatus. The zygomatic arch appears to be wider in males and narrower than in females. The mastoid processes are larger and blunter in males and appear to be smaller and more pointed in females. The external occipital protuberance tends to be more prominent in males and can appear to be hook-shaped. In females it is smoother and less pronounced.

The mandible in males has a tendency of being square shaped, while in females it tends to be more pointed. On the mandible in males, the ramus tends to be close to a right angle, while in females the ramus has more of an obtuse angle. Obtuse refers to an angle greater than 90°. A right angle refers to an angle at 90°. Also the ramus in males is wider and larger than in females. In males the palate is usually larger, wider and broader. In females the palate is smaller and narrower.

We only had a partial skull for examination; because we did not have the whole skull all of the features listed above could not be observed. We specifically looked at the supra orbital ridges, the orbits and the mandible, all of which indicated female. The shape of the eye socket appeared to be oval shaped with sharp ridges. The orbital sockets of the skull also appeared to slightly angled. The brow ridge of this individual also appeared to be less pronounced. The mandible appeared to be pointed as opposed to square. All the features we looked at on the skull pointed to the individual being female. Lastly, we looked at the humerus and more specifically the distal end of the humerus. The coronoid fossa which is located between the capitulum and trochlea condyles. It appears a foramen, which is a “hole” present in the bone, has formed. Because females have lower body densities this is commonly seen in females. It is very uncommon in males because they have a higher bone density.

Determining the age of a skeleton is highly dependent on the ability to assess the physiological age of the remains rather than the chronicle age of the individual. The physiological age of an individual is based upon the standardized growth patterns which are assumed to be accurate of the chronological age. However, the physiological age can be affected by different stresses, which can be environmental, nutritional and disease-related. These stresses, if present, can result in inaccurate age estimation. In general, the age of a younger individual appears to be more accurate because age is highly based on developmental changes. In older individuals, age is determined based on the degenerative changes present on the bones. These degenerative changes prove to be less accurate than the developmental changes. While trying to determine an age range for the remains presented to us, we looked at the dentition and the epiphyseal fusion sites visible on the pelvis. The epiphyseal fusion sites present on the rest of the remains were not visible for examination because of the shellac applied to the remains.

Age estimation using dentition is accomplished by looking at the eruption of the permanent dentition. Usually this form of age estimation is beneficial up until the age of about 15 years of age, which is approximately the age in which the 3^{rd} molars or wisdom teeth erupt. This is unreliable, however, because variation is present between individuals. In some individuals the 3^{rd} molars don't erupt at all because of impaction. In most individuals the 3^{rd} molars erupt between the ages of 15 and 21. Based on the presence of the 3^{rd} molar or tooth 32 in the mandible we placed her age range between the ages of 15 and 21.

Dental wear can also be used to help determine the age of the individual, however, it is seen as very unreliable especially when examining the remains of an individual who practiced a high-grit content diet. When referring to a high-grit content diet, it means the foods the individuals are ingesting have an increased number of minute rough granules, such as sand or stone. High-grit diets have the potential to wear the teeth down by the end of puberty. When observing the teeth present with the remains, tooth wear is evident. Some of the teeth have been worn so far down that the pulp chamber is visible. The cause for tooth wear shown by the teeth at this time is undetermined; it can be a result of grinding, a high-grit diet or occupational markers.

Epiphyseal fusion sites present on the bones are probably the most effective way to determine an appropriate age range for a set of remains. Because of the shellac applied to the remains we were unable to view most of the epiphyseal fusion sites. Instead we noted that the pelvis appeared to be completely fused. At birth the three bones that make up the pelvis, the ischium, the pubis and the ilium are three distinctive bones. Around the age of 14 or 15 the three bones begin to fuse. Because the three bones appeared to be fused the pelvis indicated the specimen was no younger than 14 years of age, supporting the age estimation determined using the specimen's dentition. The only way to view the other epiphyseal fusion sites present on the various bones would be to use radiology or x-ray technology. Being able to view the fusion sites would help to narrow down the general age range we determined for the specimen, which based on our data, is between 15 and 21.

