Earliest hominins & bipedalism

1

CENEZOIC

Paleocene

Eocene

Oligocene

Miocene

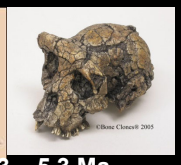
Pliocene

Pleistocene

65 – 55 Ma

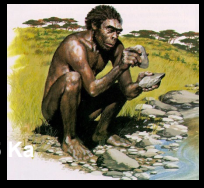
55 – 34 Ma

34 – 23 Ma



23 – 5.3 Ma

5.3 – 1.8 Ma

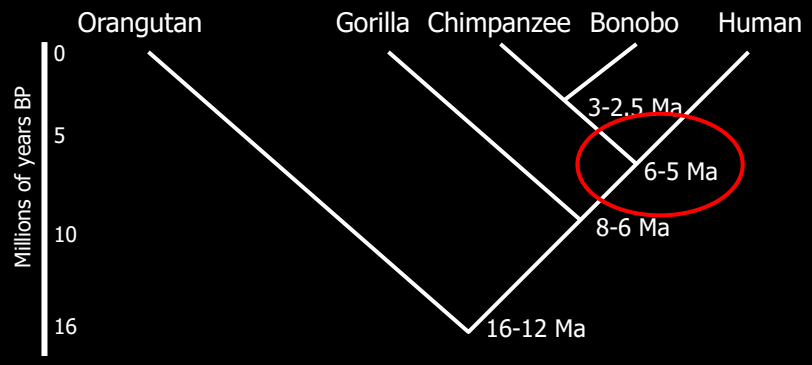


1.8 Ma-11.5

2

Late Miocene (7-5 Ma)

- Common ancestor to chimpanzees and hominins
- Evidence for the earliest hominins

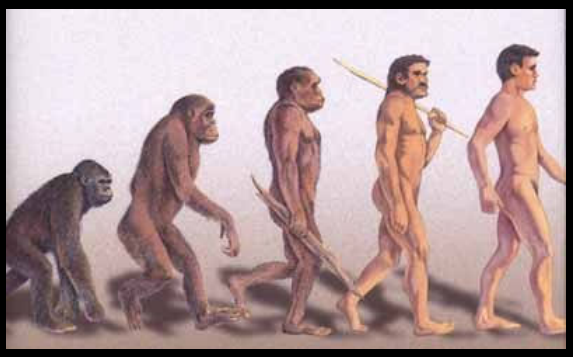


3

What defines a hominin?

Bipedalism? Fire? Tool use?

Sharing? Big brain?



Hunting? Cooperation?

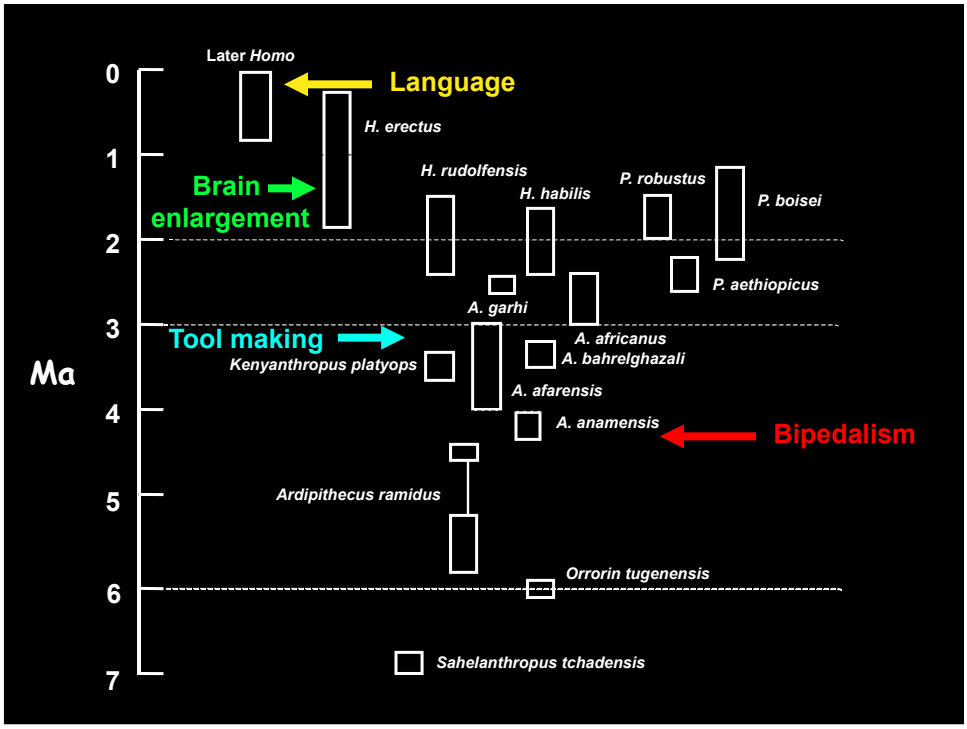
Culture? Language?

