Anthro 101:
Human Biological Evolution

Lecture 13: Early Hominins

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Biological Anthropology

Orangutan

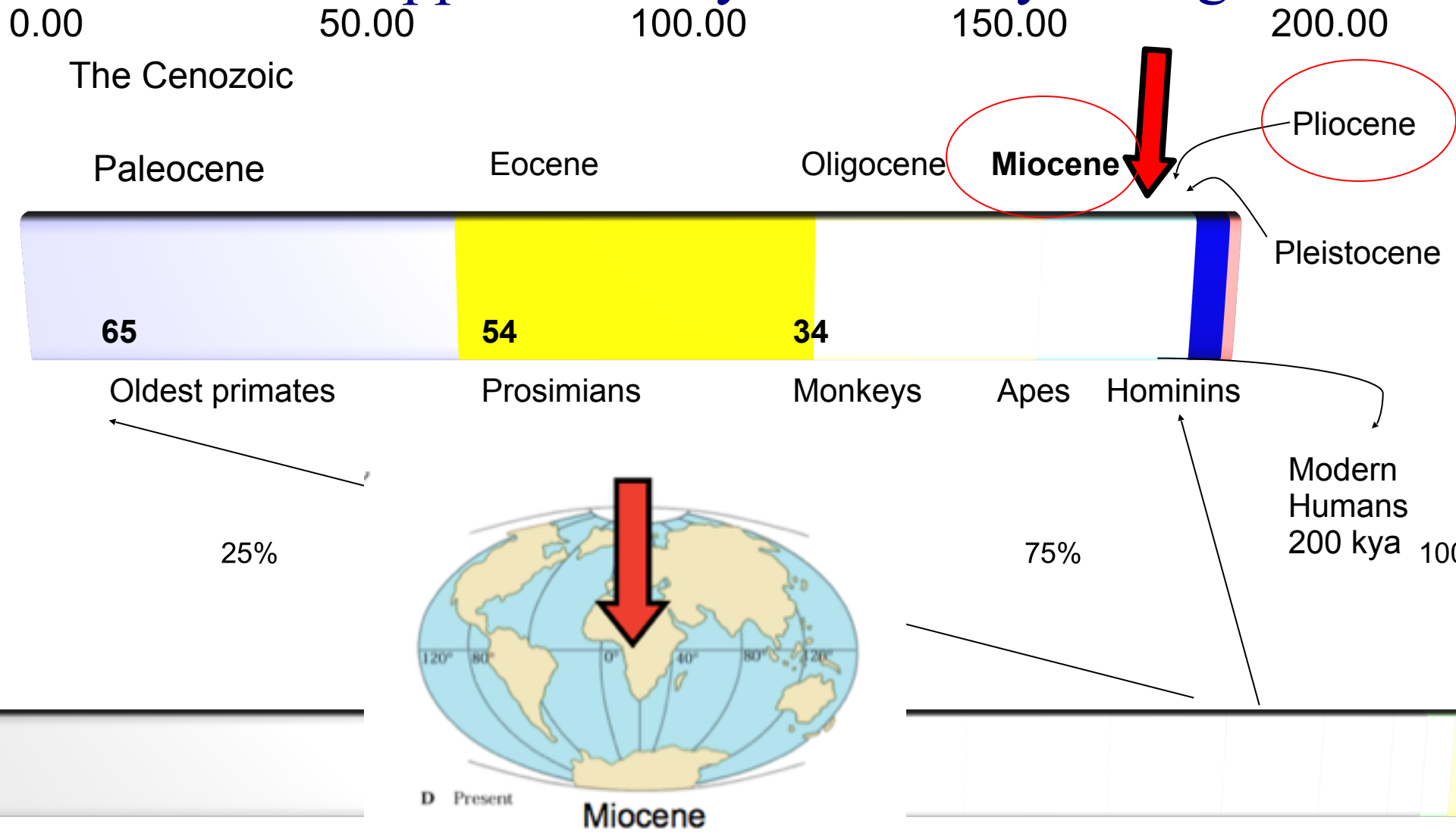
- Hominoid = Apes
  - Humans, Gorillas, Chimpanzees, Orangutans, Gibbons and Siamangs

Australopithecine

- Hominin = Bipedal Apes
  - Australopithecines, Paranthropines, genus *Homo*, including *Homo sapiens* (modern humans)

- Homo = any species in the genus Homo
  - Represent a different grade than earlier species, mor similar to modern humans

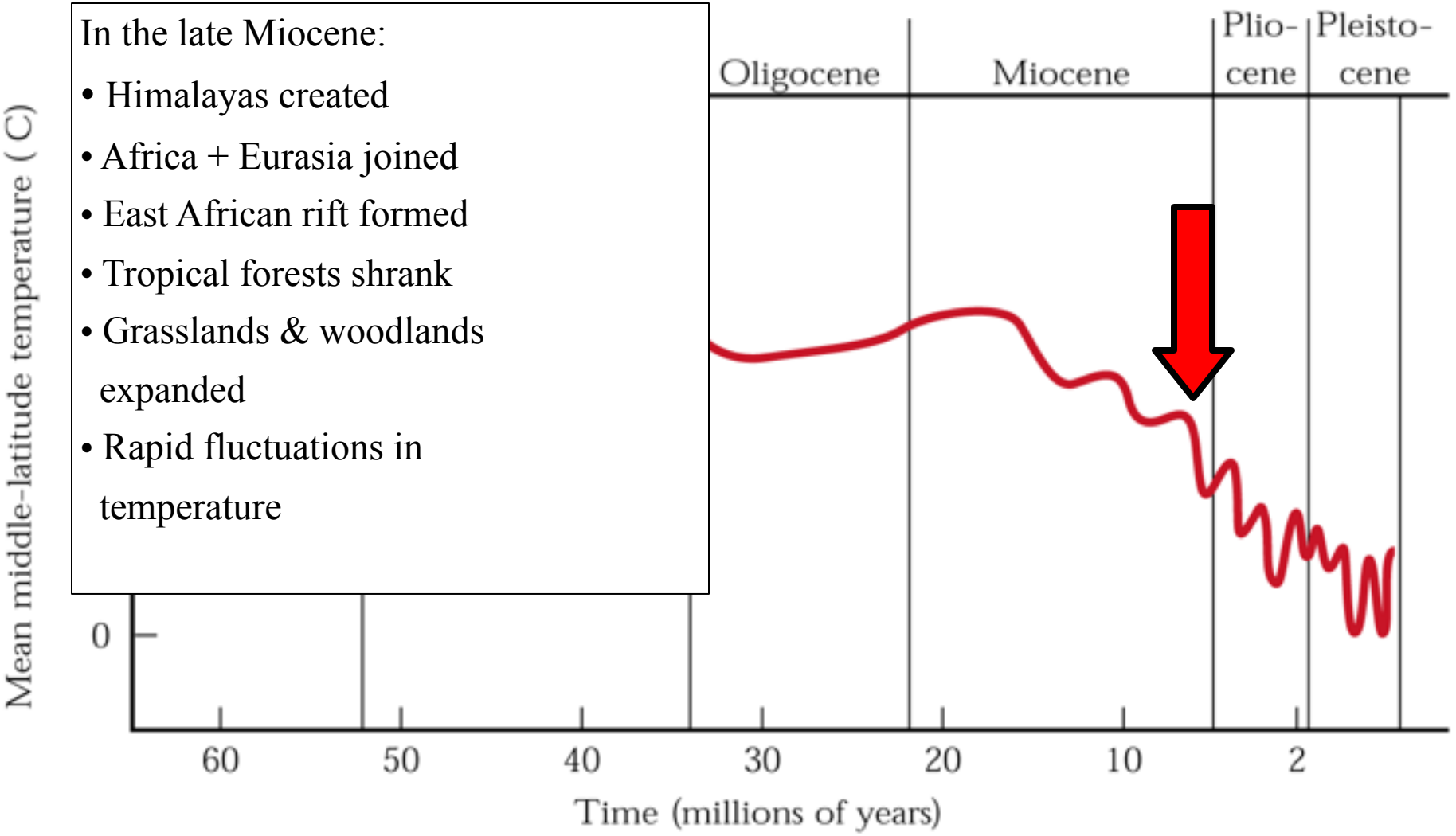
The hominin lineage diverged from hominoid ancestors approximately 7 million years ago



