Bioarchaeology

Stray skeletal find in an excavation (above)

London’s East Smithfield Black Death Cemetery

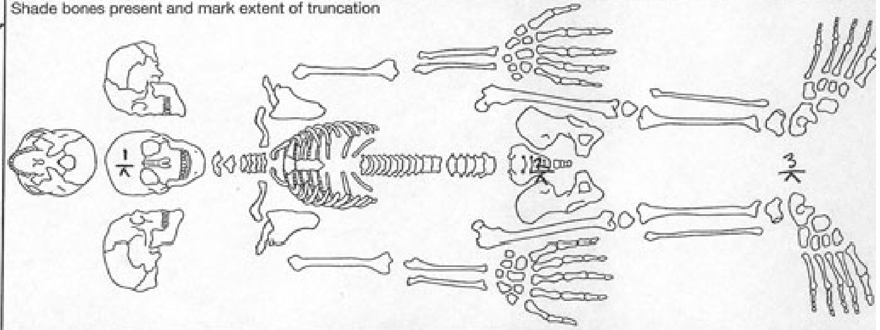
Bioarchaeology

- Archaeologists commonly must deal with human remains
- In some cases human remains are specifically targeted as part of a research design to investigate specific aspects of past societies
- This is quite commonly done through excavation of known cemetery sites
- At other times human remains are encountered in the process of excavation, and are unexpected finds
- In all of these cases, the same care and respect is paid when excavating and dealing with human remains on an archaeological site

SKELETON RECORDING SHEET

Grid Square(s) 385/805	Area/Section	SKELETON	Site Code OCU 100	Context 681
Type: Adult	Grave Cut: 737	Fills: 736		Coffin: 682

Shade bones present and mark extent of truncation



Plan overleaf ☐ If none explain below | Vertical photograph ☐ Image no:

Head at W end of grave | ◀ Co-ords of markers ▶

Attitude of:
1. body
2. head
3. right arm, location of right hand
4. left arm, location of left hand
5. right leg
6. left leg
7. feet
8. Extent of in situ bone degeneration
9. State of bone after lifting
10. Other comments

Supine extended adult inhumation. Arms extended, by side of body, hands by top of femurs. Skull upright & facing forwards. Legs extended, knees & feet together.
Ribs & in torso poor condition – crushed by lead coffin plate.
Two Cu alloy rings, probably some form of shroud fastening or eyes, found around throat

PTO

Stratigraphic matrix

736

This context is 681

697 698

Environmental samples (nos, type, location)

Finds directly associated with skeleton (type, location on skeleton, co-ords, level)

Levels overleaf Tick when reduced and transferred to plans ✓

Highest 4.19m | Lowest 3.86m

Plan nos: P — (x)	Site book refs:	Initials & date MVM 30/6/2000
Other drawings: S/E —	Matrix location:	Check by & date RC 21.8.00
Other photographs ☐ nos:		
Provisional period	Group	Burial no.	Initials & date

MUSEUM OF LONDON

Field recording

- As part of the process of recovering human remains on an archaeological site, archaeologists try to ensure that they are able to record as much information as possible in the field
- Human bones in archaeological contexts are usually quite fragile and poorly preserved so a great deal of care must be taken in both excavation and removal of the skeletal remains
- A great deal of information is recorded during the excavation of the human remains, all of which may prove useful (often vital) to the understanding of the archaeological context

Complete exposure of skeleton is essential

Field recording

- Information on the size, shape and orientation of the burial chamber or grave is recorded
- In almost all circumstances the skeletal remains are completed exposed before anything is moved
- The position and relationships between the bones provide evidence on burial posture

It is vital to record the precise location, position and identity of the bones in the grave, as well as the relationship to any grave goods

Some basic terminology for intentional deposition:

- Initial distinctions can be made in the treatment of the corpse between *cremation* and *inhumation* (burial of the body)
- Burials (inhumations) can be Primary or Secondary
- Primary burials are deposited with the intention that they remain in a final grave and are generally well articulated
- Secondary burials are re-deposited skeletal remains, which have been moved, usually from a primary grave,
  or in some cultures after decomposition or defleshing
- It usually quite clear whether the burial is Primary or Secondary, since in secondary burials it is quite common for many of the small bones to be absent

Cremation burial

Inhumation

Primary burial

Secondary burial

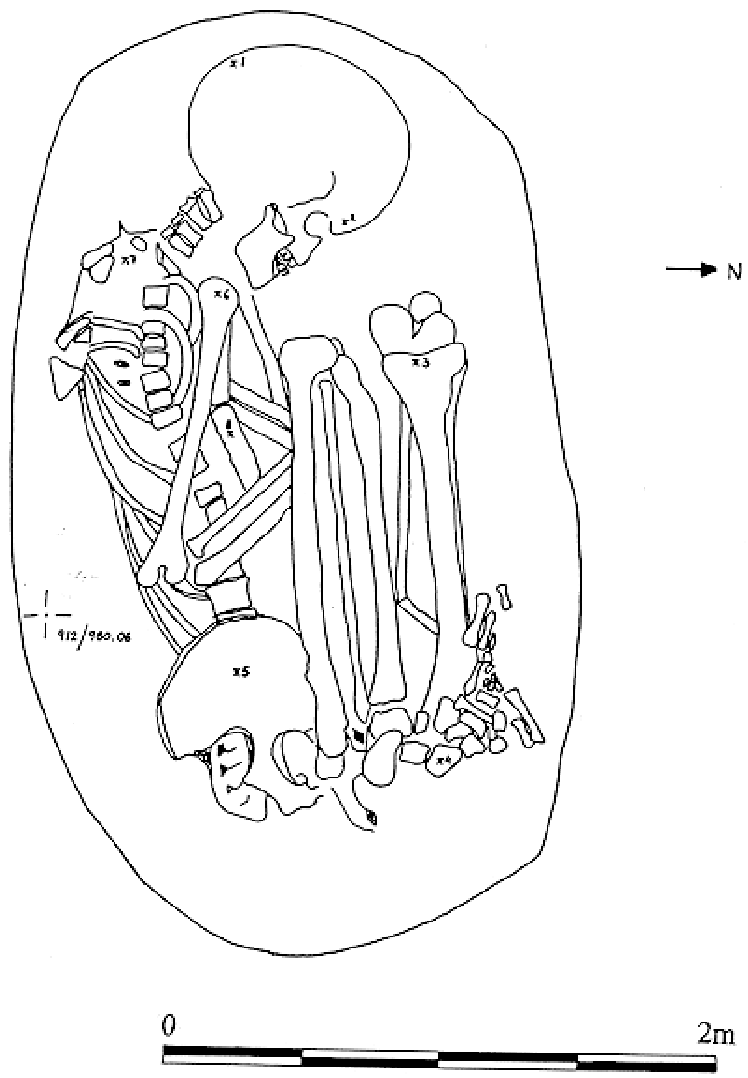
Primary burials can be buried in a variety of positions

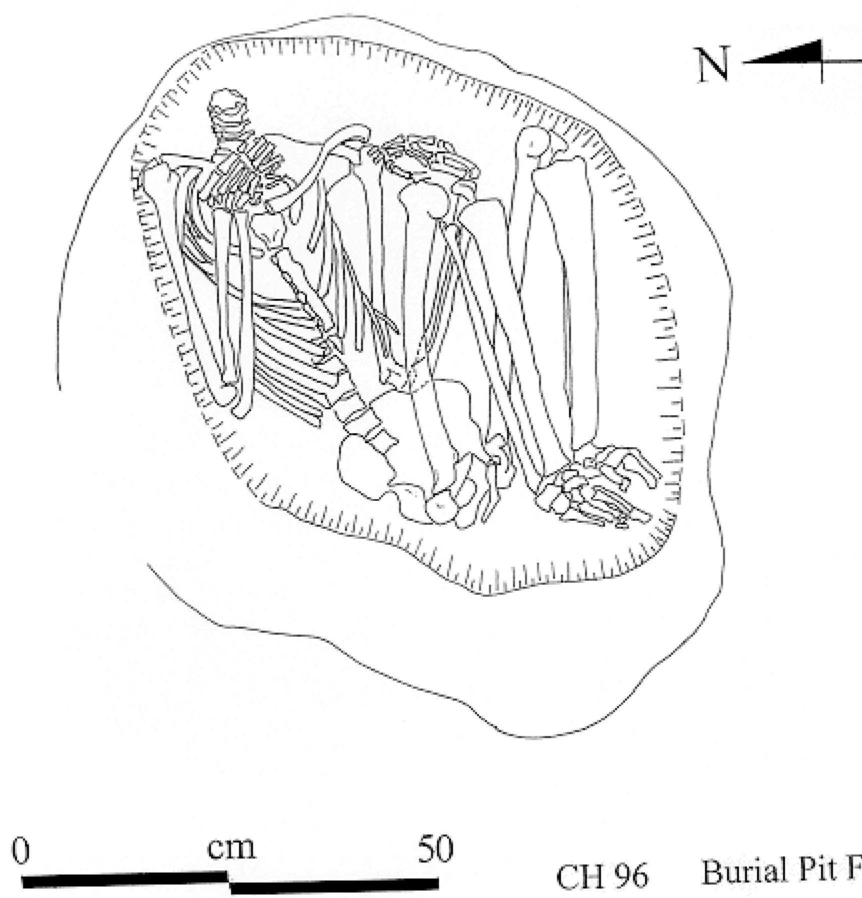
- Most commonly burials are extended or *supine*
- In some cultures and quite commonly in the past, burials were often *flexed*
- In both cases the orientation of the body can be an important factor, <u>as is the degree to which body was flexed</u>

Flexed burial

Supine burial

Figure 52 Burial 277Skeleton 2886 from Mellaart Area, Space 112





CH 96 Burial Pit F29 (1466)

Bioarchaeology

Combines the fields of archaeology and biological anthropology

Bioarchaeologists study the human biological components of the archaeological record

There are a number of sub-fields of analysis:

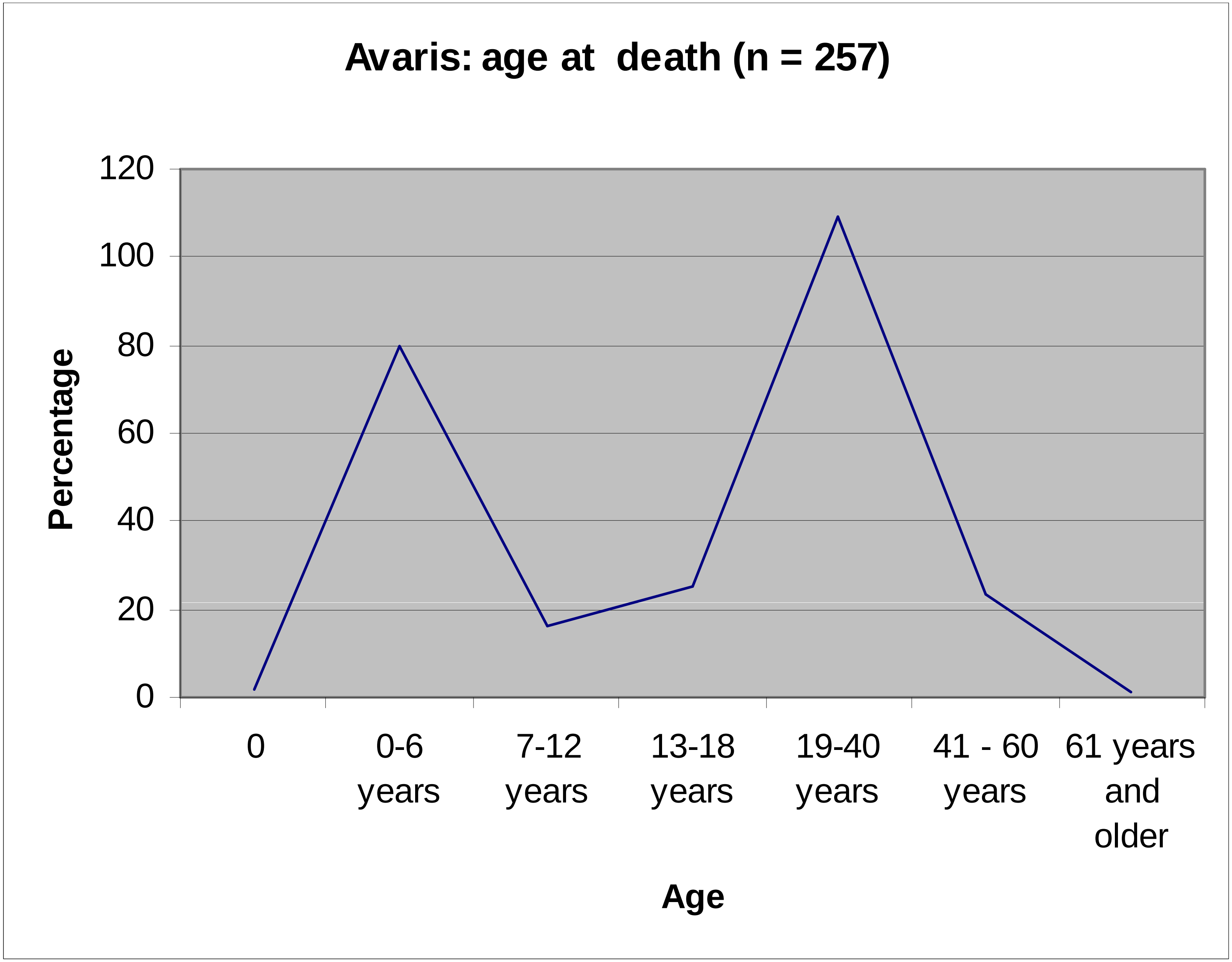
- palaeodemography
  (age, sex, stature and changes through time)
- diet and nutrition
- disease (morbidity and mortality)
- molecular studies (DNA)

Palaeodemography

- Demography is the age and sex composition of a population
- If the sample size is sufficiently large, we can look for patterns of death (infanticide, weaning death, maternal death during childbirth, adult males killed in warfare, etc.)
- We can also examine demographic changes through time, such as increase/decrease of average lifespan
- Palaeodemography works best with well-defined (usually cemetery) populations, where the samples are derived from the same biological population over time
- Bioarchaeologists use a variety of data to prepare mortality profiles of populations

Life and Death at Avaris , Egypt
(capital of the Hyksos, about 1700-1550 BC)

Prepared ‘warrior’ grave and the so-called ‘plague horizon’ (scattered skeletal remains, tumbled into pits)



Mortality profile for the population at Avaris, Egypt

Life and Death at Avaris

Age of death	number of individuals n = 257	percentage
0 (stillborn child)	2	0.8
0-6 years	80	31.1
7-12 years	16	6.2
13-18 years	25.5	9.9
19-40 years	109	42.4
41 - 60 years	23.5	9.1
61 years and older	1	0.4

1. **Very high infant mortality rate.**
2. **Average age at death for all: about 19 years.**
3. **Average age at death for adult women: about 30 years.**
4. **Average age at death for adult male: about 34 years.**
5. **Very small numbers of individuals reach age of 61**

The mortality profile can reveal a number of things:

- For example, prior to developments in medicine in the past 200 years, most human populations had infant mortality (defined as death before age 1) rates as high as 15-30%.
- Therefore, if an archaeological mortality profile lacks a high infant mortality peak, it probably means either that infant skeletons have not preserved, or that infants were disposed of somewhere other than where older people were buried (inherited vs. attained status?).
- Typically, if you survive infancy and weaning (which can produce a second peak in mortality), you are likely to survive your child and early teenage years.

- Mortality usually begins to increase in late teenage years
- For females this is often mortality due to complications of childbirth
- For males, this is often due to participation in violence/warfare
- The timing of these increases in mortality can reveal the society’s characteristic age-at-marriage for women, and the age at which ‘boys’ become ‘men’
- Female mortality typically declines rapidly after menopause, and women who have survived to that age often live many more years
- In contrast, there usually is no such drop-off of mortality for males Overall, there should be about the same number of males as females
- Significantly unbalanced sex ratios suggest different valuations attached to male and female offspring, with more attention lavished on keeping boys (or, less commonly, girls) alive

Sex estimation in adult skeletons

Sex – biological ‘identity’

Gender – social ‘identity’

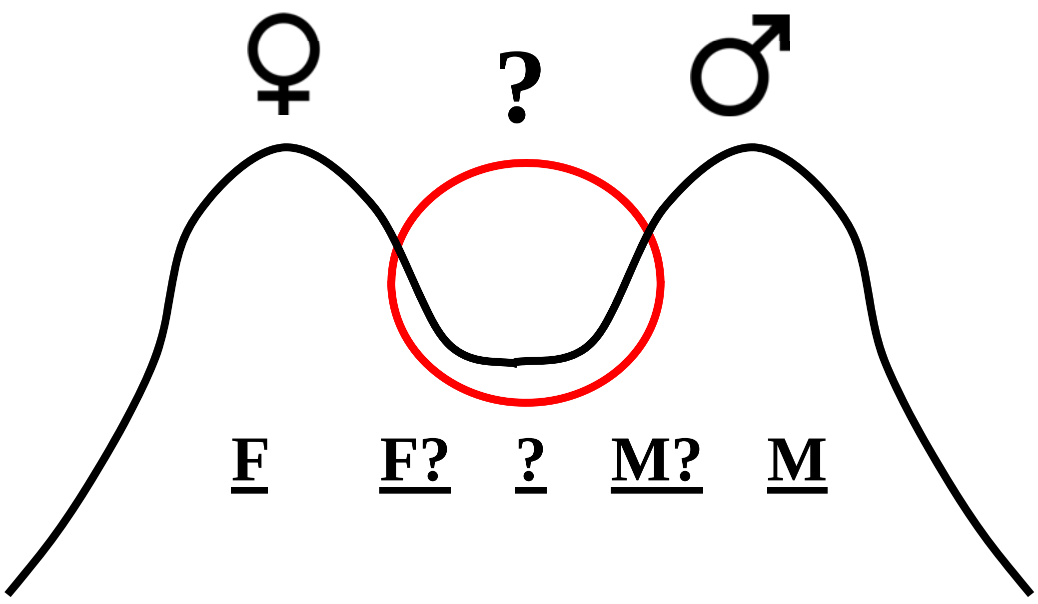
Sex differences in the skeleton are based on:

- Size differences – men are gernally larger
- Functionally related morphology – related to childbearing
- Robusticity/muscularity – often more evident in males

This best observed in distinct populations, as characteristics may vary across population groups

Sex Differences (cont..)

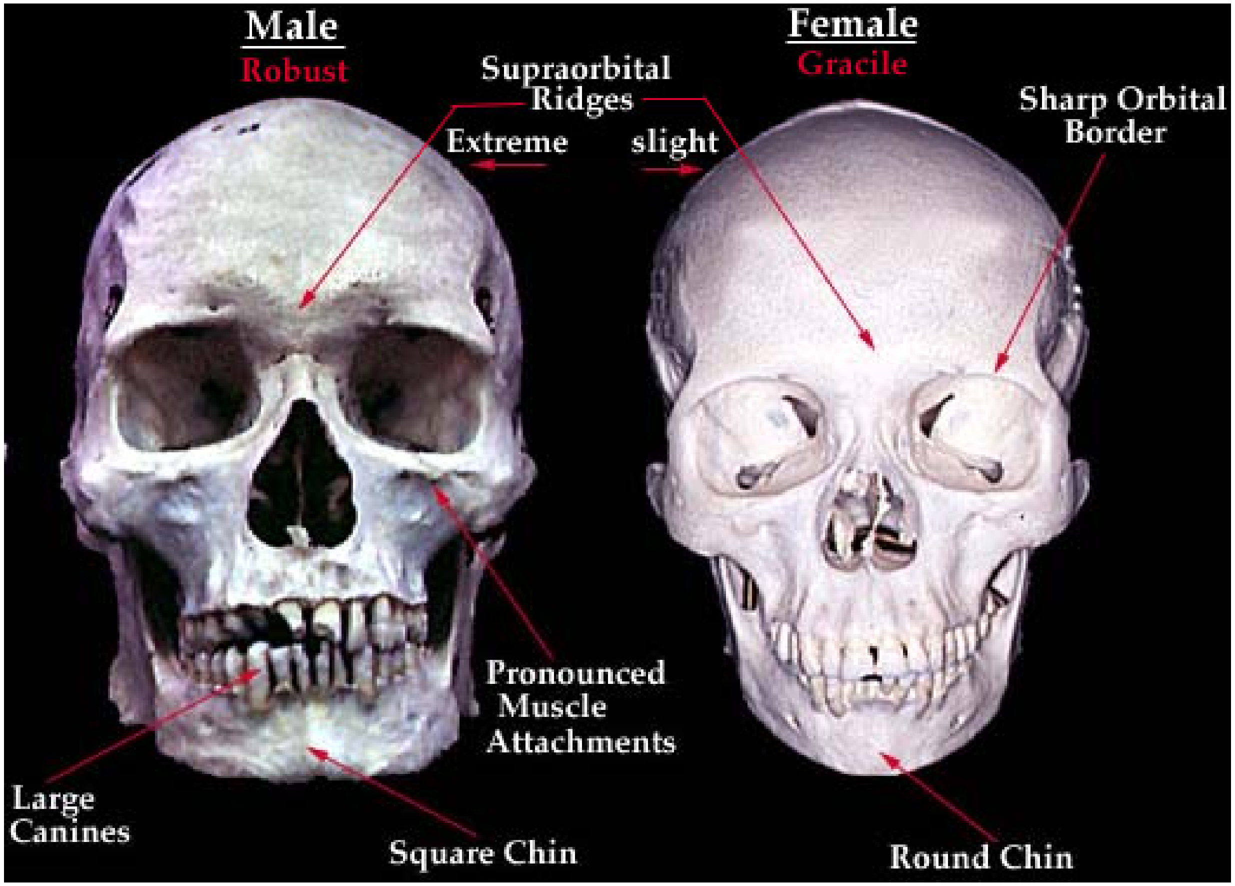
- Hormonally controlled
- Evident in adults, **not in children**
- Sex hormones increase at puberty, leading to secondary sex characteristics
- Varies both within a population and between populations