4

What is a hominin?

- A hominin is a member of the tribe Hominini (the group to which modern humans belong)
- A hominin is defined as being habitually bipedal
- Hominins also show gradual trends towards:
  - smaller canines
  - parabolic dental arcade (not U-shaped)
  - thick tooth enamel
  - reduced facial prognathism (vertical face)

5



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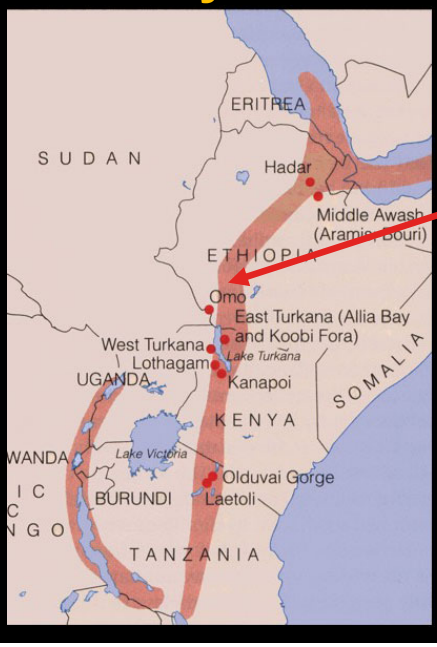
Why did humans evolve?



- Formation of East African Rift Valley 8-6 mya
- Drier, cooler & more open conditions

7

- Replacement of forest with savanna
- Humans are apes adapted to an open habitat. But many early hominins are at least partially arboreal!

8

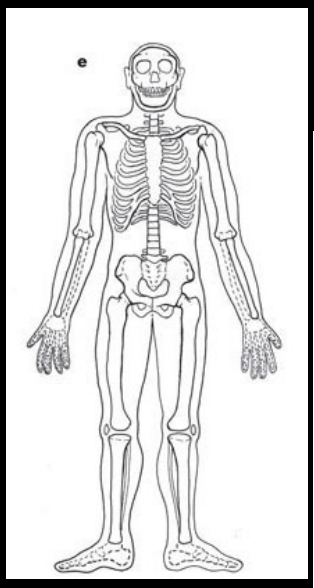
Hominin genera

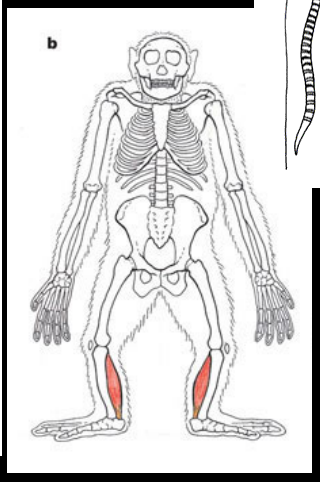
- *Sahelanthropus* (7-6 mya)
- *Orrorin* (6 mya)
- *Ardipithecus* (5.8-4.4 mya)
- *Australopithecus* (4.2-2.0 mya)
- *Paranthropus* (2.5-1.2 mya)
- *Kenyanthropus* (3.5 mya)
- *Homo* (2.4 mya-present)