Next we set out to determine the stature of the individual. After close examination of the bones and determining the measurements that could be successfully taken, we determined the most beneficial bone for stature estimation would be the left tibia. Typically when attempting to determine the stature of an individual the femur is used, in our case we found that because both the right and left femurs appeared to be incomplete they would not produce accurate measurements. As a result, we determined the bones would not offer accurate stature estimation for the remains. Before being able to use the left tibia for estimating the stature of the individual, the left femur, patella, tibia and fibula must be taken apart. Without taking the bones apart an accurate measurement cannot be collected. At this point in time no stature estimation has been determined.

The ethnicity of a set of remains can be determined by looking at the characteristics of the bones. Typically different facial features such as the nasal cavity and eye orbit are examined. Below is a table of the characteristics typically looked for when trying to determine the ethnicity of an individual based on the structure of their facial bones.

Table 4: Ethnicity Based on Facial Features

	Caucasian/European:	**Negroid:**	**Mongoloid:**
Nasal Cavity	• Steep towering nasal • Larger nasal spine • Nasal aperture is narrow • Nasal passages appear to be triangular	• Semicircular nasal • Smaller nasal spine • Larger nasal aperture • Nasal passages are square	• Nasals appear to be tented, neither towering or sharp • Diamond shaped nasal passages • Smaller nasal spine • Nasal aperture is larger than Caucasians, smaller then Negroids
Prognathism	• Maxillary Prognathism or “overbite”	• Mandibular Prognathism or “underbite”	• Usually no Prognathism is present • Face is usually flat • If Prognathism is present it favors maxillary
Eye Orbit	• Angular • Eye border	• Square or rectangular	• Round • Eye border

	receding	• Eye border receding	projecting
Jaw and Teeth	• Parabolic dental arch • Spatulate shaped teeth	• Hyperbolic/ rectangular • Shaped palate • Megadontic teeth and Spatulate	• Dental arch is rounded • Incisors are typically shoveled shaped
Zygomatic Bones	• Curved	• Curved	• Squared

The word prognathism refers to the positional relationship of either the mandible or the maxillary to the skeletal base. In order to determine if prognathism of the maxillary or the mandible is present the observer determines whether or not the maxillary or the mandible extends past a predetermined imaginary line. If the maxillary extends over the line then it is known as maxillary prognathism, if the mandible extends past the line then it is known as mandible prognathism.

The skull of the individual presented with the remains was incomplete therefore none of these characteristics were apparent. The facial bones present also showed a significant amount of reconstruction making determining the ethnicity based on the facial characteristics near impossible and highly inaccurate. In addition to the reconstruction, there were places that were determined to be incorrectly constructed. For example, there was putty applied to the maxillary that was proven to not be needed. The dentition of an individual is one of the most telling sources of ethnicity. Usually the shape of the teeth, specifically the incisors are examined and noted. As seen in Table 4, shovel-shaped incisors are most often times indicative of Native American or sometimes Asian ancestry. It has also been observed that the dental arch appears to be rounded in Native Americans. Although we had almost a full set of teeth, it was determined we were missing three incisors. The incisors that appeared to be present all showed a significant amount of wear. Some of the teeth were so worn down the pulp chambers appeared to be visible. The pulp chamber refers to the natural cavity making up the center of the tooth crown. It is filled with dental pulp, which consists of DNA. Because the teeth have been worn down so much it is impossible to determine the shape of the incisors.

If hair is present with the remains if can be used to determine the ethnicity of a set of remains. The structure and the color of the hair have the possibility to be indicative of ethnicity because of the variation present in the morphology of hair between ethnic groups. The pelvis of an individual can also be used to determine ethnicity, using the sacral index. Because the sacrum has been broken and glued together the sacral index for ethnicity cannot be properly conducted. Without the full intact bone, the measurement needed is impossible to obtain. As a result the ethnicity of the remains cannot be determined based on the pelvis.