The hominin lineage diverged from hominoid ancestors approximately 7 million years ago

In the late Miocene:

- Himalayas created
- Africa + Eurasia joined
- East African rift formed
- Tropical forests shrank
- Grasslands & woodlands expanded
- Rapid fluctuations in temperature



Check This Out

- http://humanorigins.si.edu/evidence/human-evolution-timeline-interactive

The very early hominins represent an adaptive shift

1. **Natural selection favored ability to move around bipedally**
   - bipedal, but lived in forest or woods
   - probably spent a lot of time in trees
   - Bipedality evolved when hominins diverged (7 - 6 mya)
   - Well adapted

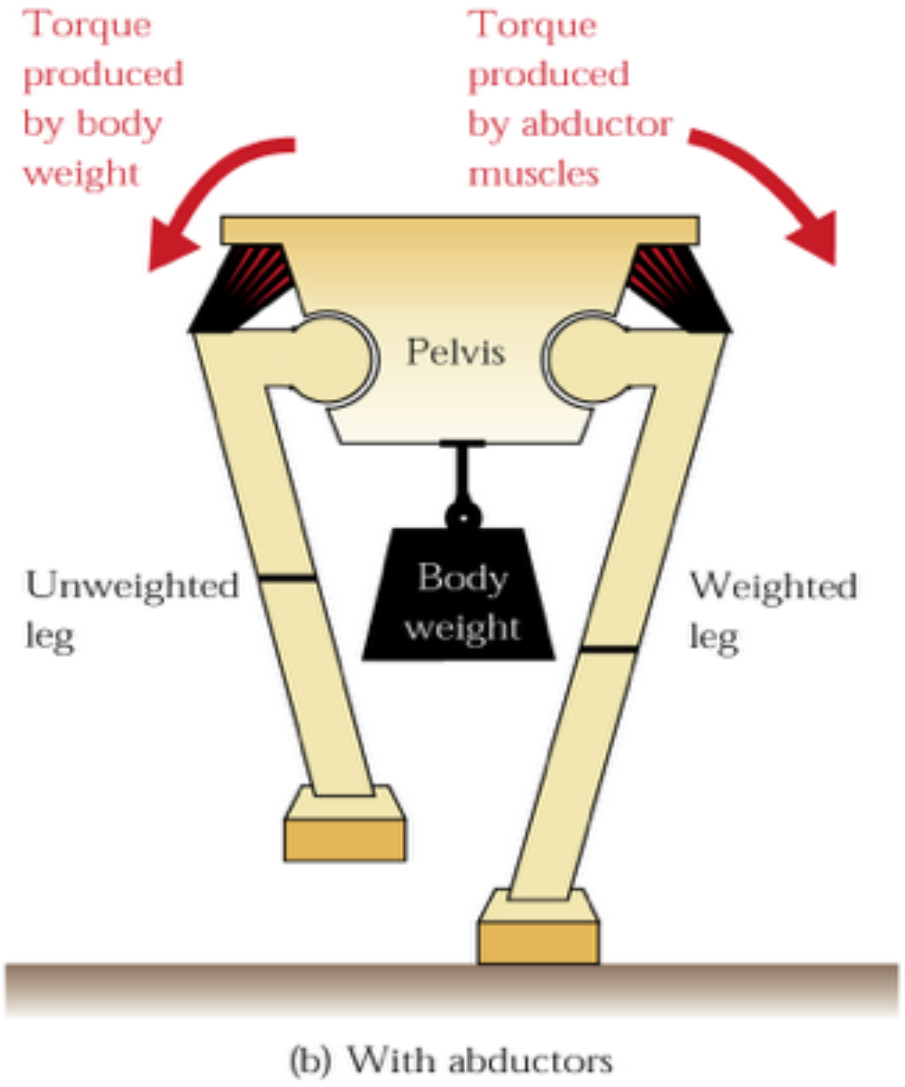
2. **Brain size & intelligence very ape-like**
   - Big brains evolved much later
   - Size shifts often just tracking changes in body size

3. **Males & females sexually dimorphic**
   - Multi-male multi-female type mating system is likely

Why don't we fall over?

- Falling is opposed by abductor muscles
- Abductors tighten each step, hold body upright
- Abductors attach the ilium on top of pelvis to the femur

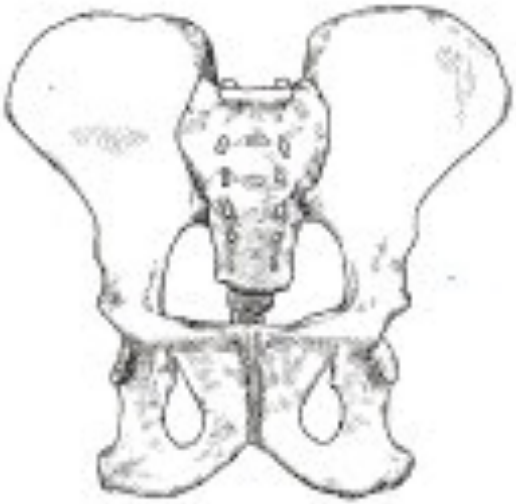
- **Wider, thicker ilium and longer neck of femur increase surface area for muscle attachment**



Changes in the pelvis

Chimpanzee pelvis

- Long and narrow
- Thin ilium
- Powerful hamstring and quadruceps
- Organs hang below



(c) Chimpanzee

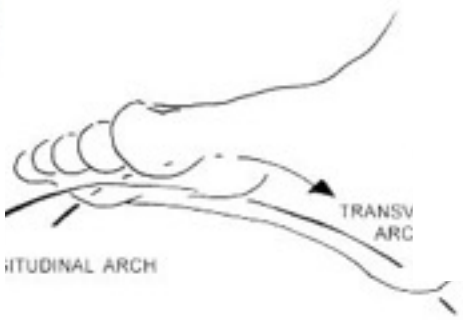
Human pelvis is a bowl

- Centers weight over one foot while walking
- Supports internal organs
- Short and broad ilium
- Abductor muscles attach to wide surface of ilium

(a) Human

Other Skeletal changes associated with bipedal walking…

- S-shaped spine
- Centered foramen magnum
- Femur angled in to close knees
- Arched, rigid foot and big toe in-line with other toes



What is (are) the adaptive advantage(s) of bipedality?

1. Hands free to carry things
2. Efficient way to travel
3. Efficient for foraging from small trees
4. Keep cool in open savannah

Benefits of bipedality: Efficient travel

- more efficient than knuckle-walking over long distances

- Colder, drier world, receding forest areas
  - Cover open ground to reach foraging sites
  - Maintain larger groups
    - Safety from predators
    - Better competition vs. other groups

Benefits of bipedality: Foraging Efficiency

Foraging efficiency ==> Bipedal standing while foraging

- Better able to reach of ripe fruits
- Shuffle from one branch to another
- Chimps, baboons already do this

Early hominins show a mixture of adaptations

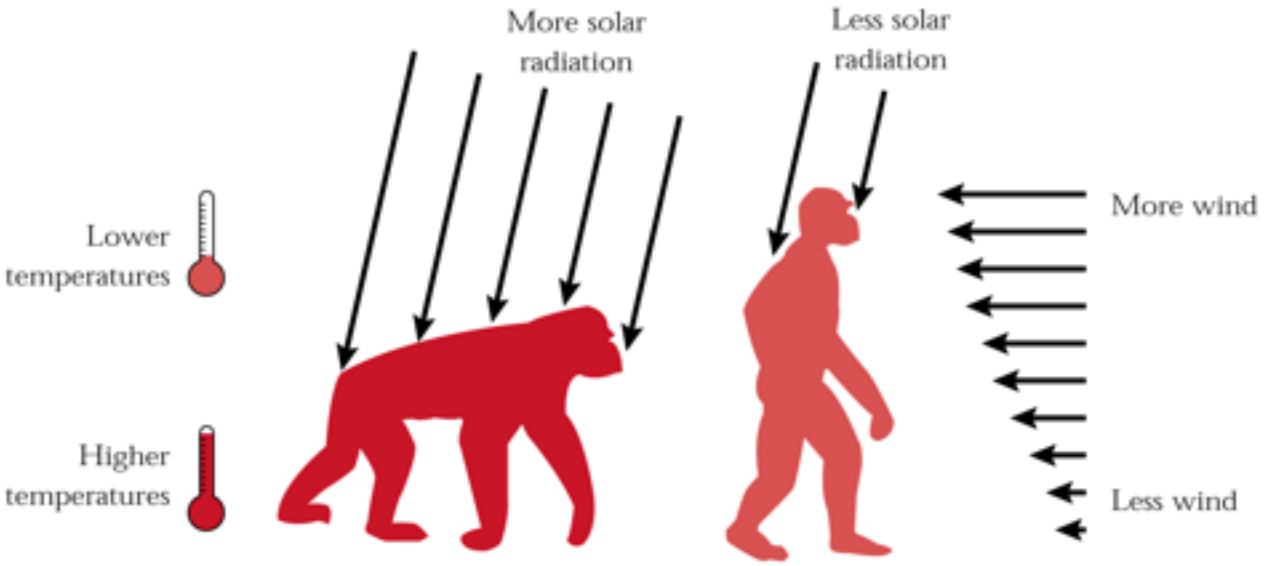
- Bipedal walkers
- Upper bodies like apes
  - Spent time in trees as well

