Introduction to Archaeology: Notes 13

Human remains

- A word about ethics and respect
  - Kelly and Thomas are absolutely right to not include images of human remains from North America
  - Many Native Americans feel strongly that showing such pictures would be disrespectful to their ancestors
    - just as you might find it disrespectful to see a gruesome picture of a dead family member in a news story about their traffic accident
  - Some Native Americans are offended by any treatment of remains of their ancestors other than burial with the appropriate rites
    - they have every right to feel this way
    - although there are principled arguments to be made for trying to gather scientific knowledge in as respectful a way as possible
    - we will look into this later in the course
  - we would be grossly inconsiderate, at best, not to honor those feelings here
  - However, in many other regions, people do not have such strong feelings about remains of the dead
    - especially if they are more than a few generations old
    - they may not feel particularly related to them
    - or they may just not attribute much importance to the remains
    - as in Peru
      - the Spanish were so successful at forcing indigenous people to convert to Catholicism centuries ago
      - that many Peruvians consider archaeological remains to be "gentiles" (non-Catholics)
      - they do not feel much connection to them
      - even though they know in principle that the remains could be of their own ancestors
      - so much so that there is a long-standing tradition of looting archaeological burials
        - many, if not most, Peruvians outside of the biggest cities have dug up burials themselves, or know people who have
  - As far as I know, all the images I use here are from regions where people do not object to the study and display of human remains

- Analysis of human remains
  - **Osteology**
    - study of bones in general
  - **Bioarchaeology**
    - general term for analysis of human remains of all kinds
  - **Paleopathology**
    - study of ancient diseases, injuries, and health
    - often using bones and teeth, but also using soft tissue, hair, bone chemistry, DNA, parasitology, etc.
  - **Paleodemography**

    - reconstructing “census” data from age at death and sex
    - suggests health status, stress, gender differences, etc.

- Quantifying human remains is usually simpler than quantifying plant or animal remains
  - Human remains are usually found as (originally) complete individuals
    - usually in burials
    - if not, usually special deposits
    - isolated heads (crania)
    - limbs, etc.
  - rarely as scattered bones in midden, like animal remains
    - so analysis is more focused on discrete individuals, less on NISP, MNI, etc.

- A bioarchaeologist typically records
  - what elements of each individual are present
    - using a standardized form with drawings of bones to annotate or named bones in a checklist
  - position
    - if the bioarchaeologist is working in the field with an excavation project
    - or the position is otherwise preserved, as in mummies
  - sex
    - only possible with late adolescents and adults, when sexual characteristics have developed
    - best indicators are aspects of the pelvis
      - because females have pelves with a larger birth canal
      - sub-pubic angle
        - narrow in males
        - wide in females
      - pubic ramus (a ramus is a bar of bone)
        - short in males
        - long in females
      - sciatic notch
        - narrow in males
        - wide in females
    - less reliable indicators are found on the cranium
      - brow ridge
        - projecting in males
        - none in females
      - superior orbital margin
        - rounded in males (related to heavier browridges in males)
        - sharp in females
      - mastoid process (where several neck muscles attach below and behind the ear)
        - large in males
        - smaller in females
  - age at death

- can be estimated fairly well up into early adulthood, as the body is growing and developing adult characteristics
  - adults can generally only be roughly aged
- tooth eruption and crown formation
  - by comparison to charts or tables of when baby teeth and permanent teeth erupt
- tooth wear allows rough age estimate for adults in specific populations
  - depends on the diet, so each population has to have a scale adjusted to that particular case
  - this can be done with a bunch of well-preserved individuals
  - then ages can be estimated for other, less well preserved individuals
- fusion of epiphyses (the ends, edges, or other parts of bones that are initially separated by an area in which growth occurs)
  - the epiphyses fuse onto the rest of the bone as growth slows and stops
  - this happens at different ages for different bones
  - the ages are known from studies of numerous skeletal populations with known ages at death
  - the combination of which epiphyses have fused and which are still unfused allows us to bracket the age
    - for small children, to within fractions of years
    - for older children, adolescents, and young adults, to within a few years
    - no help for individuals past their early twenties
  - exception: fusion of cranial sutures allows rough age estimate for older adults
    - some adults' cranial sutures never fuse
    - but for those who do, we can roughly gauge the age
- shape of surface of pubic symphysis
  - the connection between the bones at the front of the pelvis
  - wrinkles and other features change through adulthood, allowing rough age estimate
  - by comparison to drawings, photos, or sets of casts
  - usually, the shape is "scored" as having a given shape category
    - each shape category has been shown to correspond to a range of ages
  - the age ranges get quite broad at the later stages, like 23-57 years for stage IV, or 34-86 years for stage VI
- some microscopic methods also work
  - these involve cutting cross-sections of bones
  - but these methods are labor intensive and relatively expensive
  - so they are not widely used

- pathologies
  - **paleopathology**: study of ancient diseases, injuries, health, and activity-related effects on bones
    - often based on observations of bone and teeth
      - but also on soft tissue and hair if present
      - chemical and isotopic composition of bone
      - DNA (often of disease organisms, not the victim!)