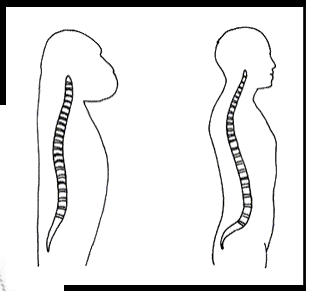
9

10

Distinguishing ape from human







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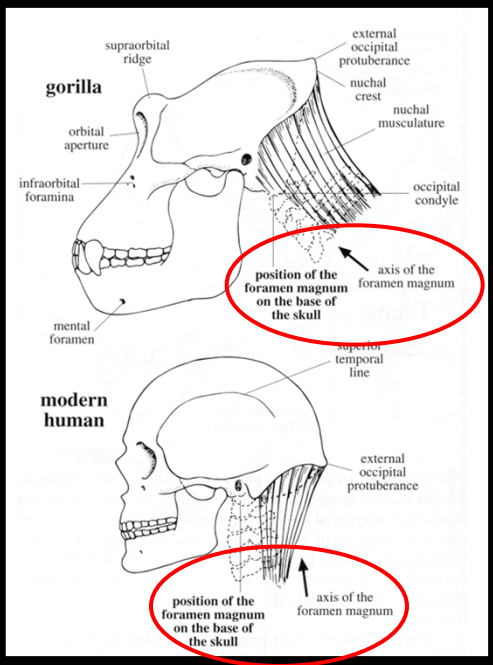