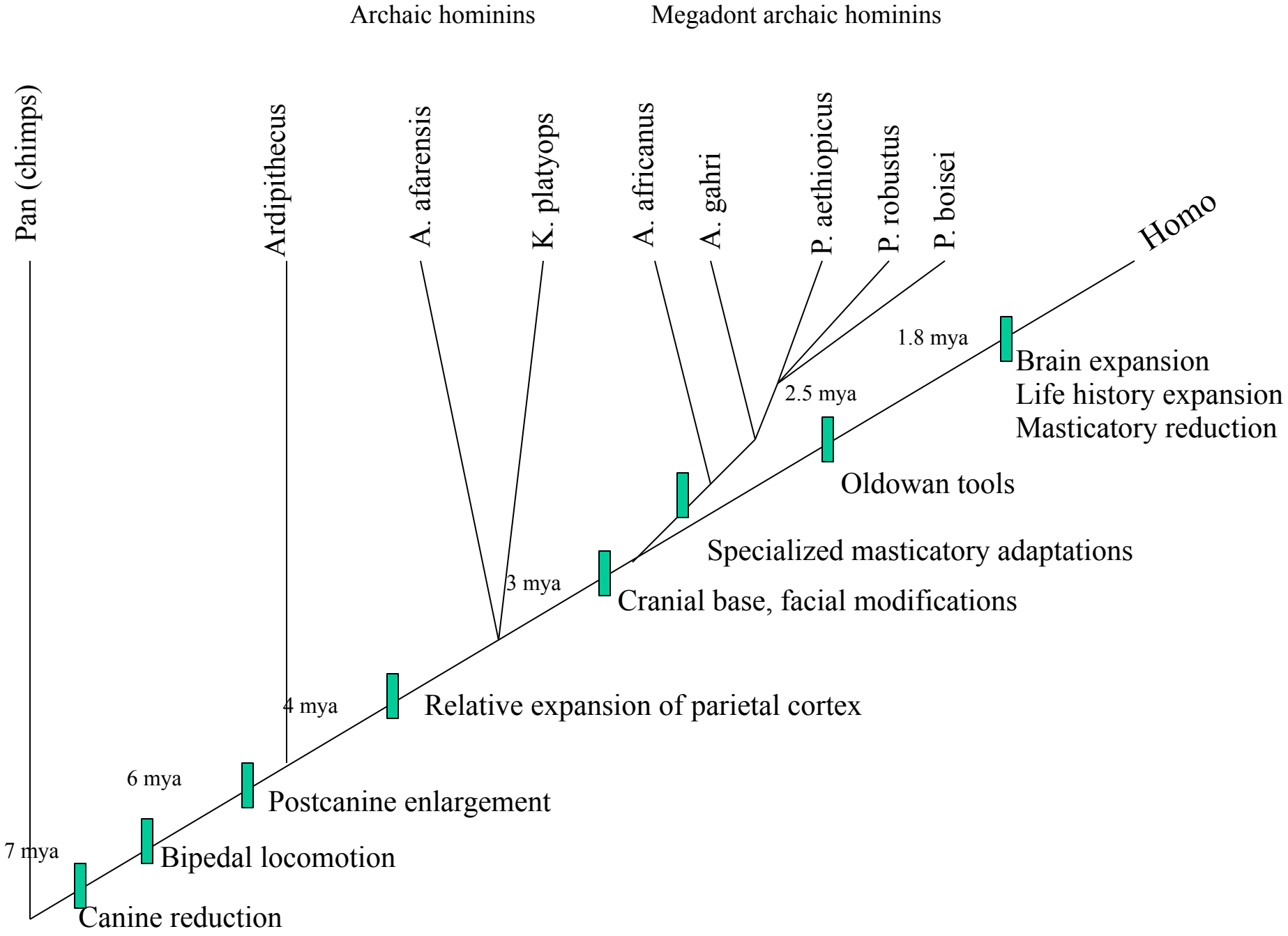
Benefits of bipedality: Keeping cool

- Savanna hot during day = best time to avoid predators
- Less surface area exposed to sun
- Sweat allows cooling + wind increases cooling
  - Cooler higher above ground
  - More wind higher above ground
- Hair loss improves effects of wind cooling, need less water

BUT…

first bipedal hominins likely lived in mixed woodland & forest




Archaic hominins
Megadont archaic hominins
Pan (chimps)
Ardipithecus
A. afarensis
K. platyops
A. africanus
A. gahri
P. aethiopicus
P. robustus
P. boisei
Homo
1.8 mya
Brain expansion
Life history expansion
Masticatory reduction
2.5 mya
Oldowan tools
Specialized masticatory adaptations
3 mya
Cranial base, facial modifications
4 mya
Relative expansion of parietal cortex
6 mya
Postcanine enlargement
7 mya
Bipedal locomotion
Canine reduction

Ardipithecus

- Found in Ethiopia
- First specimens found in early 1990s, major findings released in October 2009
- Two species:
  - *Ardipithecus kadabba*: 5.6 mya
  - *Ardipithecus ramidus*: 4.4 mya ("Ardi")
- Habitat = **Closed canopy forest**

- http://www.discovery.com/tv-shows/other-shows/videos/ardipithecus-discovering-ardi-how-ardi-walked.htm

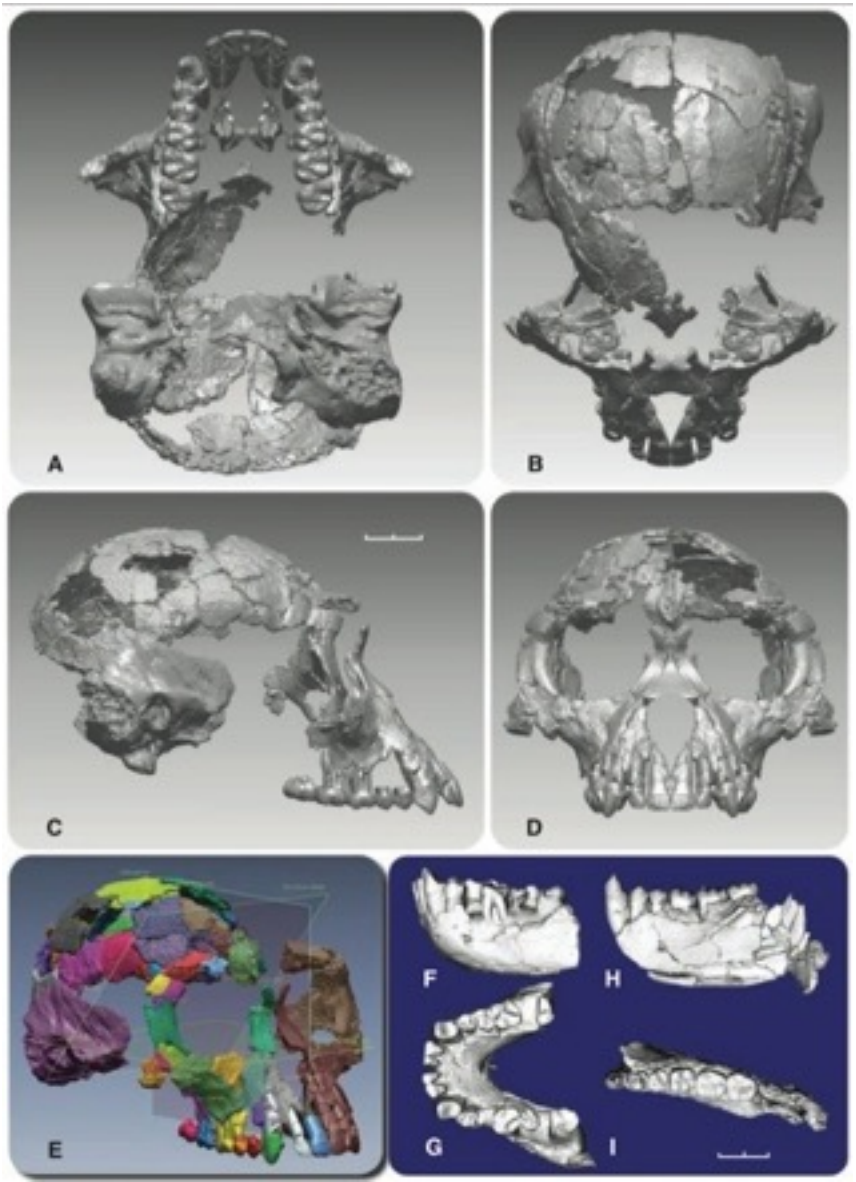
A. ramidus is a mix of ancestral and derived traits