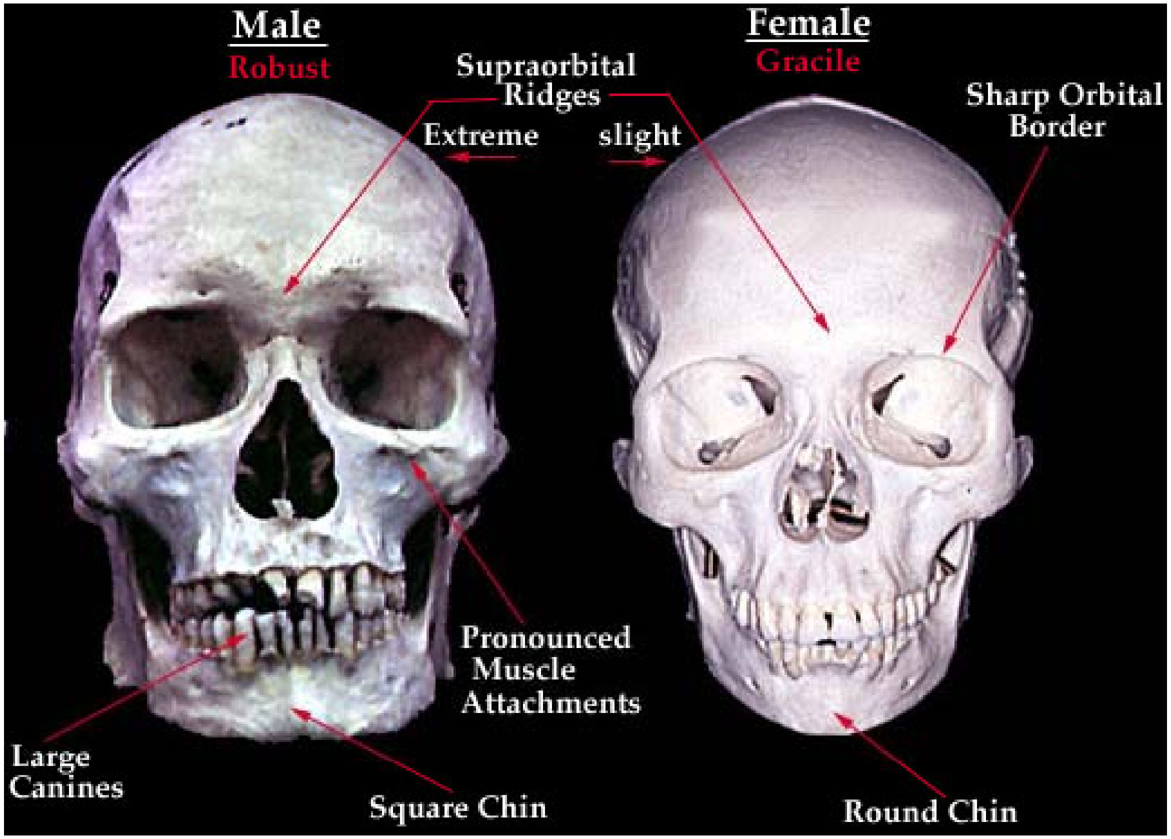


The Skull

Male skull:

- Heavier and larger
- Large mastoids
- Large supraorbital ridges
- Square orbits
- Square chin
- Sloping forehead
- Pronounced muscle markings





Female skull:

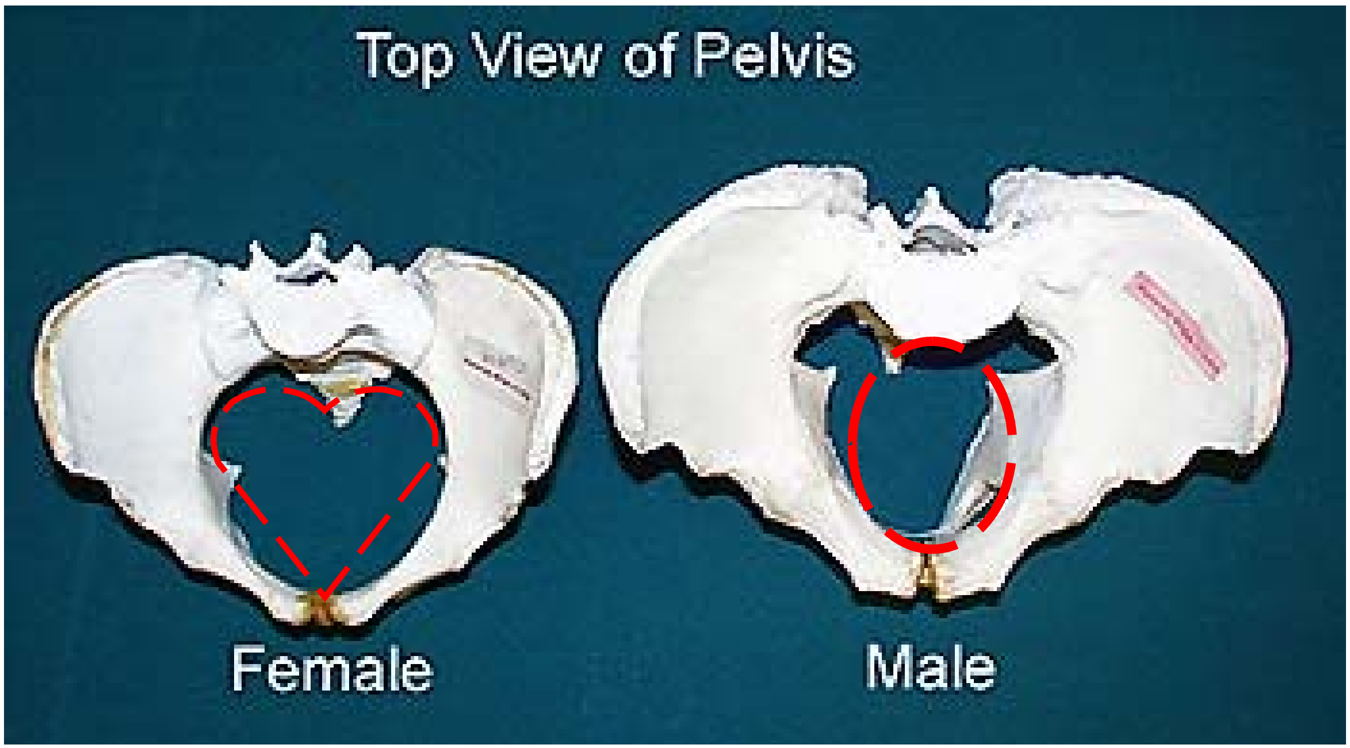
- Gracile and smaller
- Smaller mastoids
- Sharp supraorbital margin
- Round orbits
- Pointed/round chin
- High forehead
- Slight muscle markings

Accuracy is ~80-90%

- BUT reference collections are heavily biased towards males
- Systematic bias in favor of males when using morphological characters

The Pelvis

- Generally considered best for sex determination
- Related to features associated with females and childbearing
- Accuracy ~95%
- Combined skull & pelvis ~98%

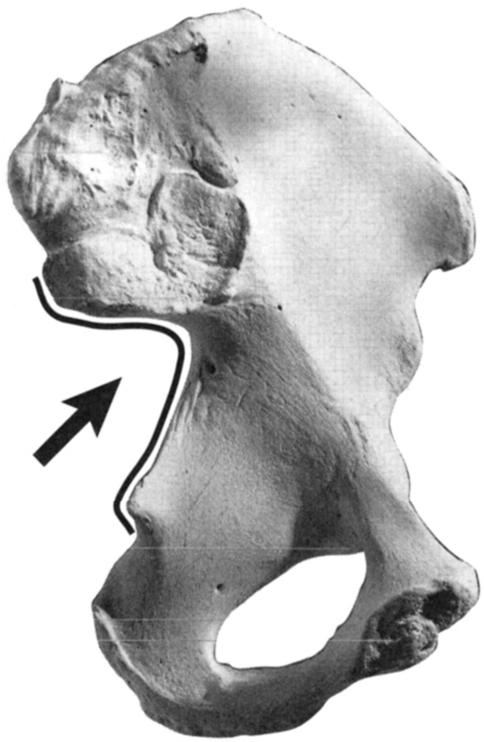


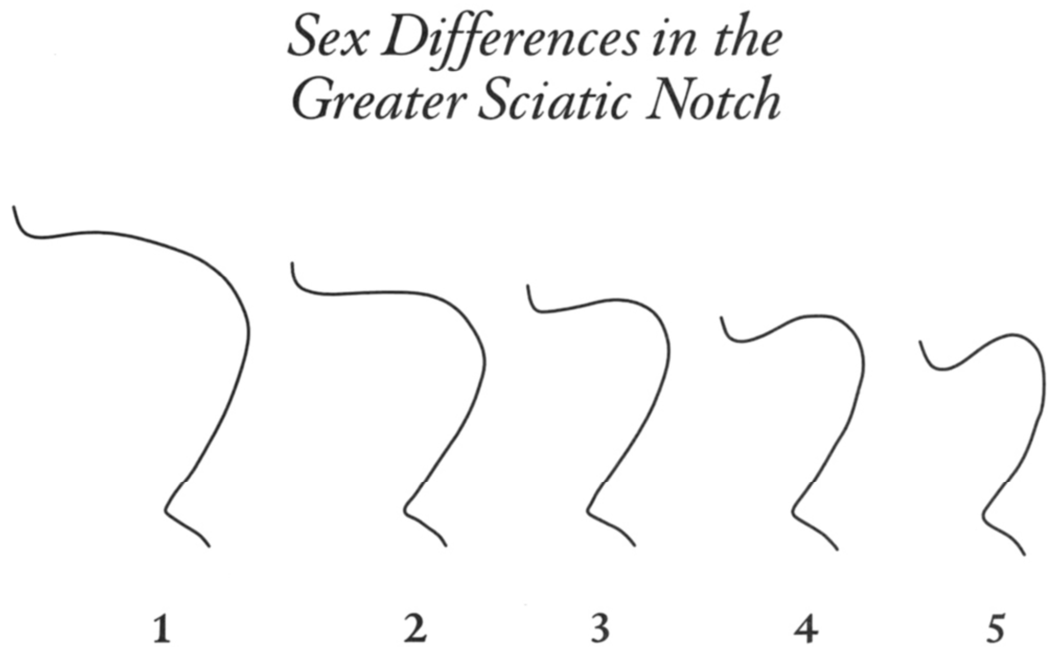
Shape of pelvic basin:

narrow in males; round (heart shaped?) and open in females

Sciatic Notch

– wider in females; narrow in males





1= F

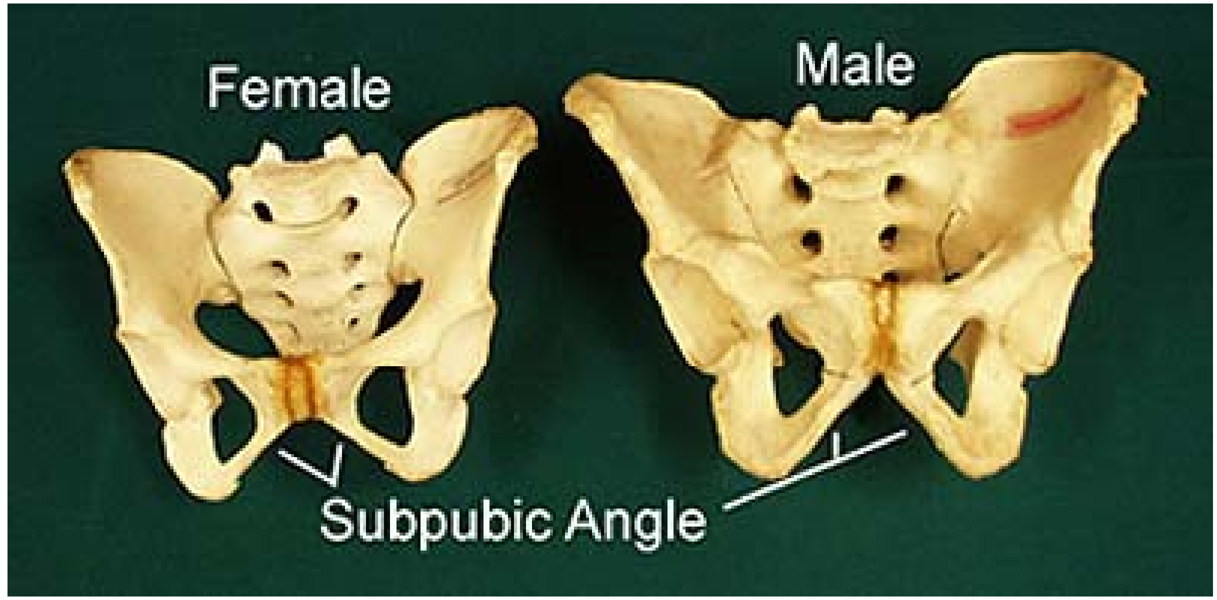
2-4 = M?

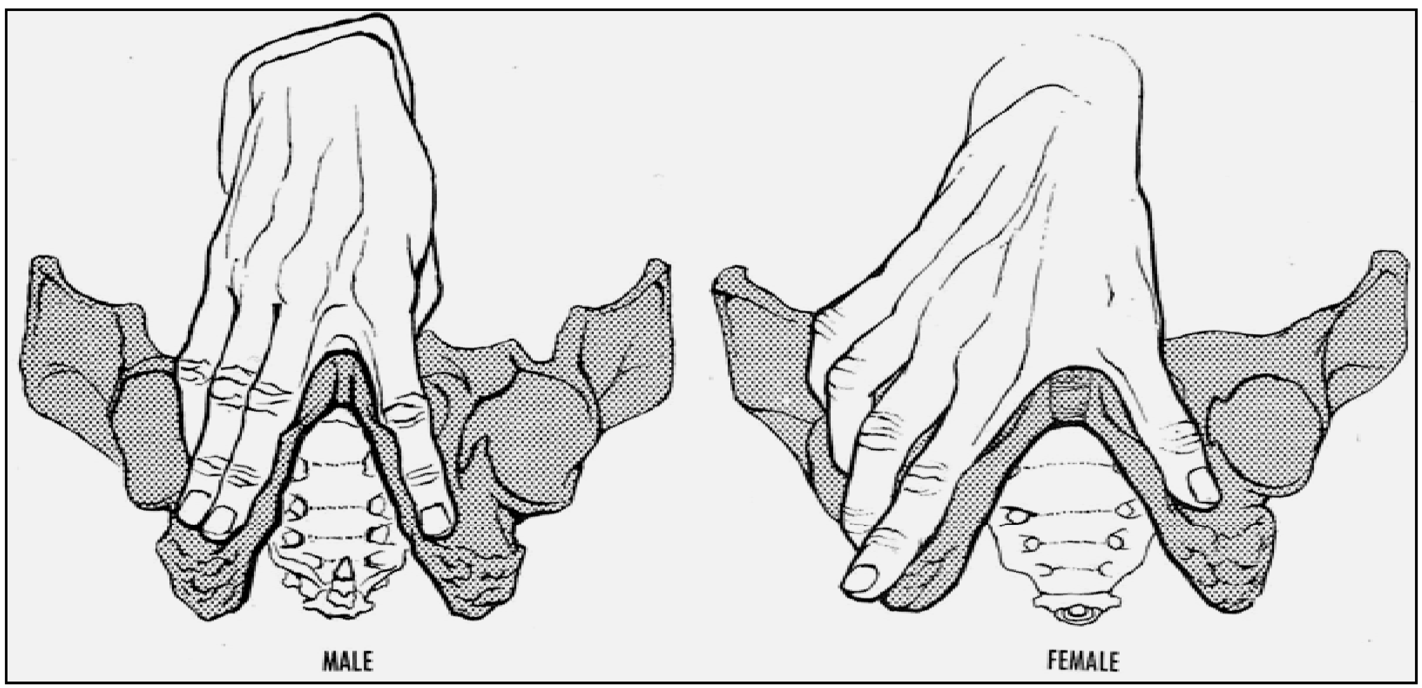
5=M

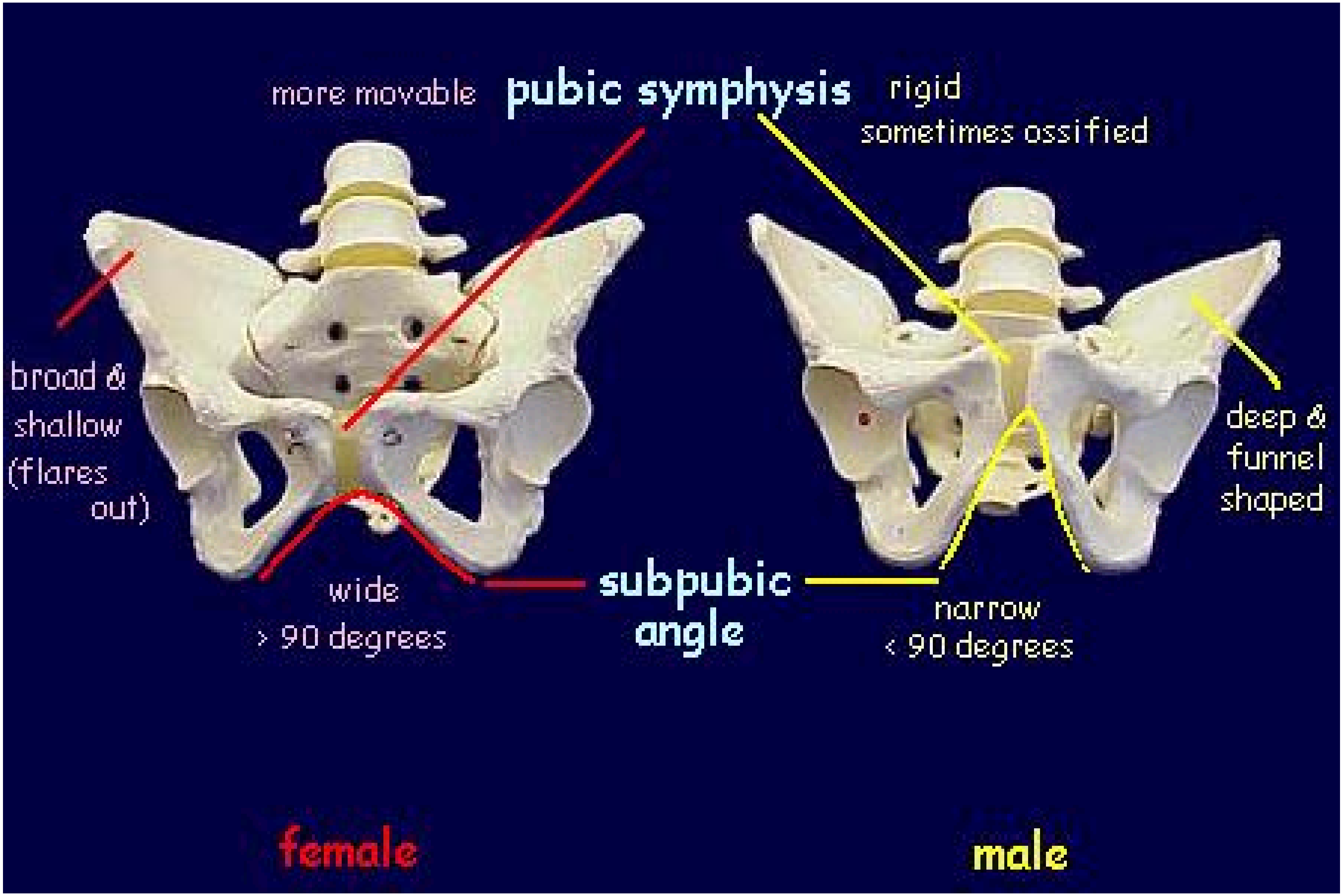
Subpubic Angle

– large in females

– narrow in males






more movable
pubic symphysis
rigid
sometimes ossified
broad &
shallow
(flares
out)
deep &
funnel
shaped
wide
> 90 degrees
subpubic
angle
narrow
< 90 degrees
female
male

Age determination

Two kinds of age determination

<25 years – estimates based on **developmental** changes

- Dental formation and eruption
- Bone growth
- Epiphyseal fusion

>25 years – estimates based on **degenerative** changes

Greater environmental influence (diet, exercise, pathology, lifestyle)