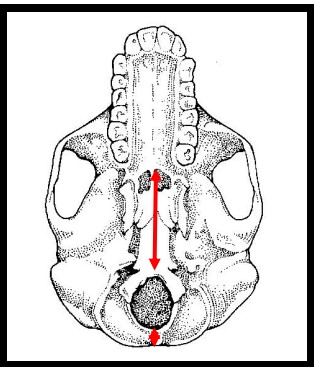

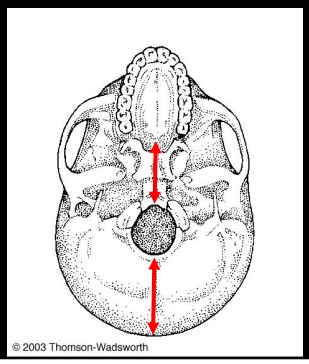

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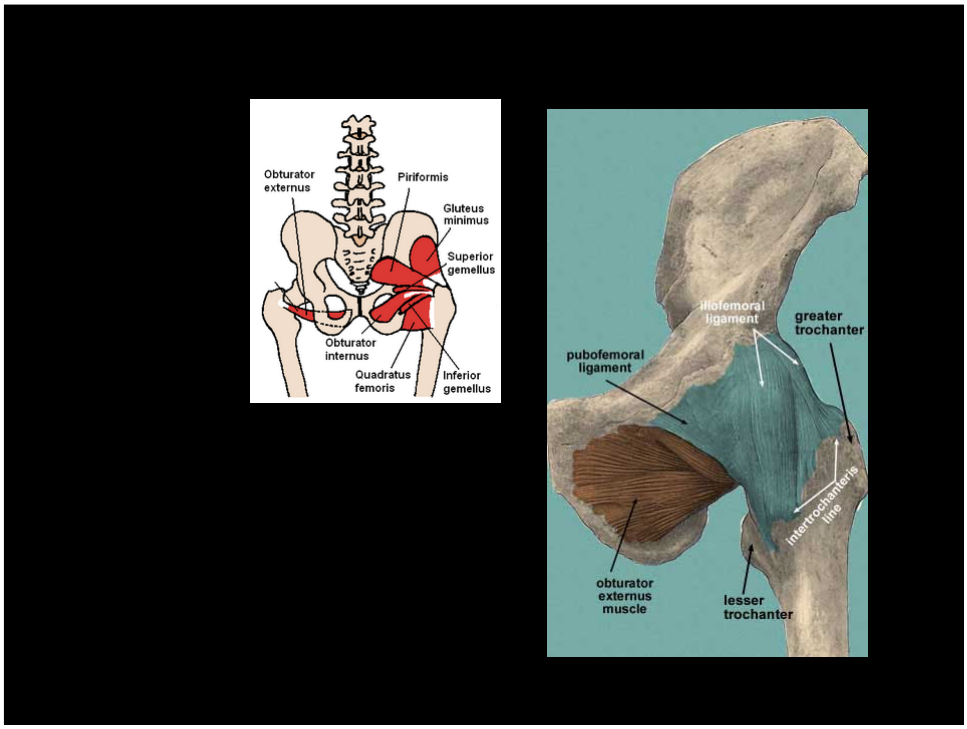
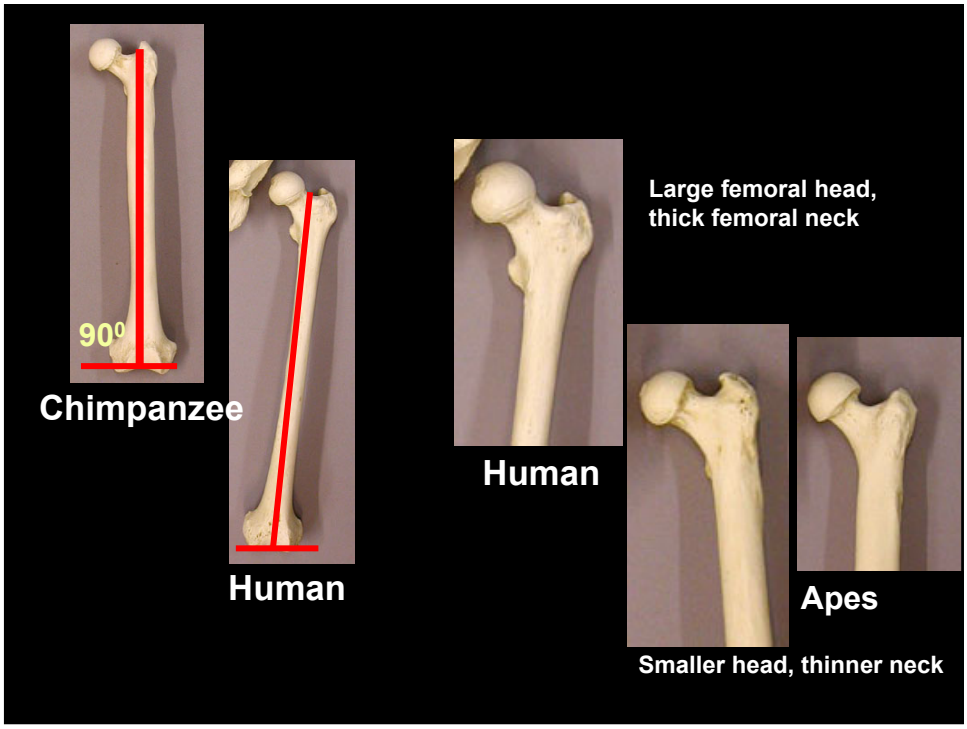
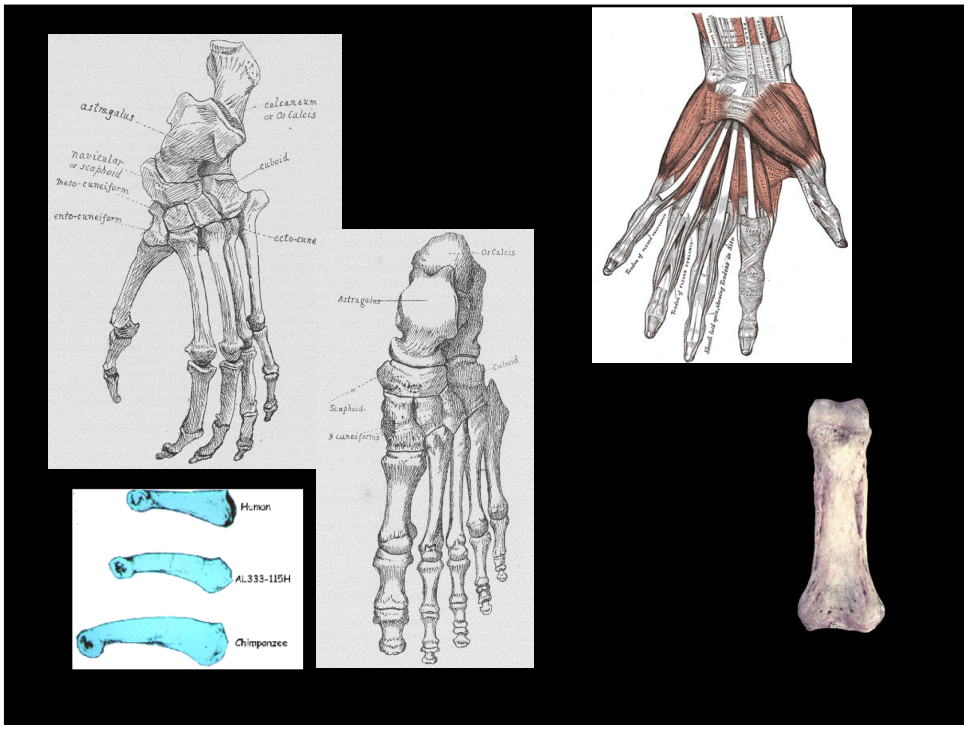