Ancestral features

- Chimp-sized brain
- Subnasal prognathism

Derived features

- Omnivorous teeth
- Little canine dimorphism
- Flexibly bipedal & quadrupedal
  - Forward position of foramen magnum



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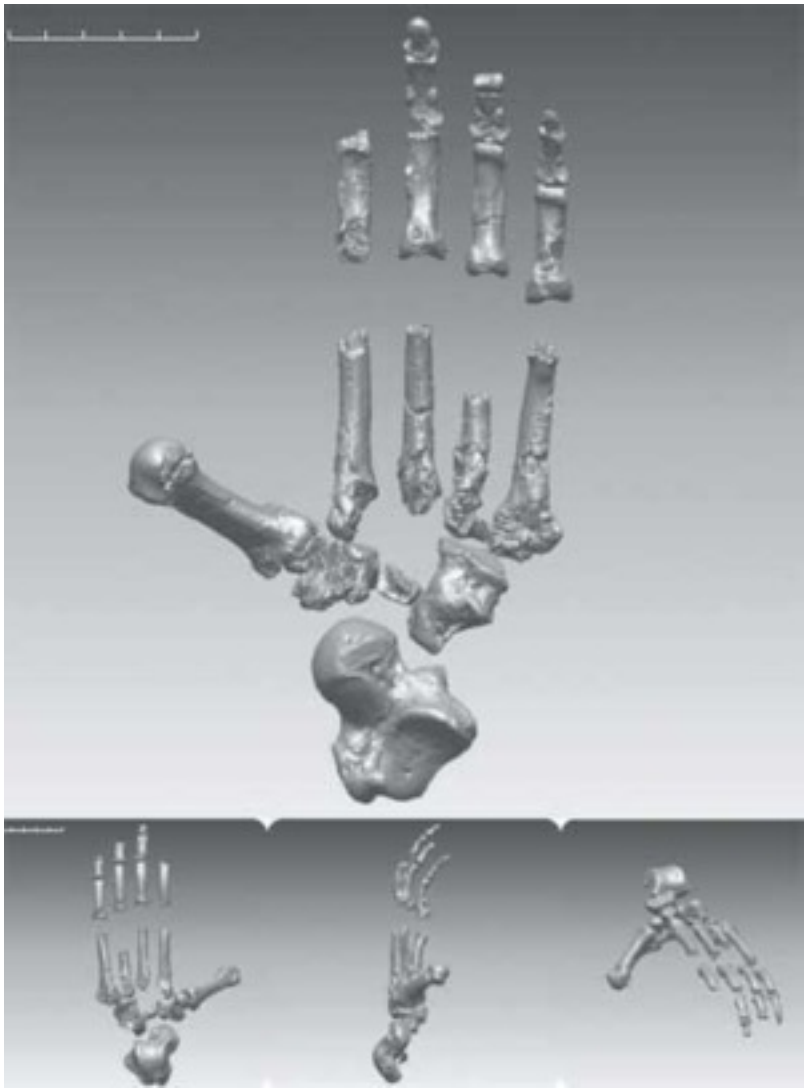
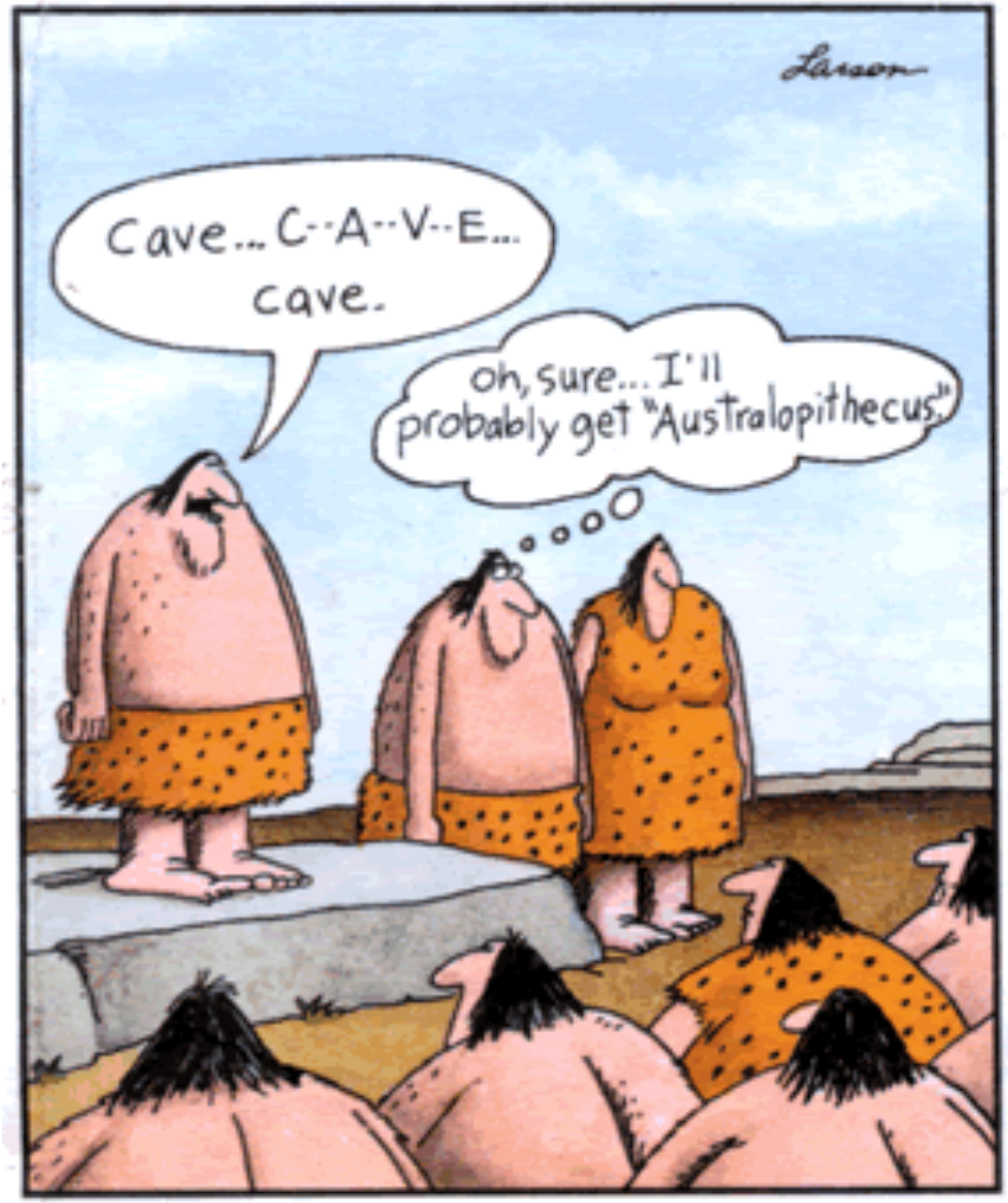
- Little canine dimorphism
- Flexibly bipedal & quadrupedal
  - Forward position of foramen magnum
  - Opposable big toe