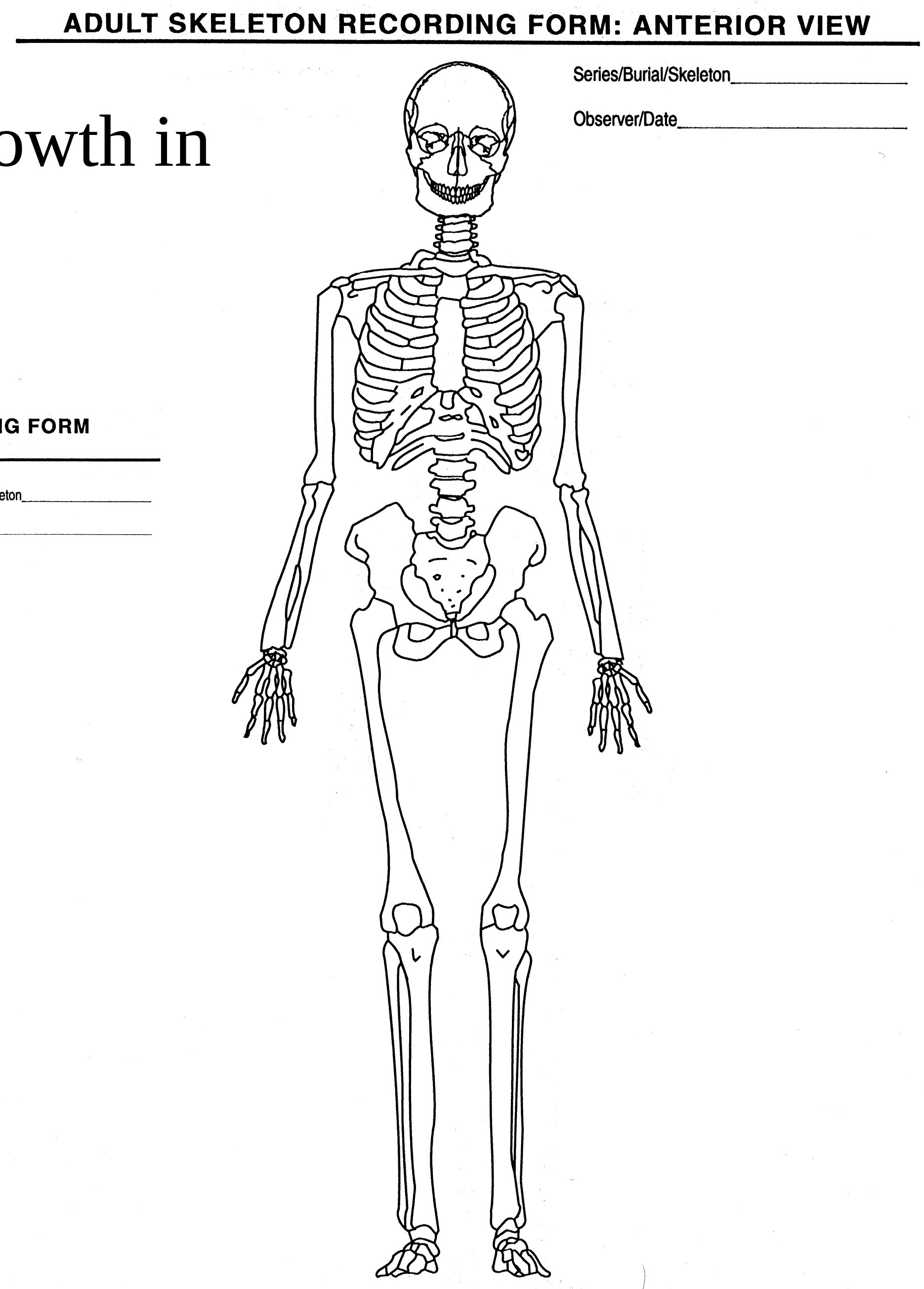
dental development
standard deviation given in months in parantheses
(scanned from White 1997:309)

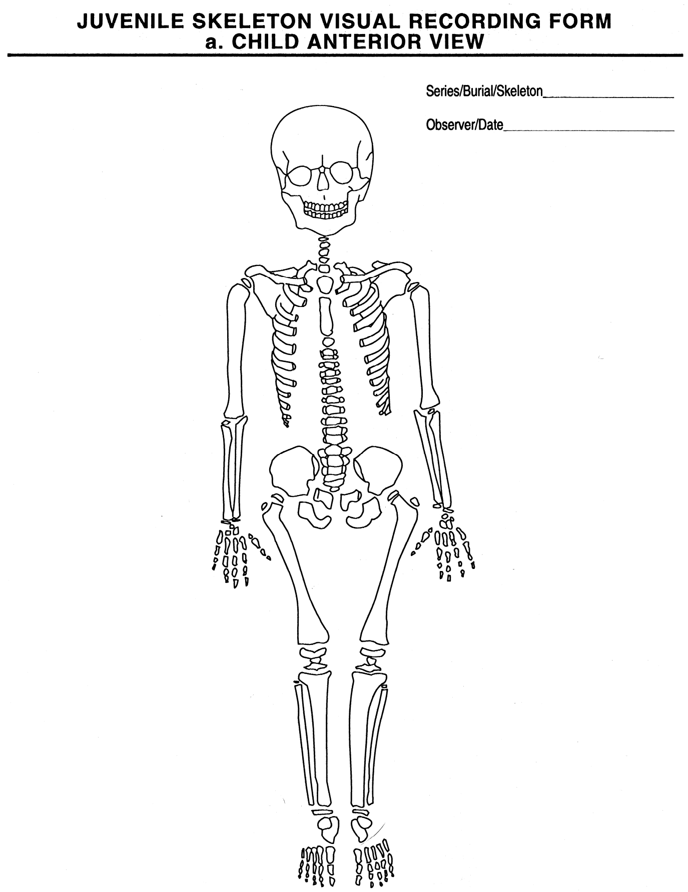
Dental information

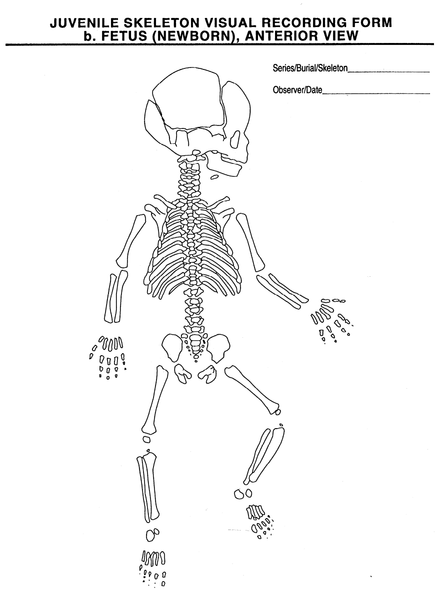
- the pattern and timing of crown formation and tooth eruption <u>is consistent among human populations</u>
- tooth formation begins during fetal development and continues through adolescence
- specific events are easily determined, such as eruption and replacement of the ‘milk teeth’ with permanent dentition
- sequence of eruption of permanent dentition
- patterns of wear on teeth of older individuals
- for these reasons teeth are especially useful in telling age in juveniles and sub-adults

Bone Growth

Long bone length – reflects growth in stature with increased age







Epiphyseal fusion

– appearance and fusion of *ossification centers*

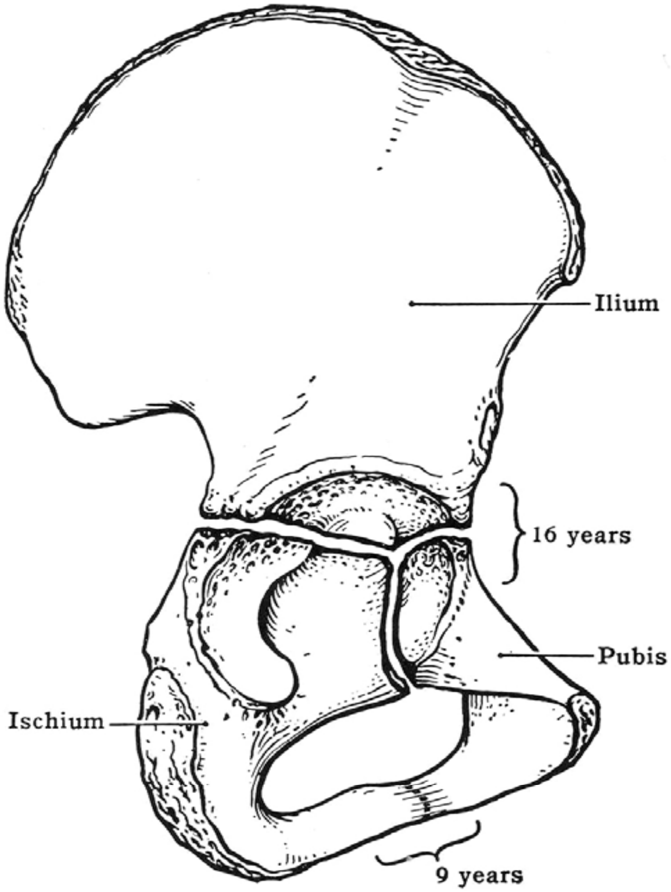
- Many bones form from multiple ossification centers
- Over time growth stops and epiphyses fuse
- Temporarily visible line / Eventually line is obliterated
- Schedules of epiphyseal fusion have been developed
- Known rates, useful between 10-25yrs