    - parasitology (lice in hair; parasites and eggs in coprolites, etc.)
- Examples of pathologies due to disease, injury, or stress
  - (a random sample of many pathologies that bioarchaeologists routinely observe)
  - spinal osteoarthritis
    - bone growth ("lipping") around the vertebral bodies
    - may indicate heavy workload
  - Pott's syndrome
    - collapsed vertebral bodies, but not the denser bone at the back of the vertebrae, causes the lower spine to bend over
    - caused by some (not all) cases of tuberculosis
  - cribra orbitalia
    - a form of porotic hyperostosis
      - porotic: porous
      - hyperostosis: excess growth of bone
      - outside the usual surface of the bone
      - cribra orbitalia is porotic hyperostosis in the upper surface of the orbits (where the eyes are)
    - mostly in children
    - apparently causes no permanent harm
    - goes away in healthy adults
    - attributed to anemia, caused by various forms of stress
      - infections, poor diet, parasites
  - healed and unhealed fractures
    - can suggest certain kinds of accidents, which can suggest categories of activities
    - example: parry fractures
      - characteristic kind of fracture in the forearm that often occurs when someone flings up their arm in front of their face to deflect a blow
    - example of cranial depressed fractures in south Andean populations studied by Tiffiny Tung
      - males with have multiple, healed fractures
      - disproportionately on the front left of the head
      - suggesting ritual fights between men facing each other, in a way that often did not kill the loser
      - vs. females, with more injuries to the back of the head
      - suggesting blows while the women were running from the attacker
      - suggesting either domestic violence or raiding
  - distinguishing between perimortem (around the time of death) and postmortem fractures caused by natural processes after deposition or by the excavators
    - by the slightly flexible, tough quality of breaks in "green" bone of a living or recently deceased individual
    - versus the brittle, dry, flaky quality of older, dry bone
  - enamel hypoplasias
    - bands of incompletely formed tooth enamel

        - indicates a period of stress in childhood, when that portion of the enamel was forming
      - tooth wear, loss, caries, abscesses, etc.
        - resorption of bone around aveolae (tooth sockets) if the tooth loss was long before death
        - caries (cavities) and abscess can suggest a starchy diet
        - tooth loss commonly in one area on one side can suggest that coca chewing was habitual in a population
      - auditory exostoses: bony growths in the ear canal that seem to be associated with spending a lot of time in cold water
        - they probably indicate people who did a lot of diving for shellfish
    - Examples of pathologies due to intentional body modification
      - can suggest activities, ethnic identity, etc.
      - extreme, angled wear on the upper incisors of many Neanderthals
        - suggests use of teeth to scrape hides to make leather
        - presumably for clothing
        - makes sense, since they were living in near-Arctic conditions in the Pleistocene of Europe
      - intentional cranial deformation
        - by binding infants' heads so that they grow into a desired shape
          - elongated towards the rear
          - flattened and wide when seen from the front
          - etc.
        - does not cause any damage to the brain
        - widely practiced in the South, Central, and North America, in the Near East, and elsewhere
        - often appears to have been a marker of ethnicity
          - culturally determined, not biologically
          - created intentionally in infancy by the child's parents
          - a life-long marker of ethnic identity
      - trepanation: removing part of the cranium
        - widespread in the Andes, apparently to treat depressed fractures sustained in fighting with clubs or maces
        - many examples of partially or fully healed trepanations
        - some individuals have multiple healed trepanations
        - takes some skill to perform a trepanation without damaging the brain or cutting any significant blood vessel right below the bone
  - sometimes measurements for reconstructing stature
    - Sue Hayes' project to evaluate the agricultural productivity of the Camaná valley in southern Peru
      - she needed to estimate the amount of food needed by each the inhabitants, which depends in part on their body size
      - we found some bone measurements from an adjacent valley that let her reconstruct their typical stature, hence body mass, hence dietary requirements
  - sometimes traits useful for genetic relatedness studies