Questions

- What is a Hominin?
- Why is important that our ancestors became bipedal
- What could have caused this change?
- Is bipedality an adaptation?
  - explain

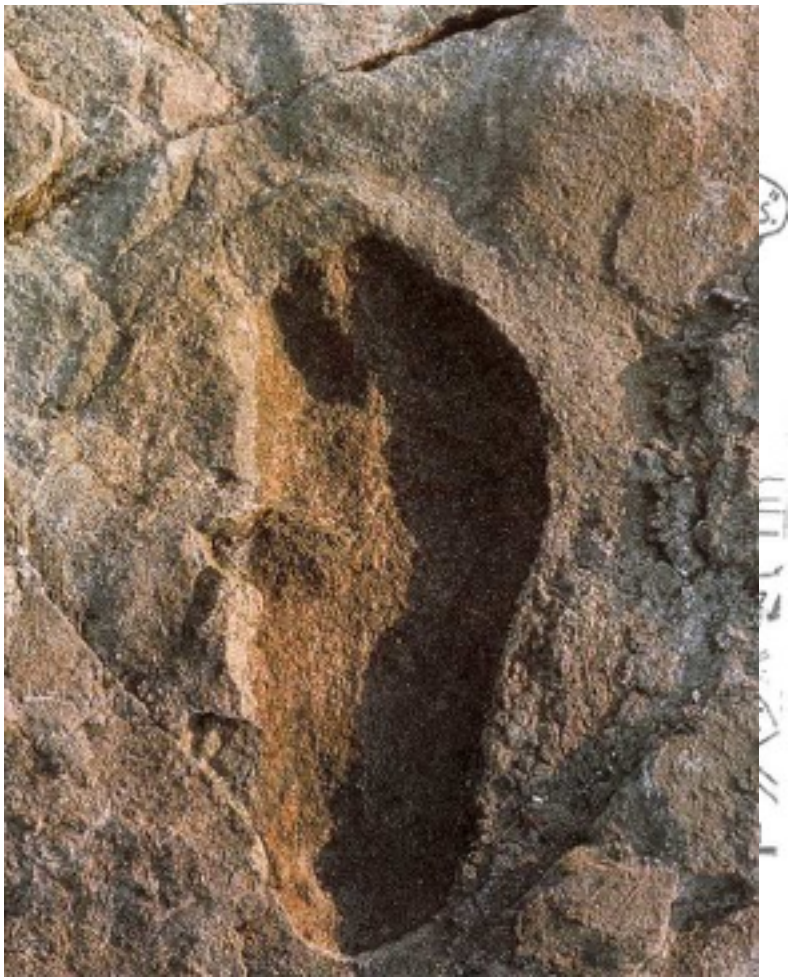
The Australopithecines



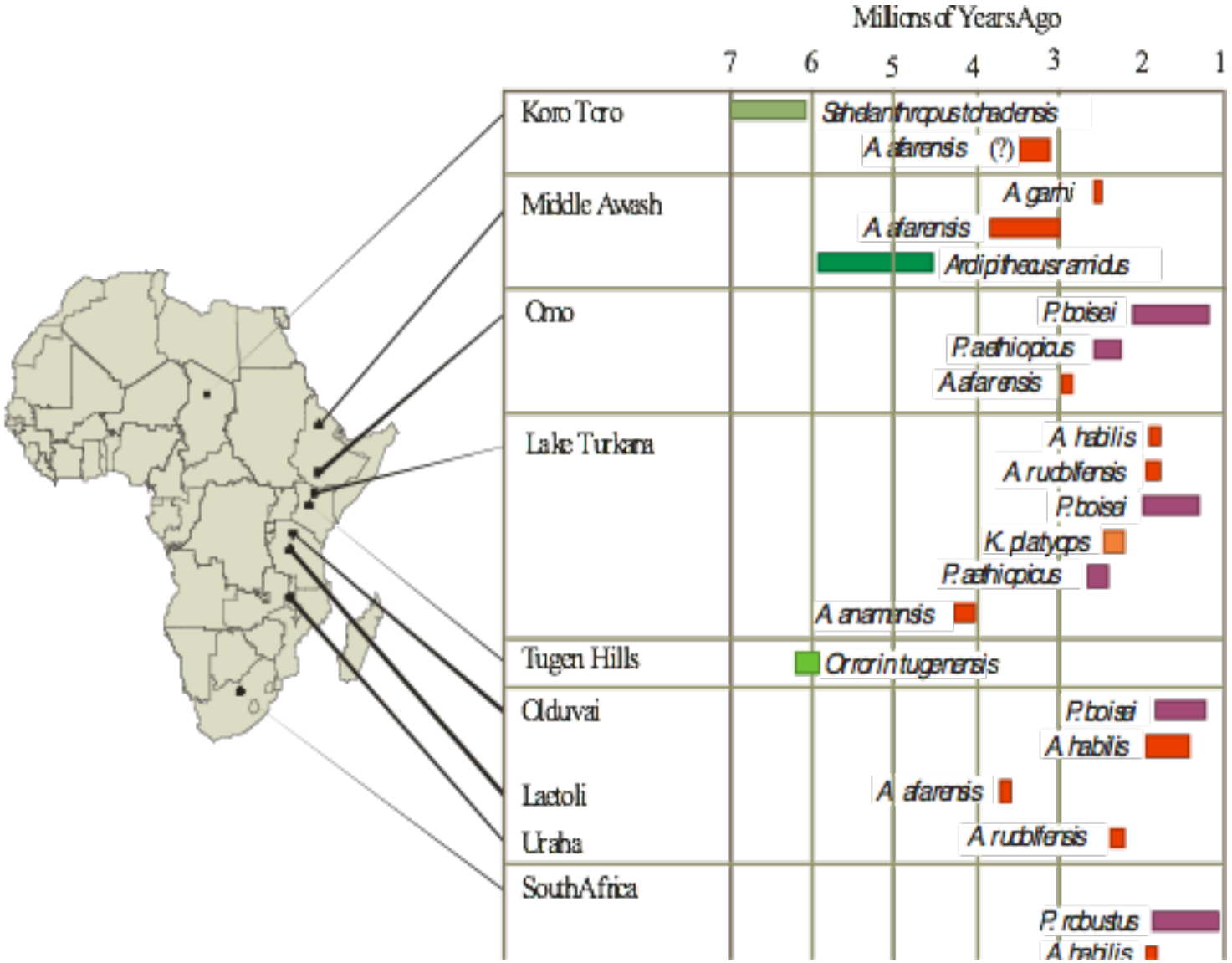
Primitive spelling bees

4 - 2 MYA bipedal apes ventured out of the forest and the hominin community diversified

- ***Australopithecus***
  - 4 - 6 species known
  - ape-like prognathic face
  - **adapted to generalized diet**
  - fast development
- ***Paranthropus***
  - 3 species known
  - ape-like prognathic face
  - **adapted to hard food diet**
- 4 – 7 species coexisted