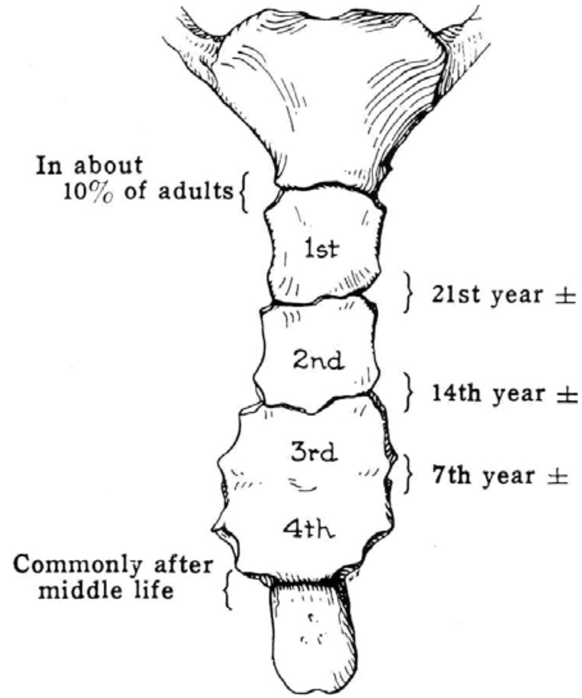
Epiphyseal fusion

– appearance and fusion of *ossification centers*

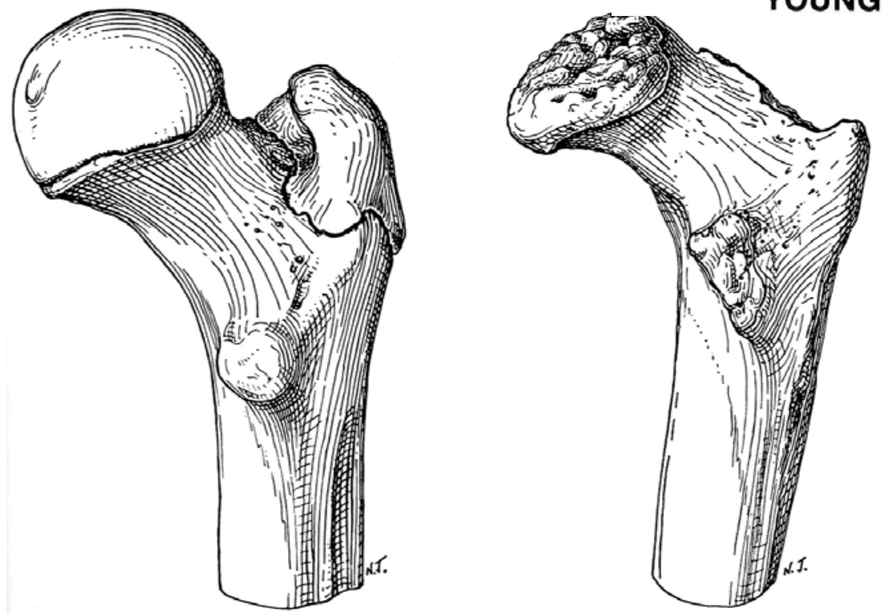
Example: Long bones are made up of a central shaft and two epiphyses (the ends that articulate with other bones)

- proximal (end nearest center of body) of the radius (forearm) completely fuses by age 19
- portions of the scapula (shoulder blade) do not fuse until age 23
- determining which bones are fused and which are not can narrow age ranges





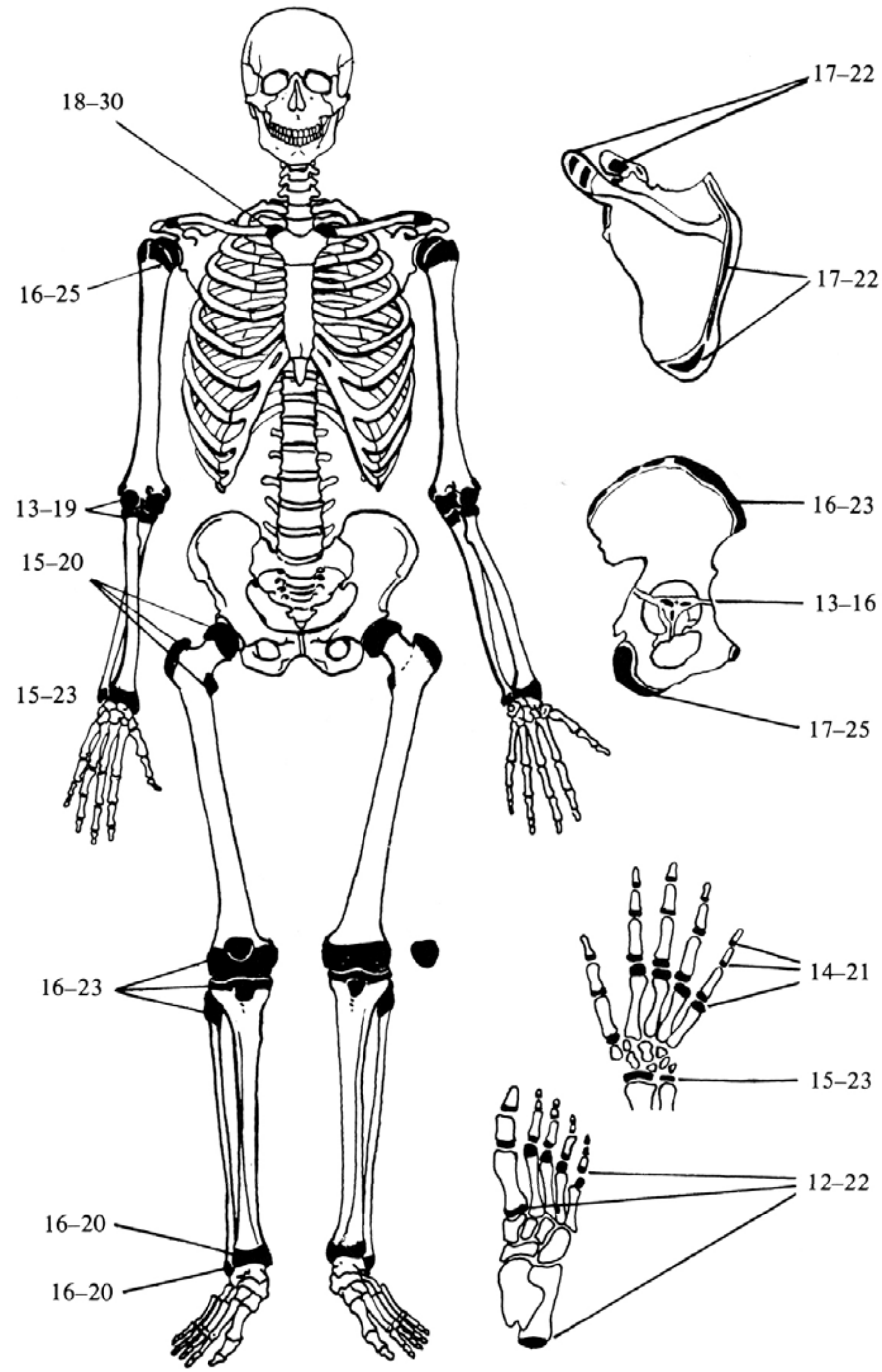
YOUNG STERNUM



EPIPHYSES AT THE PROXIMAL END OF THE FEMUR

A variety of epiphyses

Schedules of epiphyseal union

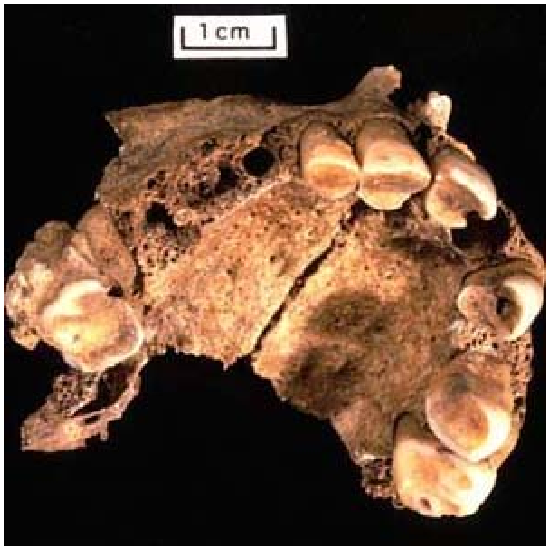


Most bones are fused and teeth erupted by age 25 - from this point on age can begin to be determined by wear in various parts of the body – degenerative changes

a. dental wear

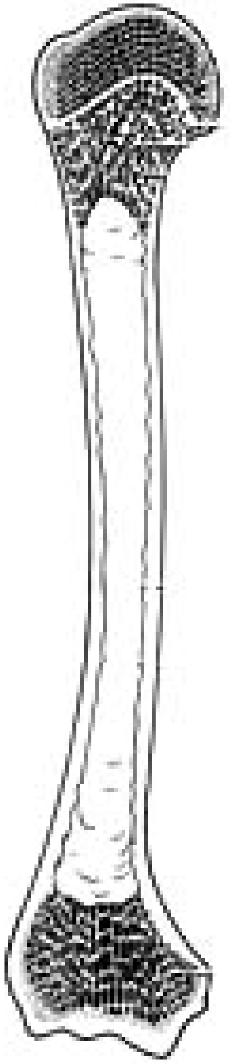
b. degenerative joint changes
- loss of bone
- new bone formation

c. decreases in cortical thickness



a

b



c

Stature

- Like sex and age, estimates of stature are based upon skeletal stature traits from historical and modern populations
- We use this data to work back to past populations
- Measurements of known height, body proportions, and the length of long bones in different populations are expressed in mathematical formulas that can be applied to bones from the archaeological record
- Race is a term no longer in favor with anthropologists, but it is clear from the archaeological record that populations that maintain some level of reproductive isolation from other populations may possess traits that make them distinctive

Stature

- many possess traits that make them distinctive from other populations
- due to the fact that skeletal characteristics are inherited and follow the rules of genetics, skeletal traits seem to be statisically significant for specific geographic regions and populations
- In order to see this however you need a wide sample of a population to *infer* specific charateristics for the population group
- we use a combination of metric (measurable) and non-metric (observable) skeletal traits to determine specific population groups

Nutrition

- Nutrition is increasingly of interest to bioarchaeologists
- Understanding what ancient populations ate and how this affected their health is dependent upon how humans interacted with their environment
- Whether they favored specific agricultural crops, were dependent upon meat (hunted or domesticated), or were largely dependent upon sea food resources tell us a great deal about the population
- In understanding nutrition, bioarchaeologists use a variety of techniques, including the analysis of specific traits on the skeleton, as well as increasingly chemical analysis of the bone for clues to specific diets

Health and Diet

- the general health of a population is often directly related to diet
- scarcity of food, or variation which reduces specific types of food can lead to noticable patterns in skeletal stature
- nutritional deprivation, such as specific vitamin deficencies and other nutritional stress leave evidence in the skeleton as well, sometimes in very specific clues
- malnutrition (chronic food and nutrition shortages) were not uncommon in the past
- we have both historic and artistic evidence of this, which can also support our understanding of the human archaological record

Famine as depicted in ancient records

- Many cultures have written and art records which record famine or food shortage in the past
- Some of the earliest examples come from the Old Kingdom (the pyramid age) in Egypt, where reliefs show starving Egyptians