    - more on this later

- **paleodemography**: reconstructing the age-sex structure of ancient populations and their changes over time
  - the population-wide pattern of age at death of both sexes reflects differences in fertility, mortality, general health status, different causes of death
    - war vs. childbirth vs. childhood diseases, etc.
    - high infant mortality shows up clearly
    - in a highly stressed population, more people die younger
  - can be depicted as survivorship curves
    - show the fraction of the individuals born that survive to any given age
      - this highlights the mortality rate at different ages
      - makes infant mortality obvious
      - makes mortality of young adults vs. old adults obvious, etc.
      - suggests overall stress on population, particular kinds of causes of death, etc.
    - a steep decline means high mortality; a shallow decline means few people died in that age range
  - example of changing survivorship curves in the Upper Mantaro Valley, Peru
    - Infant and adult mortality improved considerably from Wanka II to Wanka III
      - infant and younger adult mortality was relatively high in Wanka II
        - when they lived in walled hilltop towns that were at constant war
      - both infant and younger adult mortality improved in Wanka III
        - to when they were conquered by the Inka
        - and some were resettled into lower, less dense, less defensible towns near farmland
        - this was surely done to facilitate control by the Inka empire
        - and to increase crop production for imperial taxes or tribute
        - but it proved to be a very healthy change for the Wanka people
        - although they apparently did not appreciate it, since they allied with the Spanish to fight against the Inka

- diet reconstruction using **stable isotopes**
  - isotopes that are not radioactive; they do not decay away
  - the most commonly used are ^{13}C and ^{15}N; these are rarer isotopes that are found in small amounts in the environment along with the common ^{12}C and ^{14}N.
  - Remember "isotopic fractionation" from our discussion of radiocarbon dating
    - different plants take up the different isotopes of carbon at slightly different rates
    - so they are more or less "enriched" in the heavier isotopes
    - ^{14}C decays away, but the ^{13}C and ^{12}C are stable
    - so the ratio of ^{13}C to ^{12}C does not change, and it depends on the particular chemical pathway that the plant uses to extract carbon from air.
      - or, in animal tissues, it reflects the mix of plants that the animal ate - or that its prey ate.
    - there are three common chemical pathways for fixing carbon, called C3, C4, and CAM
      - C3 is used by most food plants in temperate environments
        - C3 plants are relatively enriched in ^{13}C

- C4 is used mostly by arid-adapted grasses, of which maize (corn), sorghum (a grain most used in sub-saharan Africa), and millet (another grain) are the main one of archaeological interest
  - C4 plants are "normal" in ^{13}C
- CAM is used by plants like cacti, which rarely form a large part of human diets.
  - CAM plants are intermediate in ^{13}C content, but fortunately we can usually ignore them

- So, as a first approximation, we can estimate how much of the diet was from C4 plants versus C3 plants by measuring the ^{13}C in ancient human bones
  - in practice, that means we can identify early farmers in the New World (they started eating maize) and parts of the Old World (they started eating millet or sorghum)
- But… (there is always a "but")
  - seafood (fish and shellfish) is also enriched in ^{13}C
  - so bone that is enriched in ^{13}C could indicate a diet with a lot of maize, OR a diet with a lot of seafood
  - so ^{13}C studies are ambiguous anywhere near a coastline where C4 plants were used
    - in some cases, this is not a problem
    - in the American midwest, there is no need to worry about seafood in the diet
    - in studies of Vikings on Greenland, there is no need to worry about maize, millet, or sorghum, since those plants don't grow that far north
    - but in many coastal regions, both could be present, so the ^{13}C data alone don't allow us to reconstruct the diet
  - another "but" that people have not taken too seriously yet
    - many wild plants that foragers might have collected have not been characterized as to whether they are C3 or C4
    - especially in remote places like the desert coast of Peru
    - so it is possible that there might be C4 plants in the diet other than maize
    - that would really complicate things…
- A partial solution: look at a different stable isotope: ^{15}N
  - most nitrogen in the environment is ^{14}N
    - a small amount of natural nitrogen is ^{15}N, which is also stable
  - seafood (fish and shellfish) are relatively enriched in ^{15}N compared to terrestrial plants and animals
    - so the ^{15}N content of ancient bone can indicate the fraction of marine food in the diet
  - so if we measure both ^{13}C and ^{15}N, we can estimate the relative amounts of C3 vs C4 plants, and the relative amount of seafood vs. terrestrial plants
    - often done by plotting samples on a graph with ^{15}N on the vertical axis, ^{13}C on the horizontal axis, and boxes enclosing the areas where the bones of eaters of pure diets (all terrestrial C3, all terrestrial C4, and all marine) would fall
- But… (as always)
  - terrestrial plants also vary a little in ^{15}N content
    - particularly legumes (beans, lentils, etc.) vs. other plants
  - ^{15}N content in animal tissues varies with "trophic level"
    - trophic level describes how high up the food chain the organism is