Lastly, when looking at the remains we need to take into account the dental health of the individual. The dental health of this individual does not reflect that of a traditional Native American diet. Traditional Northeastern Native American diets were heavily dependent on fish/seafood (lobster, clams, mussels, whale, squid, scallops) and game (rabbit, deer, elk and turkey), wild plants(fiddlehead ferns, garlic, leeks and berries) and the cultivated crops of native vegetable species (squash, corn and beans). This provided them with a healthy well-balanced diet with no processed foods. As a result of their diets, their dental health was generally very good; if these remains are in fact Native American she would most likely have come in contact with European settlers. Her dental health appears to be more consistent with that of a European settler. Traditional European diets consisted of highly processed foods; when they moved to the "New World" their diets began to change reflecting their surroundings and what was present. They still, however, consumed highly processed foods that they brought with them on their ships.

A significant amount of the teeth present with the remains appeared to be rotted and decayed. Some of the missing teeth were determined to be lost ante mortem. A portion of her mandible even appears to have decayed. A theory has arisen regarding her cause of death or COD. It is thought she suffered from sepsis of the brain brought about sepsis of the teeth. Sepsis is a medical condition that is caused by an overwhelming response to an infection. The inflammation has the possibility to result in widespread organ damage; this is because the blood clotting associated with sepsis reduces the blood flow to the organs and limbs. As a result, organs are deprived of nutrients and oxygen. If organ failure is present in more than one organ, the blood pressure of the individual can drop significantly, known as septic shock. This will result in multiple organ failure which will inevitably lead to death.

We also looked for any markers present on the bones that would indicate illness or poor health. Specifically we looked for criba orbitalia which results from anemia. Criba orbitalia is the presence of pores on the surface of the orbital cavities. Anemia is a very common blood disorder. It is a condition in which the blood lacks a normal amount of red blood cells or hemoglobin. Hemoglobin is an important component of blood and binds to oxygen present in the blood. If a red blood cell count it too low or the hemoglobin is abnormal or low, the amount of oxygen needed by the cells in the body will not be received. This can result in abnormal organ function. In order to determine if criba orbitalia is present on the remains, we examined the orbital cavities with a stereomicroscope.

The right orbita appears to have some visible pores that resembled those caused by anemia. The pores were not very prominent and could possibly be the result of bubbles present in the shellac. We were unable to say with certainty that these pores present in the eye orbitals were in fact a result of anemia conclusively. The left orbita appeared to have a significant amount of debris visible. The debris prevented us from visualizing any pores present on the surface of the left orbital cavity. There are a lot of darker areas present on the orbital cavities which could also be an indicator criba orbitalia. The pores observed on the bones could possibly be an indicator of the anemia, however, we could not definitively determine if the bubbles present in the orbitals were a result of anemia.

Based on our analyses, we were able to determine the remains belonged to a young woman between the ages of 15 and 21. Ethnicity was unable to be determined, however, based on her dental health it seems she may be of European descent, but because of the condition of the remains there is no skeletal morphologies identified to substantiate European versus Native American descent.

Next, we took the maxillary and the mandible in order to obtain dental photographs using a comparison microscope. The only thing the images using the comparison microscope did was maximize the dental pathologies. The images amplified the wear patterns present on the teeth. The dental photographs didn't really show conclusively anything but additional details regarding tooth wear and cavities for documentation purposes. In my opinion, the images weren't very helpful toward the analysis of the remains.

Lastly, we obtained dental radiographs from the University of New Haven's Dental School. In order to obtain these images a support system was constructed by the dental staff using a box of gloves and dental floss. The radio images showed the mandible had been fractured in two distinct places. The fracture lanes are shown in some of the digital and radiographic images. We were unable to determine whether or not these fractures occurred perimortem, postmortem or ante mortem.