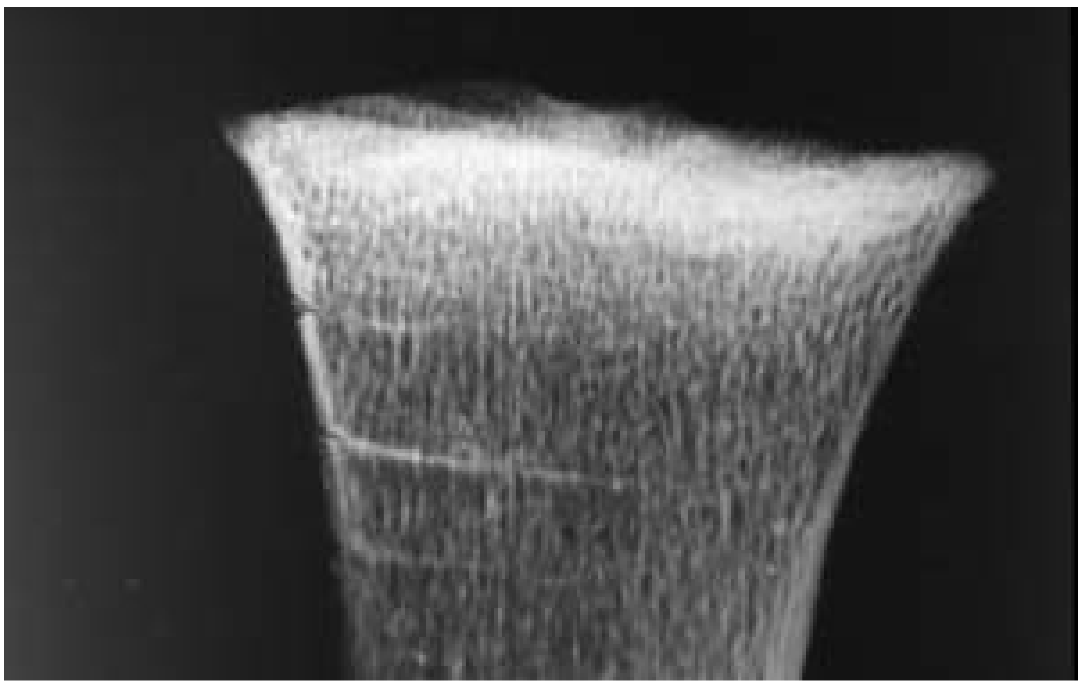
Paleonutrition: study of the nutritional (in)adequacy of a past population's diet

Poor nutrition results in:

- retarded growth
- delayed maturation
- diminished stature
- increased susceptibility to infection
- several nutrient-deficiency syndromes which produce characteristic skeletal abnormalities

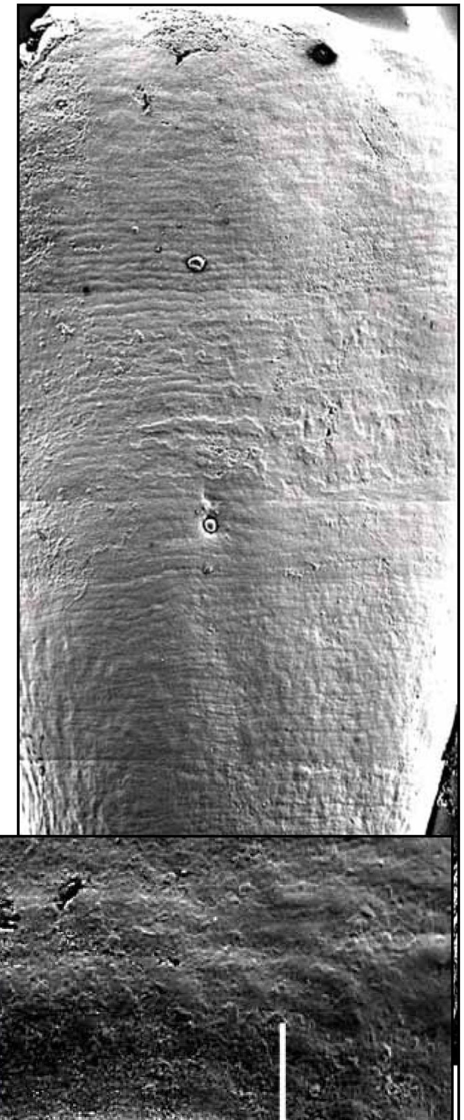
Retarded growth: Harris lines

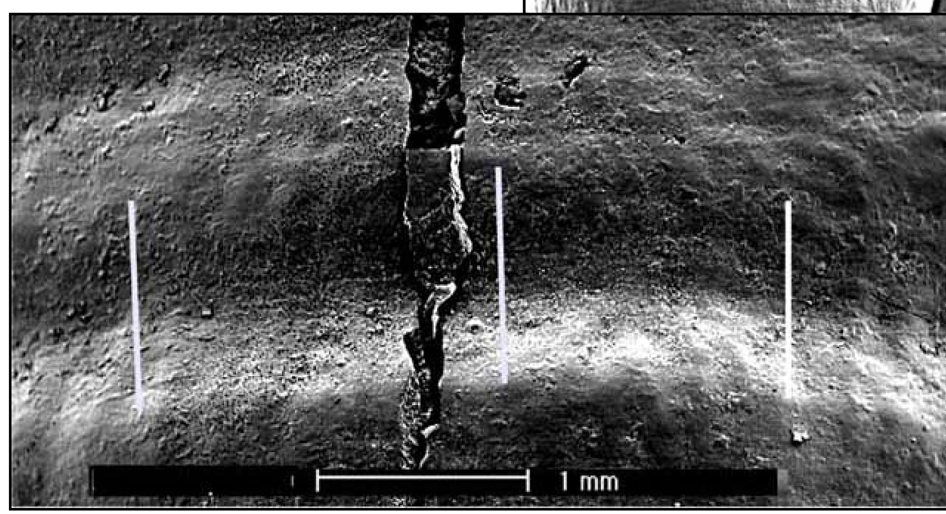
- growth arrest lines
- Dense lines parallel to the growth plates of long bones on radiographs, representing temporary slowing or cessation of longitudinal growth
- this is usually indicative of nutritional ‘stress’ caused by malnutrition



Retarded growth: Dental hypoplasias

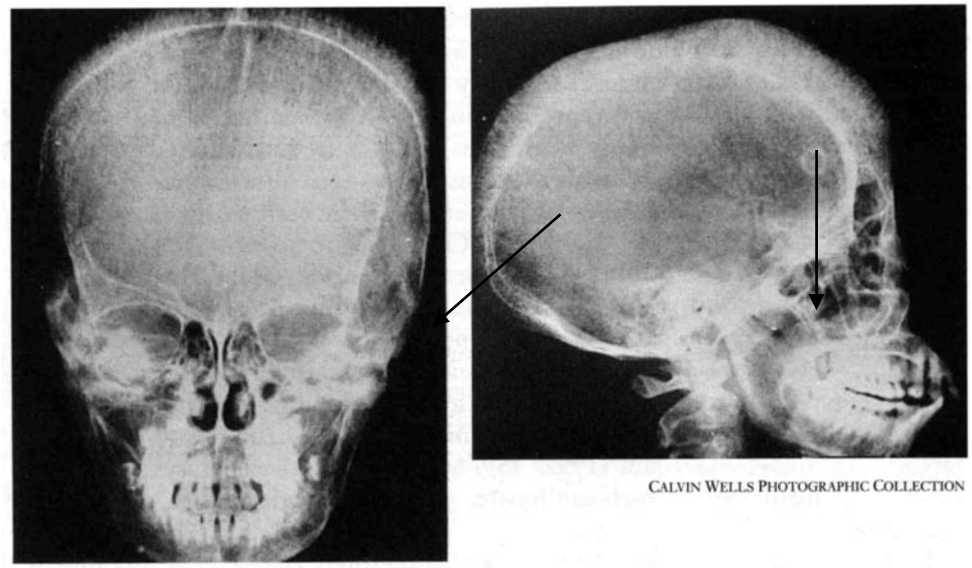
- Counting the number of linear *enamel hypoplasias* allows one to estimate the period of time during which enamel growth was disrupted due to stress



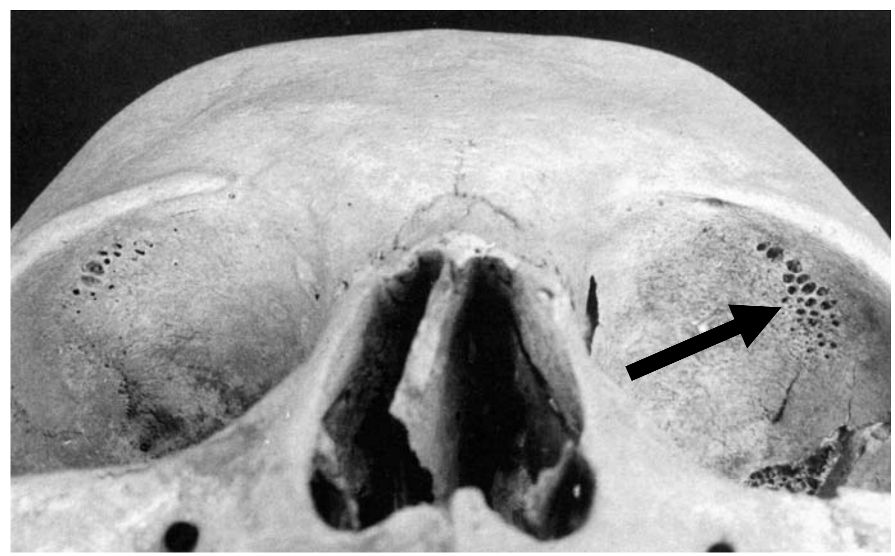


Nutrient-deficiency syndromes: Iron Deficiency (Anemia)