        - plants are at the bottom
        - herbivores are at the next level
        - carnivores are above herbivores
      - carnivores are enriched in ^{15}N relative to herbivores
    - so when people might have been eating legumes or carnivore meat, the reconstruction of diet gets complicated again
      - fortunately, both of these effects are smaller than the terrestrial vs. marine difference
      - but they are large enough to add a lot of error to the method

- Genetic distance or relatedness studies
  - using genetically-controlled macroscopic traits (features visible to the naked eye)
    - among individuals, for family relationships
      - perforated sternum (hole in the breastbone) seems to run in families
        - so a number of buried individuals from the same cemetery that all have this trait may be related (have a common ancestor)
    - between populations
      - indicating how closely related the whole populations are
        - whether one might have split off from the other, as in a colony
        - whether they had been intermarrying a lot
      - may be based on cranial non-metric traits
        - like the frequency of various small openings (foramina) in the cranium
        - or on dental characteristics
        - or others…
      - requires data from a good number of individuals from each population, say a minimum of 30 from each…
  - using DNA
    - for relatedness of populations in general
    - usually mitochondrial DNA (mtDNA)
    - DNA, and especially mtDNA, is sometimes preserved in soft tissues, hair, or well-preserved bone
      - but this is so mostly in relatively recent material or material from especially good preservation conditions
        - artificial or natural mummies
        - bone that was not exposed to the elements and was buried in a fairly dry or frozen context
    - DNA studies often use mtDNA
      - found in mitochondria, not nuclei of cells
      - there are many mitochondria per cell, vs. only one copy of each chromosome in the nucleus
        - so there is a lot more mtDNA to start with
        - this improves the odds of getting usable mtDNA from an ancient sample
      - inherited only from the mother
        - no recombination due to sexual reproduction
          - so offspring's DNA is theoretically identical to its mother's

          - this allows for reconstructing or confirming family relationships, as in Thomas's example of the bodies of Czar Nicholas II and his family
        - so the only changes are from the occasional error in natural DNA replication
        - these build up slowly over generations
        - so people who share a female ancestor in their maternal descent line (mother-grandmother-greatmother-etc.) have
          - identical mtDNA if no errors have occurred in either line since that common ancestor
          - almost, but not quite identical mtDNA if one or more errors have occurred since the common ancestor
          - the more differences in the two people's mtDNA, the more time has passed since they had a common maternal ancestor
      - by comparing these differences among many individuals in different populations
        - we can reconstruct the order of splitting of biological populations
        - useful for reconstructing population movements like migrations, colonization, etc.
        - that is, the similarity of the mtDNA indicates the recentness of the split between the populations
    - practical details
      - The DNA has usually broken down into short segments; the less well preserved the tissue, the shorter the pieces
        - longer pieces are more likely to include complete nucleotide base sequences that can be used for matching or contrasting with other samples
      - very small amounts can be copied or "multiplied" into usable quantities using PCR
        - Polymerase Chain Reaction: a test-tube method that essentially imitates the natural process of replication of DNA
      - but *all* the DNA in the test tube will get multiplied, including any from microscopic bits of skin, finger oils, saliva, etc. of the lab technician, the excavator, etc.
        - so control of contamination is crucial
        - ideally, all the people ever associated with the sample provide DNA samples
        - and the "ancient" DNA is first checked against these to make sure that none of it comes from the modern people involved

- Population movement studies
  - Using the ratio of Strontium isotopes in tooth enamel vs. dentin
  - the ratio of Stronium isotopes in the available surface water varies from region to region, depending on the geology of the region
  - Strontium is similar to Calcium, and gets incorporated into human bone, tooth enamel, and dentin (the softer, but still hard, interior of the tooth)
  - enamel is formed in infancy
    - reflects the strontium isotope ratios of water in region of childhood
  - dentin is remodeled during life
    - reflects the strontium isotope ratios of water in the region of the last decade or so of life

- so if the Strontium isotope ratios are different in the enamel and the dentin, that individual probably grew up in one region, then lived the last decade or more of his/her life somewhere else
- we can even find possible places of origin
  - by measuring the Strontium isotope ratios in short-lived animals from possible regions
  - we can then rule out any region with a Strontium isotope ratio that does not match that of our individual’s dentin
  - although we can’t be positive about proving a given region, since regions with similar geology may have similar Strontium isotope ratios
  - but if there are only a few likely possibilities, we can often make a pretty good case for a particular region of origin