Obturator externus
Piriformis
Gluteus minimus
Superior gemellus
Obturator internus
Quadratus femoris
Inferior gemellus
iliofemoral ligament
greater trochanter
pubofemoral ligament
intertrochanteric line
obturator externus muscle
lesser trochanter

13

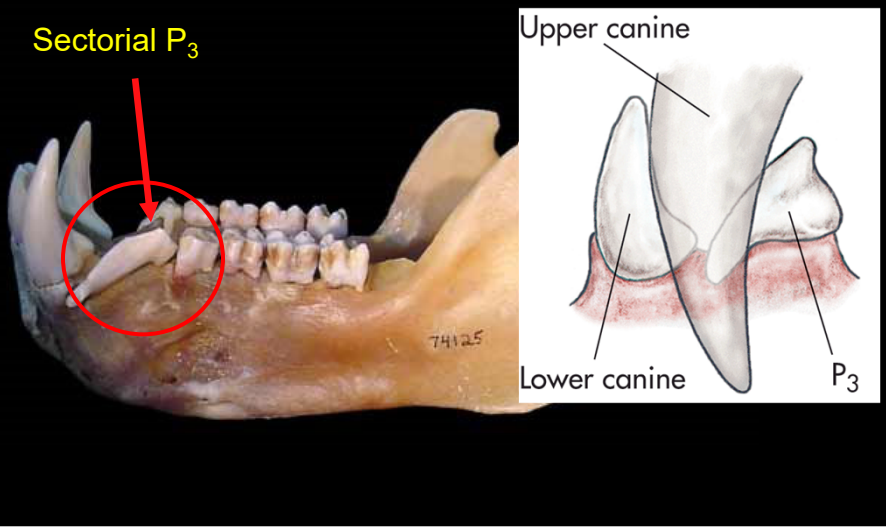

90⁰
Chimpanzee
Human
Human
Large femoral head, thick femoral neck
Apes
Smaller head, thinner neck

14



15

Dentition: canine honing complex



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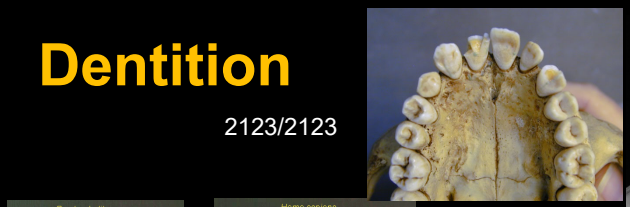
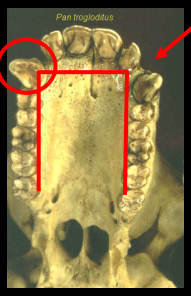
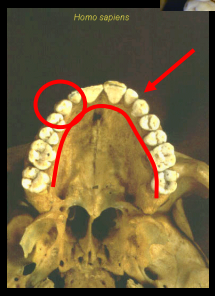
Dentition