Pulp stones were also identified in the pulp chambers of the molars. A pulp stone is a small dense mass typically present in pulp chambers or the root canals of teeth. They are usually present in the molars. Pulp stones are associated with three different things: a genetic disorder known as dentine, inflammation or old age. Because the remains were determined to be between the ages of 15 and 21, it is unlikely the pulp stones are a result of old age. The presence of multiple pulp stones could be indicative of a rare genetic disorder known as dentine.

Dentine dysplasia is a known autosomal dominant trait resembling the opalescent dentin. Dentine dysplasia occurs in two types: Type 1 and Type 2. Type 1 dentine dysplasia affects the root of both the primary (baby) and permanent teeth resulting in shortened periapical radiolucenices. Type 2 dentine dysplasia is indicated by the pulp chambers containing pulp stones in the chambers of the permanent teeth. If the individual suffered from this rare genetic disorder, they would have had Type 2 dentine dysplasia. Looking at the dental x-rays it does not appear that the pulp stones are present in multiple teeth; although the pulp stones are show in some of the radiographs (all show the same tooth). In my opinion the pulp stones present in the teeth are indicative of inflammation, which would be plausible based on her poor dental health. The pulp stones could also support the theory of sepsis of the brain through the teeth. Lastly the emergence of tooth 32, which is a 3rd molar, indicates the individual is close to the age of 15. The tooth appears to be approximately 60% developed. This data supports the age estimation collected from the pelvis analysis.

Further Analysis:

At this point in time, further analysis of the bones could be conducted. More specifically, radiographs of all the bones could be obtained which would help to further narrow the age range of the girl. The radiographs could help to visualize the epiphyseal sites on the bones which are not visible because of the shellac applied to the bones. Stature estimation can also be conducted if the left leg is disarticulated which will allow us better access to the bone. In order to conduct the needed measurements using the tibia, an osteometric board is needed.

At this point in time, the only way to 100% determine the ethnicity or authenticate the skeleton as Native American may be by analysis of the remains through DNA testing. We believe a sufficient amount of DNA is still present in the chambers of the teeth for specialized DNA testing. There are many different non-destructive extraction methods that can be utilized to obtain the DNA from the chamber. A sterile lab environment will be needed to conduct this type of testing. We unfortunately are not equipped for this type of testing at University of New Haven. Because there is a chance the remains could be Native American, the bones cannot be disarticulated without permission granted from the Native American Council. Also DNA testing cannot be performed without express permission. If DNA testing were to be performed, a special facility for ancient DNA testing for nuclear and mitochondrial DNA (haplotype analysis) such as Paleo-DNA should be consulted (www.ancientdna.com). Even with DNA testing, there may be no resolution regarding ancestry due to admixture of Europeans and Native Americans potentially. It is anticipated that DNA test results would yield one of two possible results: a haplotype or DNA results consist with one population group or the other if no much mixing of populations had occurred at time of death or a result of inconclusive if sufficient mixing of populations had occurred and the haplotype is common to both population groups.

Conclusions:

Based on our analysis of the remains, it is apparent the specimen is a young female between the ages of 15 and 21. The development of the 3rd molar suggests she's probably closer to 15. At this time, we are unable to determine with certainty the ancestry of the remains. Her poor dental health suggests European decent; however, she could also be a true ancestral Native American. At this time I cannot positively rule out the possibility of Native American or European ancestry. Due to her dental health and the condition of the cranium we cannot use the markers traditionally utilized to suggest or rule out Native American ancestry. In order to positively identify the remains as Native American or European in origin, DNA analysis should be performed as a group recommendation.