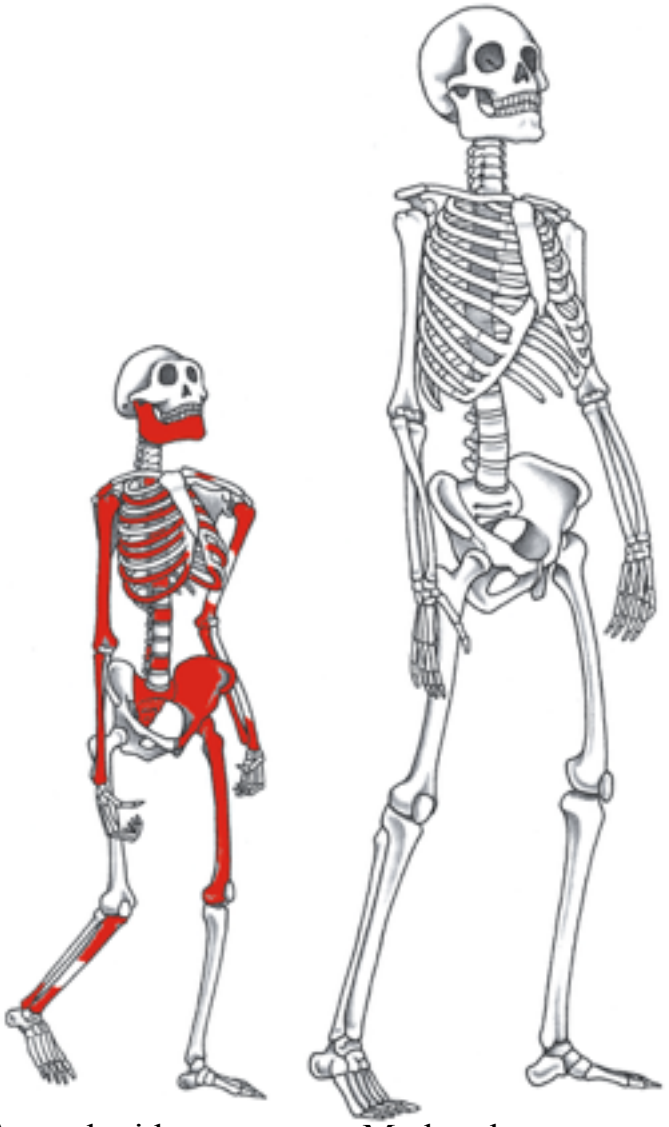
Australopithecines ranged across Africa



- https://www.youtube.com/watch?v=gN_ulMJMgNU

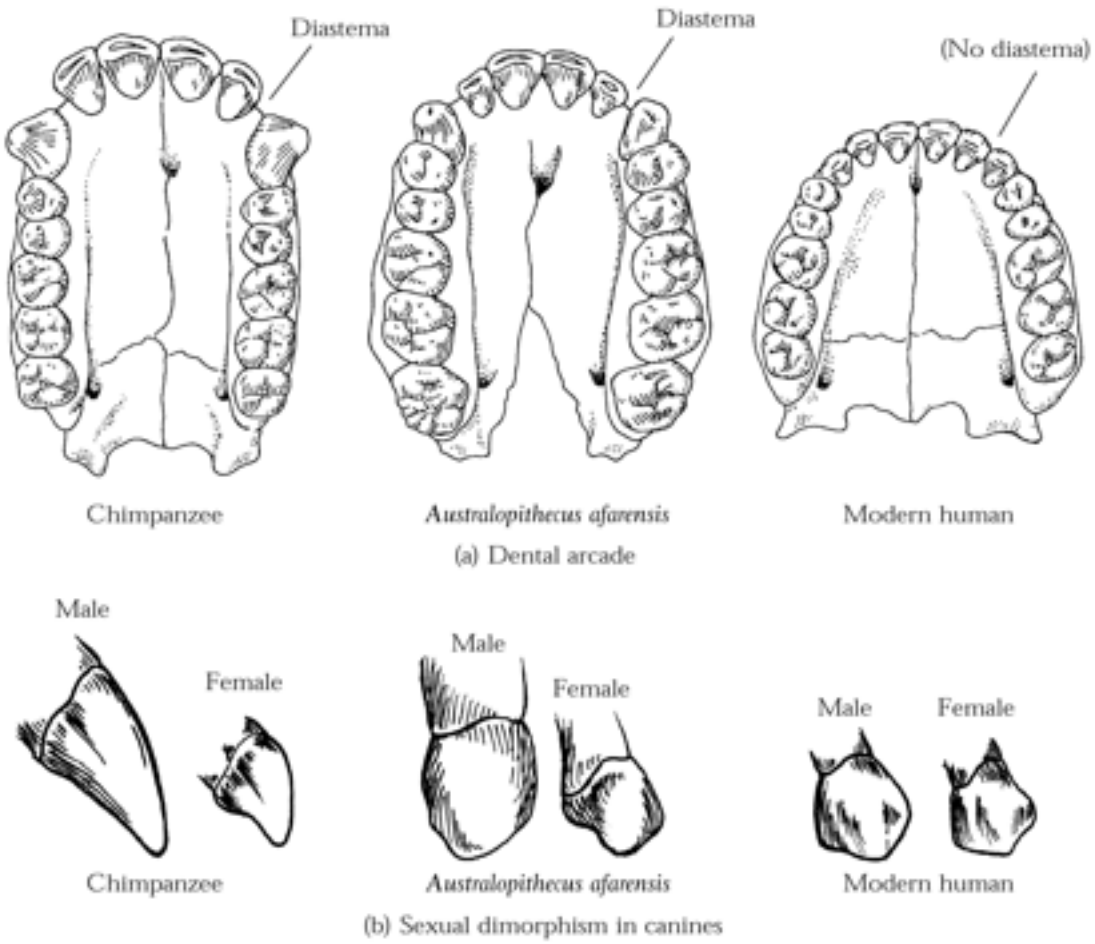
The *Australopithecines* shared certain key adaptations

- Bipedal
  - Arched foot
  - In-line big toe
  - Short & wide illium blade
- Still adept in trees
  - Curved fingers & toes
  - Short thumb, thin fingers
- Small bodies
- Teeth, jaws, skull intermediate between apes and later hominins
- Ape-like development patterns
- Ape-sized brains
- Pronounced sexual dimorphism
- Woodland/scrub/grassland habitat



Australopithecus Modern human

Australopithecus afarensis teeth & jaws were intermediate between chimps and later hominins



- Molars nearly parallel
- Front teeth & palate rounding more
- Larger molars
- Large incisors
- Canines project & conical
- Small diastema
- Premolar slight 2nd cusp

- *A. africanus* teeth no longer intermediate
- Bigger, but otherwise like *Homo*