2123/2123

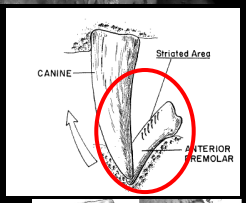


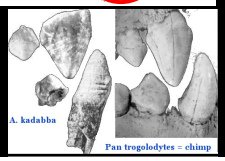


rectangular



parabolic





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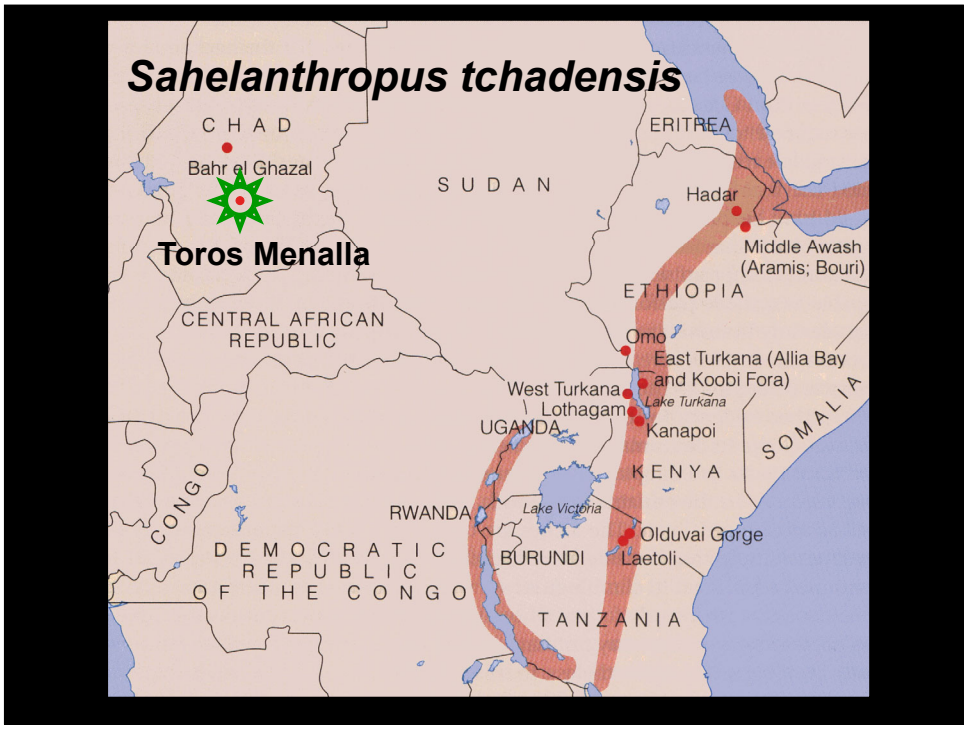
Stem hominins

- smaller jaws
- smaller canines showing less sexual dimorphism
- larger cheek (posterior) teeth
- evidence of adaptations to upright posture and facultative bipedalism

18



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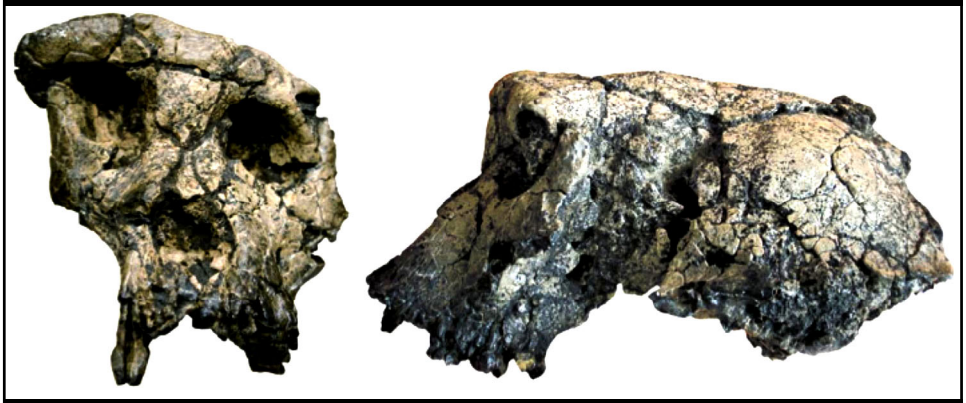
The earliest hominin?