Work Cited:

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Dental Report

Forensic Report

Name of Remains (skull): Tuttle

- **Report Prepared by:** Richard Diotalevi, DMD, Adjunct Instructor, Dental Hygiene Program, University of New Haven; and Sandra D'Amato-Palumbo, RDH, MPS, Associate Professor, Dental Hygiene Program, University of New Haven
- **Type of Radiographs Exposed:** 2 Panoramic radiographs (upper and lower jaws) and a full mouth series (13 periapical radiographs)
- **Exposure Date of Radiographs**: November 8, 2012

Known information taken from the radiographs:

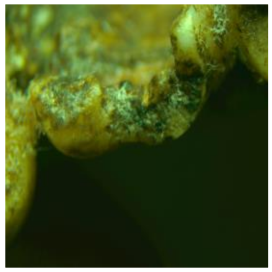
Panoramic radiographs reveal mandibular mid body fracture bilaterally in areas of 3^{rd} molars. Condylar heads are absent along with right angle of the ramus. Also, fractures in area of the symphysis, and maxilla fractured area #7.

List of Teeth:	Known Information:
#1 maxillary right 3^{rd} molar	tooth missing
#2 maxillary right 2^{nd} molar	tooth present
#3 maxillary right 1^{st} molar	tooth present with pulp stone/ calcification in tooth
#4 maxillary right 2^{nd} premolar	tooth present
#5 maxillary right 1^{st} premolar	tooth missing
#6 maxillary right canine	tooth present- severe attrition
#7 maxillary right lateral incisor	tooth missing
#8 maxillary right central incisor	tooth missing
#9 maxillary left central incisor	tooth present with severe attrition
#10 maxillary left lateral incisor	tooth present
#11 maxillary left canine	tooth missing
#12 maxillary left 1^{st} premolar	retained root tips
#13 maxillary left 2^{nd} premolar	tooth present
#14 maxillary left 1^{st} molar	tooth present with pulp stone/ calcification in tooth
#15 maxillary left 2^{nd} molar	tooth present
#16 maxillary left 3^{rd} molar	tooth missing
#17 mandibular left 3^{rd} molar	tooth missing
#18 mandibular left 2^{nd} molar	tooth present with occlusal fracture and/or decay

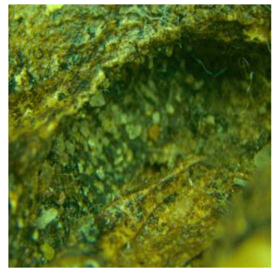
- #19 mandibular left 1st molar tooth present – evidence of periapical bone resorption and evidence of severe fracture and/or decay
- #20 mandibular left 2nd premolar tooth present
- #21 mandibular left 1st premolar tooth present
- #22 mandibular left canine tooth present with moderate attrition
- #23 mandibular left lateral incisor tooth present with moderate attrition
- #24 mandibular left central incisor tooth missing
- #25 mandibular right central incisor tooth present
- #26 mandibular right lateral incisor tooth present
- #27 mandibular right canine tooth present with attrition
- #28 mandibular right 1st premolar tooth present
- #29 mandibular right 2nd premolar tooth present
- #30 mandibular right 1st molar tooth present (severely decayed and/or fractured with periapical pathology)
- #31 mandibular right 2nd molar tooth present
- #32 mandibular 3rd molar tooth is partially impacted with incomplete root formation