Australopithecines grew up quickly & were sexually dimorphic

- **Australopithecines grew up more quickly than modern humans do**

Males: 4'8" to 5' and 90-110 lbs

Females: 3'6" to 3'11" and 66-70 lbs

Males weigh 30-50% more than females

⇒ Not pair-bonded

⇒ Multi-male, multi-female

Australopithecus afarensis vs. africanus

Paranthropus

- *Paranthropus aethiopicus*
  2.4 mya, East Africa

- ***Paranthropus bosei***
  2.2 – 1.0 mya, East Africa

- *Paranthropus robustus*
  2.0 – 1.0 mya, South Africa

The Paranthropines: bipedal apes with very big teeth, particularly molars

Formerly called “robust” Australopithecines

P. boisei

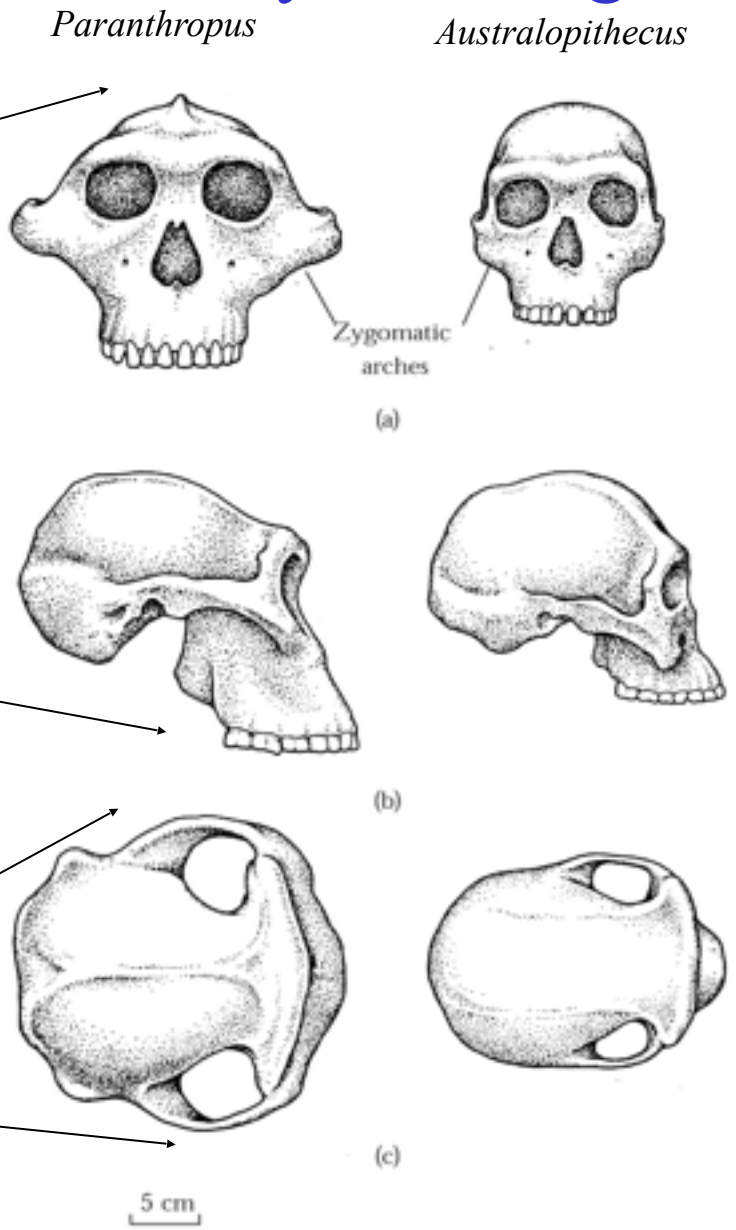
A. africanus

Jaw and skull reorganized for heavy chewing

Sagittal crest enlarges attachment surface for temporalis muscle that works jaw

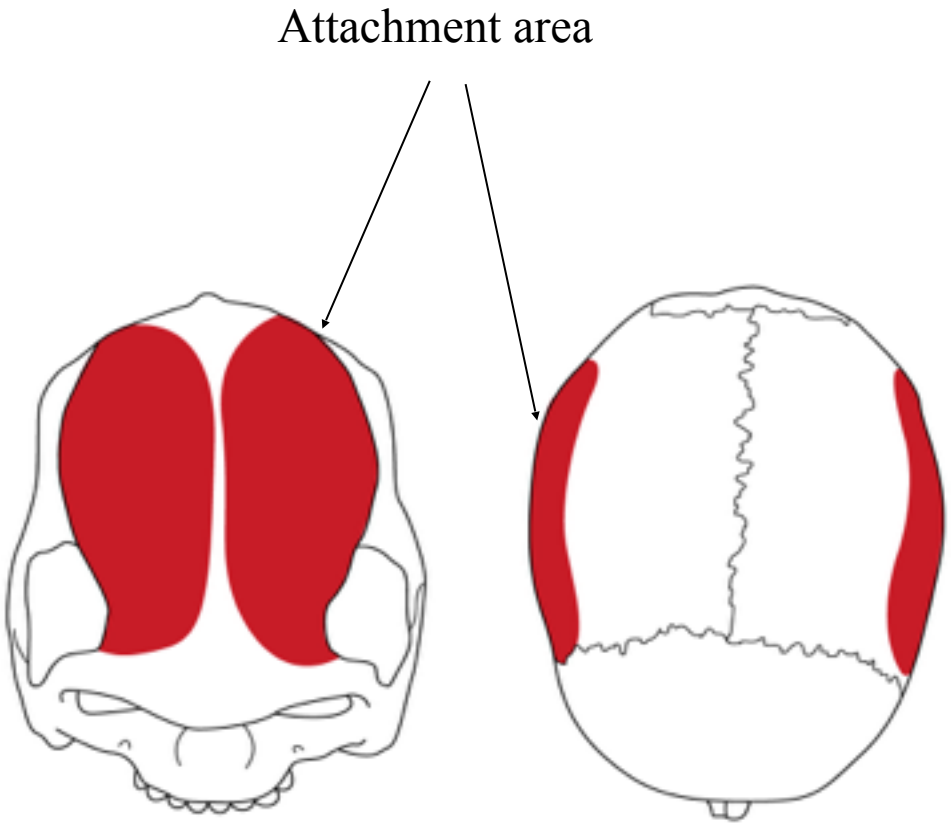
Very large molars

Cheekbones flared out to make room for enlarged temporalis muscle



The *Paranthropus* jaw required massive musculature

P. boisei



P. aethiopicus

H. sapiens

Phylogenetic conclusions to remember

- Hominins originated in Africa during the late Miocene epoch = 6 to 7 mya

- One or more of the Miocene species evolved into the Australopithecine and those into Paranthropine species
  - Two genera included **many diverse** species

- *Australopithecus* (mostly) went extinct about 2.5 mya
- *Paranthropus* & (*Homo) rudolfensis & habilis* appeared about 2.5 mya (and *A. sediba* at 2mya!)

- Likely one of the *Australopithecus* genus gave rise to *Homo*

Ancestor to the *Homo* lineage at 2.5 mya was:

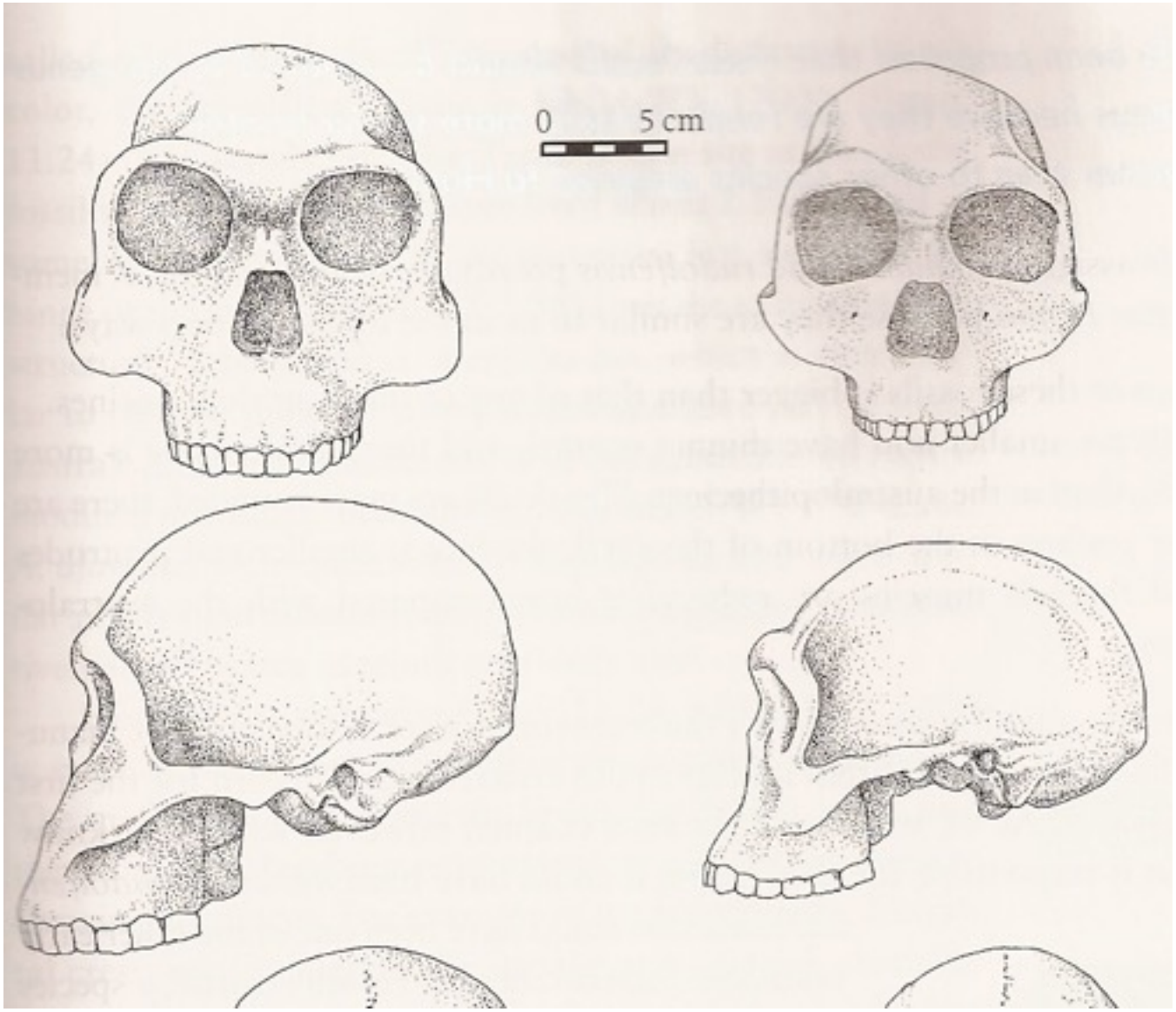
- Bipedal, but still time in trees, small body size
- Teeth adapted for generalized diet (NOT *Paranthropus*)
- Sexually dimorphic, small brains
- Living in mixed woodland, grassland habitats
- **2.5 mya Africa further cooling & drying trend**
  - **Appearance of the first stone tools!**