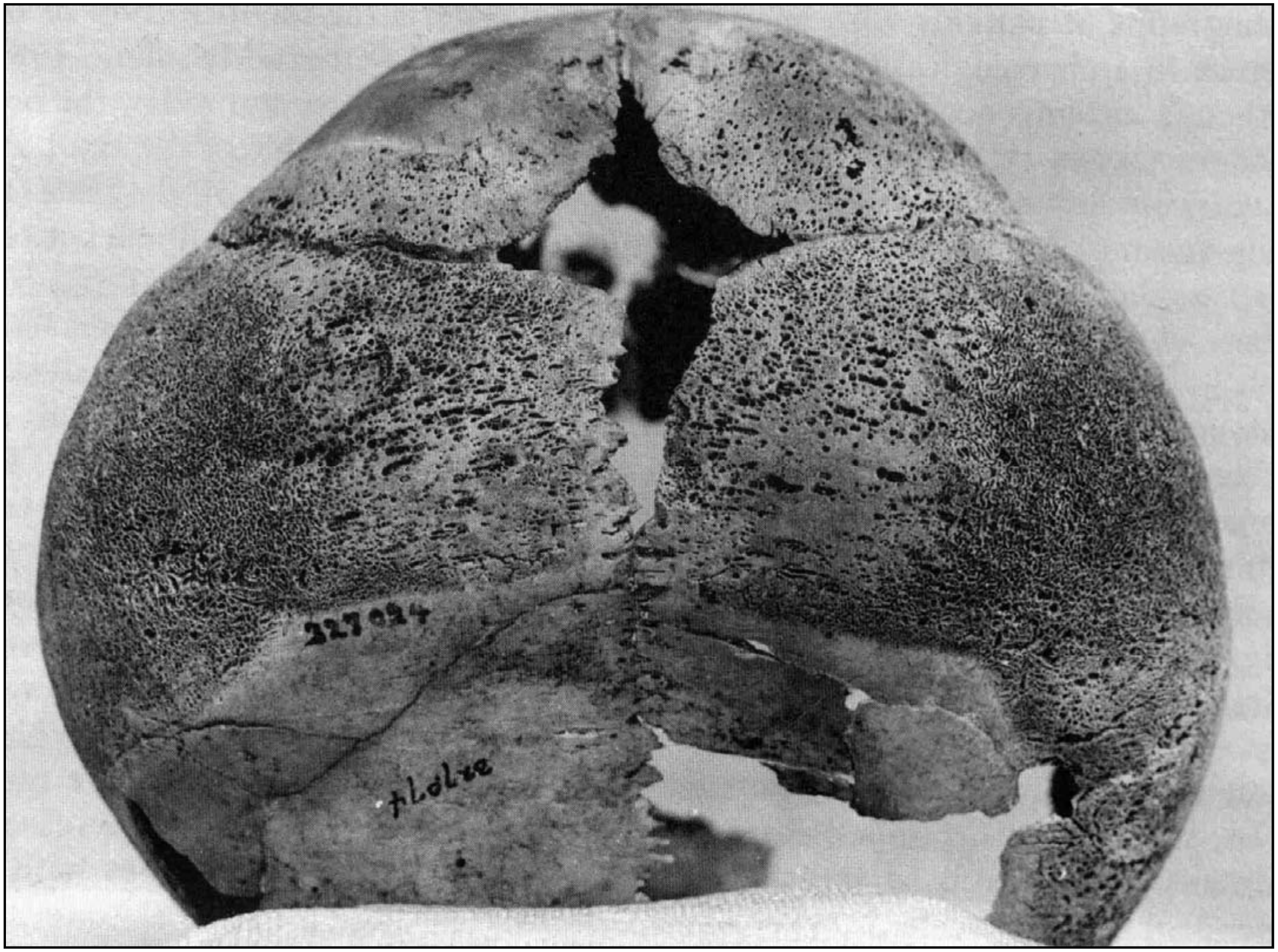
Characteristic 'hair-on-end' appearance, and thinning of compact bone


CALVIN WELLS PHOTOGRAPHIC COLLECTION

Cribra orbitalia: a porotic hyperostosis (porous bone growth) likely caused by iron deficiency



Porotic Hyperostosis (porous bone growth) likely caused by iron deficiency



Nutrient-deficiency syndromes: Scurvy

- Vitamin C deficiency leads to a defect in the formation of bone matrix as it is necessary for formation of hydroxyproline, which is vital for collagen
- About 90% of matrix of mature bone is collagen and hence a lack of collagen will have severe effect on bone formation
- Skeletal symptoms of scurvy include the re-absorption of bone around the teeth
- lack of vitamin C has been a chronic problem in past populations
- most humans get their vitamin C from fresh fruits and vegetables
- in artic regions where humans subsisted largely upon meat and fish, vitamin C came from eating uncooked meets, as well as whale blubber and skin

Nutrient-deficiency syndromes: Scurvy

Nutrient-deficiency syndromes: Rickets

- Vitamin D deficiency
- Characteristic bowing of legs
- 'Trumpet-shaped' appearance of long bones

Diet Reconstruction

There are a variety of aspects of the skeletal biology which infer back to diet

- caries
- meat vs. plant foods
- stable isotopes

Abundance of sugar or starch in the diet

- *Streptococcus mutans*, one of the hundreds of species of microorganism that lives in our mouths, consumes sugar and produces lactic acid as a waste product
- The acid etches tooth enamel, causing caries (the technical term for cavities)
- More sugar (or starch, which is converted to sugar by an enzyme in saliva) in the diet leads to more growth of these microorganisms, and hence more caries

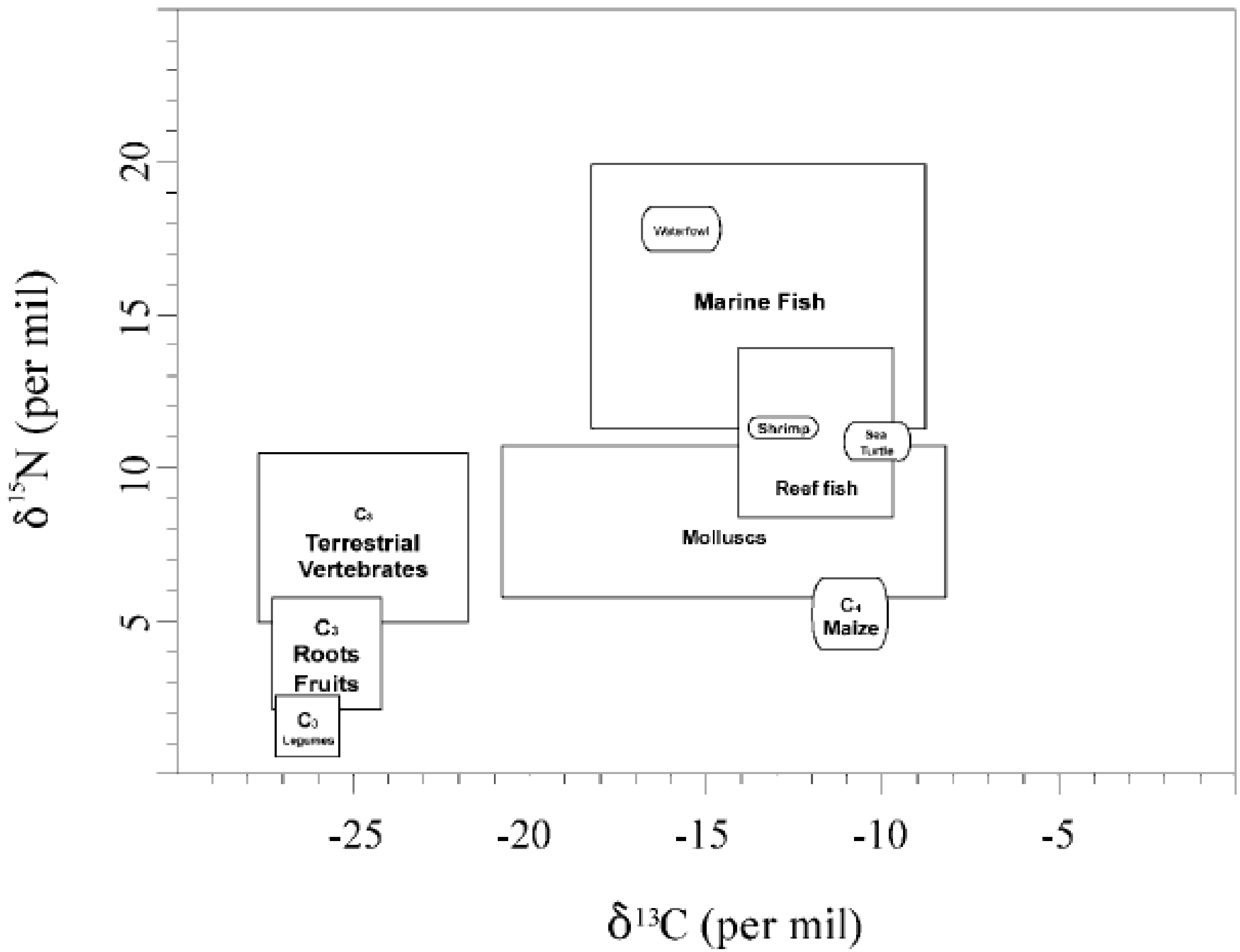
Meat vs. plant food

- Trace element analyses (neutron activation analysis, principally) are used to determine the ratio of strontium to calcium in bone mineral
- Higher ratios = more meat in diet
- By comparing the human Sr/Ca ratio to the ratios in local herbivores and carnivores, we determine actual percentage of human diet that was meat

Stable Isotopes

- ancient diets can also be reconstructed by analyzing the carbon and nitrogen stable isotopes preserved in human bones
- human bones will reflect the isotopic ratios of plants (and animals) ingested during life
- the two principle isotopes used are Carbon and Nitrogen
- bioarchaeologists analyze a bone’s stable isotope to determine its composition, which can infer which types of food are being consumed

Carbon *vs.* nitrogen isotope ratios in common New World food groups



Stable Isotope

Example: Maize in North America

- maize has different photosynthetic pathway than all native North American food plants
- it discriminates slightly in favor of heavier isotopes of carbon
- tissues of maize-eaters have different 13C/12C ratio (also called the the δ13C ratio) than the tissues of eaters of native North American plants
- The 13C/12C ratio of human tissue allows us to measure actual dietary % of maize

Disease and trauma

Includes a range of infectious and degenerative diseases and injury ('trauma')

Mass graves

English civil war – “Roundhead” burial pit at York

Viking/Saxon massacre pit at Weymouth
Mass-beheadings


Blunt force trauma

Trauma

Egyptian battle axe and
Hyksos sword

Head of Pharaoh Sekenenre

Thebes and Avaris conflict

Disease

Acute infection – recovery/death within a matter of days

No evidence on bone (e.g., flu virus)

Chronic infection – ‘subacute’, long term infections

Will leave evidence on bone

Tuberculosis

Mycobacterium tuberculosis

- Mainly thoracic and lumbar vertebrae (<4)
- 1^{o} identified by lesions on the vertebral column
- Pott's disease (tuberculosis spondylitis), inter-vertebral disc tissue death leading to disc collapse
- Hip and knee joints also affected

Treponemal Infections

- Endemic Syphilis, Venereal Syphilis
- Caused by spirochete bacteria from the genus *Treponema*
- Distinguished by frequency of bone involvement, age at onset, and geography

Treponema spirochete

Saber shin

Venereal Syphilis

Approx. 10-12% exhibit skeletal lesions

1º, 2º, and 3º stages (final stage – skeletal involvement) – tibia, knee joint

Classic lesions on skull – ‘Caries sicca’

Leprosy

Mycobacterium leprae

- ➢ Slow developing disease
- ➢ Probably spread from person to person via respiratory droplets
- ➢ Possibly skin-to-skin contact from an ulcerated, infected lesion

- Characteristic deformity and loss of fingers and toes
- Slow resorption of hands and feet