Dental Digital Photographs – UNH Forensic Science

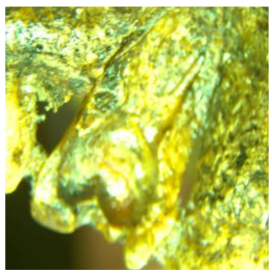
LL1 molar



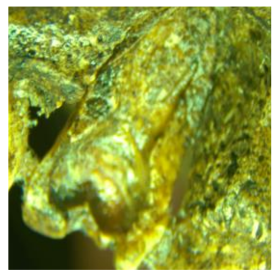
LL1 molar 1



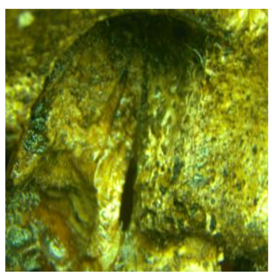
LL1 molar 2



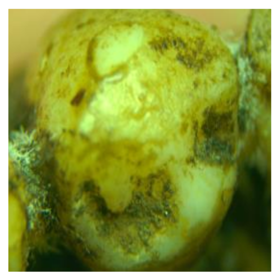
LL1 molar 3



LL1 molar 4



LL1 premolar

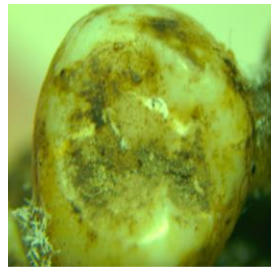


LL2 molar

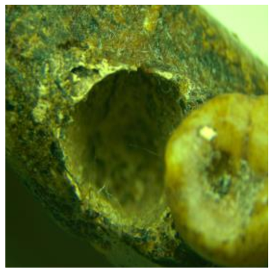
LL2 molar 1

LL2 molar 2

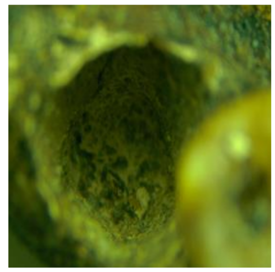
LL2 premolar



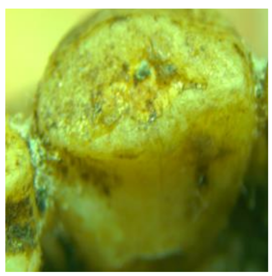
LL3 molar



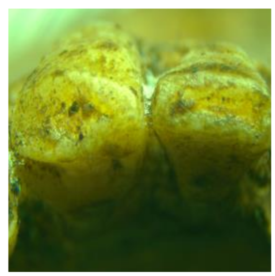
LL3 molar 1



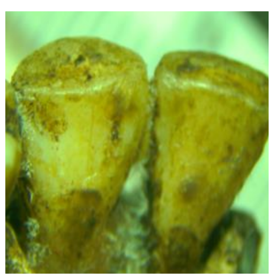
LL canine



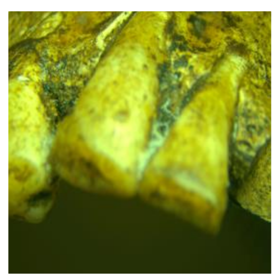
LLI1 and canine



LLI1 and canine 1



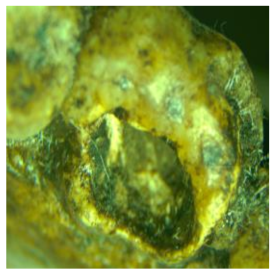
LLI1 and canine 2



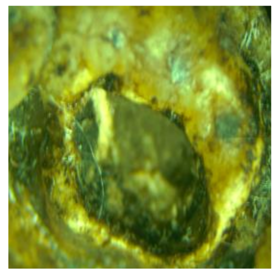
missing LLI1

RL1 molar

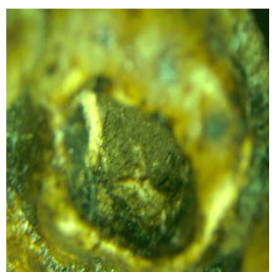