JH Matternes, AMNH

Homo habilis & rudolfensis trend to bigger brains and appear about 2.5 mya

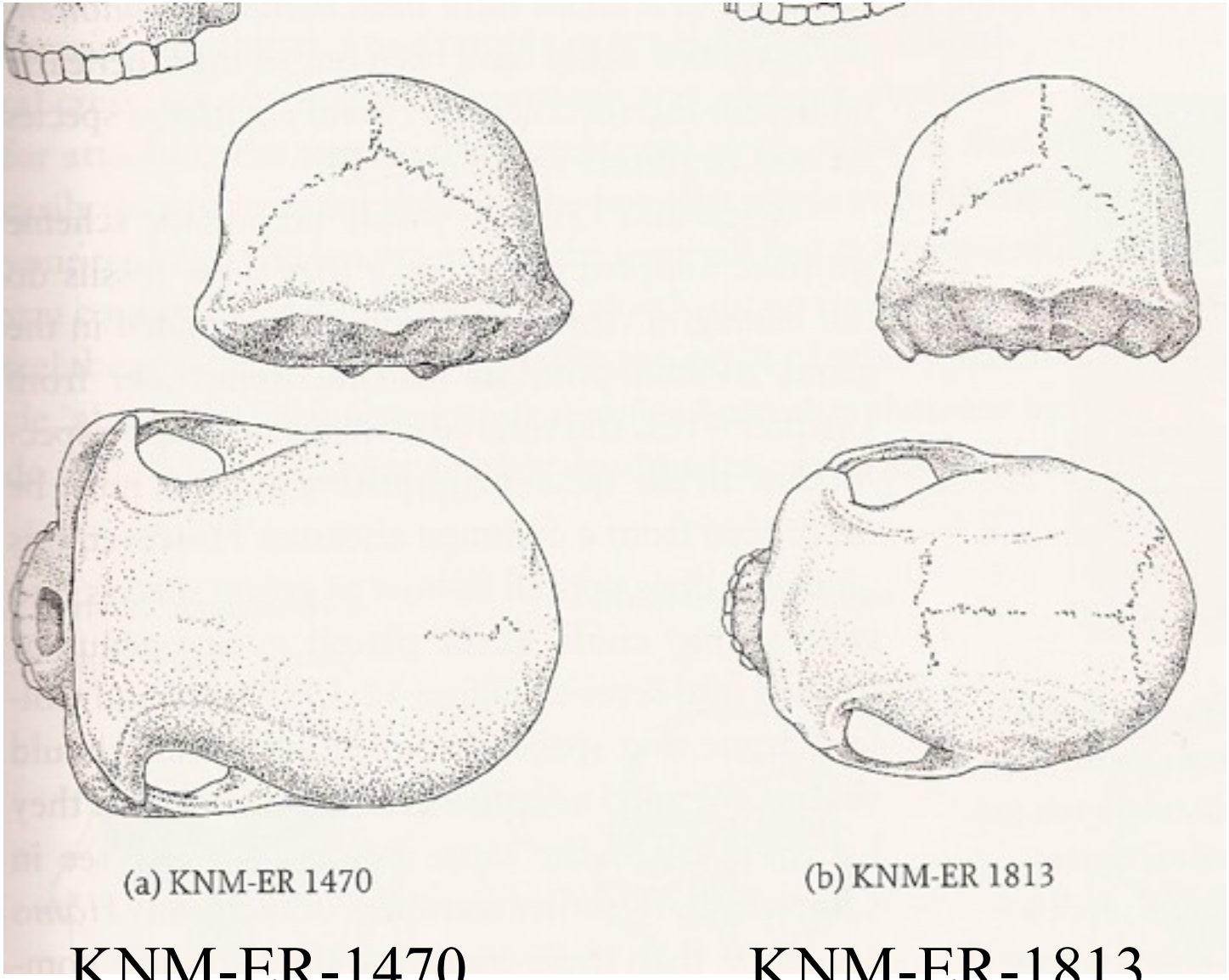
- Brain size
  - *habilis* = 600 cc
  - *Rudolfensis* = 750 cc
  - *Australopithecus & Paranthropus* = 400 to 530 cc

- Skull more rounded
- Less prognathic, smaller face
- Smaller teeth, parabolic dental arcade, thinner enamel



KNM-ER-1470
(*H. rudolfensis*)

KNM-ER-1813
(*H. habilis*)



KNM-ER-1470
(*A. rudolfensis*)

KNM-ER-1813
(*A. habilis*)

What kinds of selective pressures did they face 2.5 mya?

- Spending more time on on ground, less time in trees
  - More vulnerable to terrestrial predators

- Probably still slept in trees

- Might have formed large, multi-male groups

What kind of selective pressures did they face 2.5 mya

- Seasonal environment makes finding food harder
  - less plant food in the dry season
  - alternate food sources needed when dry

How did early hominins cope with seasonality?

- *Australopithecines & Homo*
  - smaller teeth may have eaten more meat
  - Carbon analysis of teeth supports this

- *Paranthropus*
  - huge molars, heavy jaws, and massive chewing muscles
    - may have shifted to tough, dry plant materials
    - May also have eaten harder nuts & tubers
    - Possibly also ate meat

- Flexible diet in a fluctuating world

Hominin Transition: From meat to tools to culture

- **Increasing reliance on meat characterizes the transition to genus *Homo***
  - May have led to changes in human behavior and social structure
- These changes begin to appear about 2.5 mya with the appearance of stone tools

All of the early hominins probably made tools

- Chimps make and use tools
  - twigs to probe termite mounds
  - leaves to sponge up water
  - rocks to hammer open nuts
  - sticks as weapons

⇒ little trace in archaeological record

2.5 mya Hominins make stone tools: The Oldowan Toolkit

- **Cores** are round stones, with **flakes** knocked off to produce an edge

- used **flakes** as cutting tools
  - Remove skin
  - Butcher animals quickly

- Used **cores** as hammers & choppers
  - knock off the flakes
  - Crack open bones for marrow

Oldowan tools are simple, but took skill

- Piece together pile of flakes to the original core that they were struck from
- Toolmakers chipped as many as 30 flakes from 1 core
- Various kinds of stone
- **No apparent design in mind when making**

Next slide NSFW

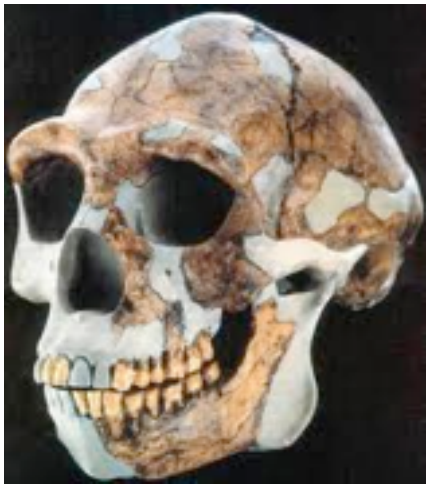
Modern experiments suggest flakes were good for butchering game

In Olduvai Gorge we find butchery sites

- Large piles of tools and animal bones
  - some marked by tools, some by carnivore teeth, some both
- Hominins carried carcasses to butchery sites
  - Dismembered carcass there
  - Carry good bits away for more intensive processing
  - Scavengers waited for remains or competed for carcass
- Sites for raw stone material for tools
  - Made tools in these locations


Who made the first stone tools? (probably all of them!)

- *A. garhi* is possible candidate
  - Present at right time and place
  - Bones with stone tool marks found nearby



- But, many species present 2.5 mya
  - *A. sediba* (more recent)
  - Paranthropine species – precision grip
  - *H. habilis & rudolfensis*
    - (habilis was the presumptive tool maker for long time)

Olduwan Toolmakers at the cusp of another adaptive shift

- Greater reliance on meat & tools
  - Changes in social life
  - Changes in brain
  - Changes in lifespan
- Hominin becoming more like us