RL1 molar 1



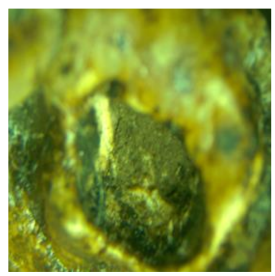
RL1 molar 2



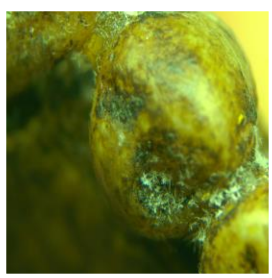
RL1 molar 3



RL1 molar 4

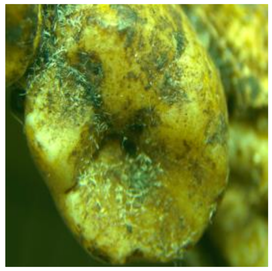


RL1 premolar

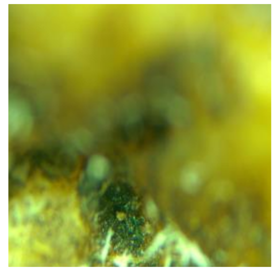


RL2 molar

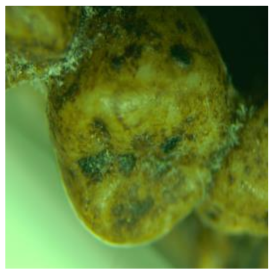
RL2 molar 1



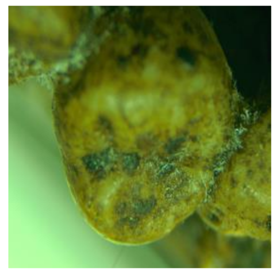
RL2 molar 2



RL2 premolar



RL2 premolar 1



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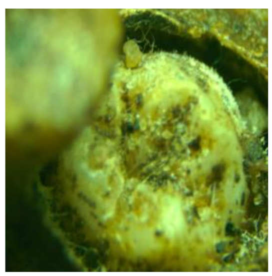
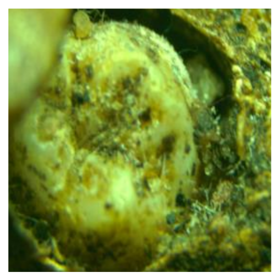
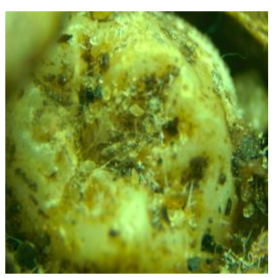
RL3 molar



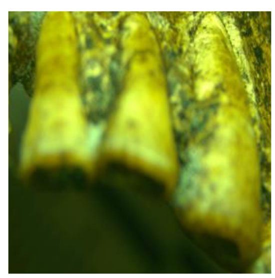
RL3 molar 1



RL3 molar 2



RL12IC



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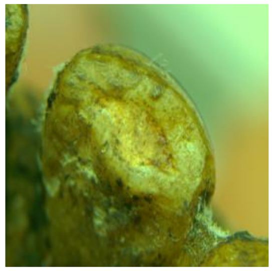
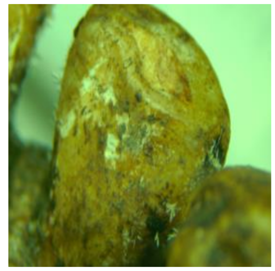
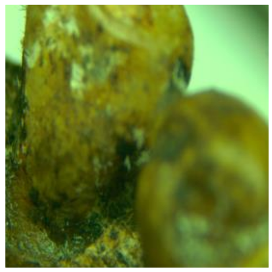
RL canine



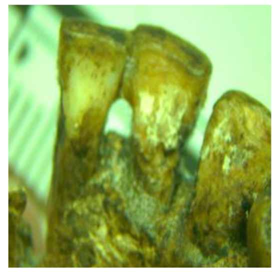
RL canine 1



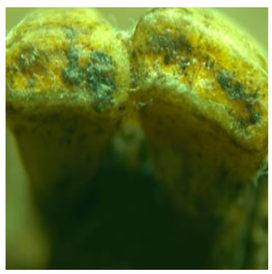
RL canine 2



RLI12

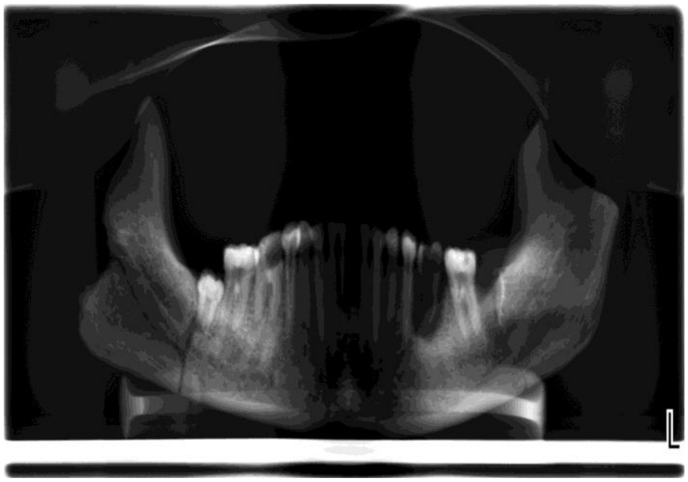


RLI nc1 and 2



RLI nc1 and 21

Dental Radiographs



radiograph - mandible

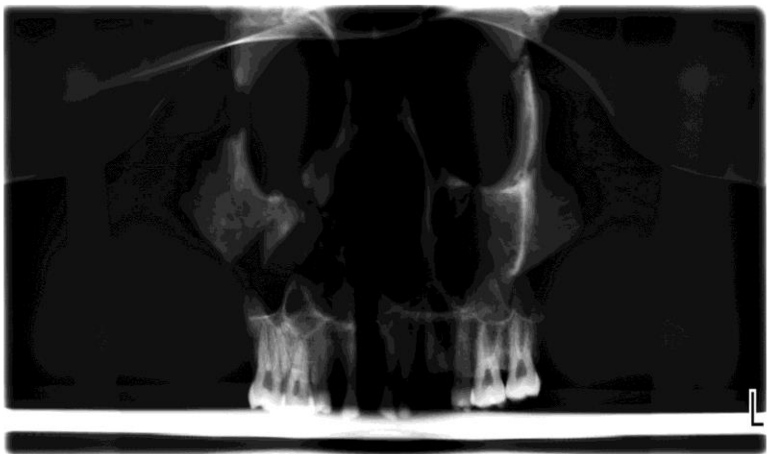
Several fractures are visible in the jaw line.

The skull was reported to be recovered in fragments in the 1950's and was glued together before addition of shellac.

digital image - mandible

Many teeth are intact and original.

Areas of bone and teeth have been covered with shellac as a preservative by original discoverer.



radiograph - skull

Central portion is missing with putty used to align fragments in the front.

The rear portion of the skull is absent.

No hair or artifacts were recovered during the intial excavation.

- 

Digital image of recovered portion of skull

Red areas are putty.

Shellac has been applied to coat and preserve the surface by the original discoverer.

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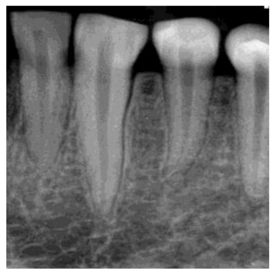
canine

radiograph - dental

radiograph - dental



radiograph - dental

radiograph - dental
with pulp stone

pulp stone

radiograph - dental

radiograph - molar

radiograph - cavity

radiograph - cavity

radiograph - molar - partially erupted

radiograph - dental

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Appendix

- *IRB Certificate*

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Heather Miller Coyle** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/08/2012

Certification Number: 775097

- *Acknowledgements:*
- Thank you to the generosity of our anonymous donor, Judge Joel Helander (Guilford Probate Court; Guilford, CT), Dr. Nick Bellantoni (Department of Anthropology, University of Connecticut; Storrs, CT), Dr. Gary Aronsen (Yale Biological Anthropology Laboratory, Yale University; New Haven, CT) for their generosity of time and expertise, Professor Sandra Palumbo, Professor Adrianna Fields and Dr. Richard Diotalevi (UNH dental hygiene program) for their skill in dental radiographs, Dr. Harry Gill-King (University of North Texas Center for Human Identification; Denton, TX) for his generous time, expertise and report, The Henry C. Lee Institute (West Haven, CT) for assistance with storage and advice, University of New Haven (West Haven, CT) for use of their equipment and facilities, and forensic science students Laura Reimer, Jordyn Valoroso, Scott Tardiff, and Marcela Slavikova (Intelex, LTD; Stamford, CT) for their extreme dedication, research and time on this project.