Sahelanthropus tchadensis

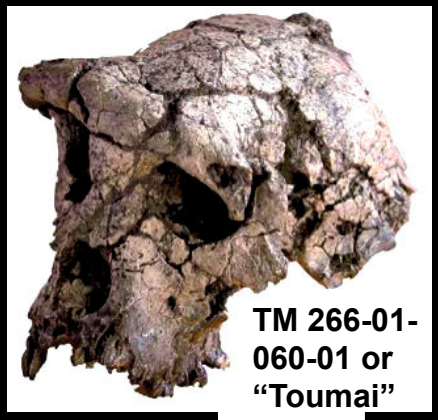


Debate over which fossil is the earliest hominin & to what extent these early upright creatures walked bipedally

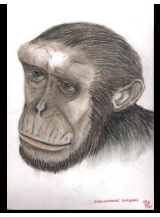
20

Sahelanthropus tchadensis

- Discovered in northern Chad (North-central Africa) in 2001
- Dated to ~7-6 mya using faunal correlation and beryllium 10 radiometric dating
- Very small brain (320-380cc), massive brow ridges, & heavy cranial cresting
- BUT vertical face & more derived, human-like dentition.



TM 266-01-060-01 or "Toumai"



Ape (e.g., a gorillin) or hominin?

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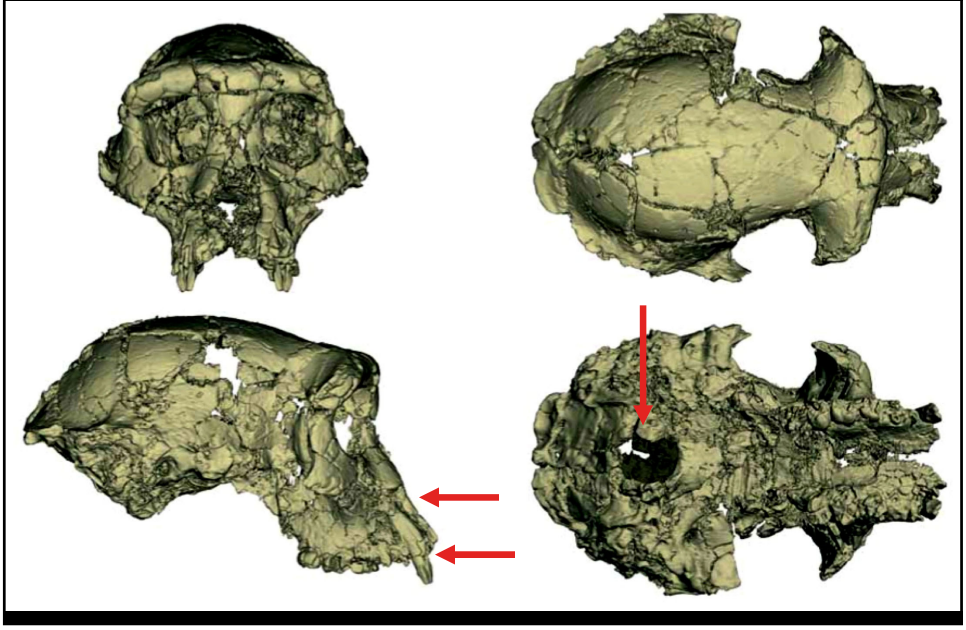
Sahelanthropus tchadensis



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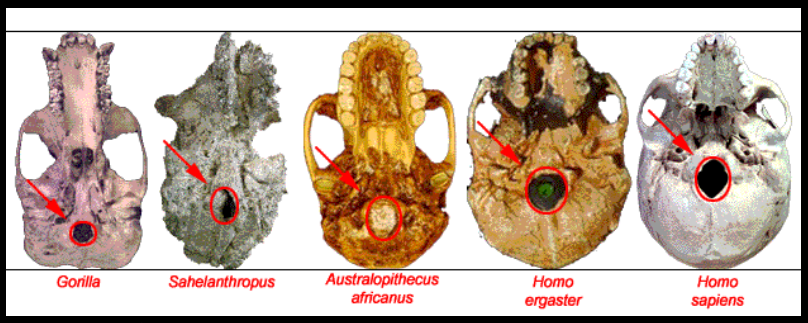

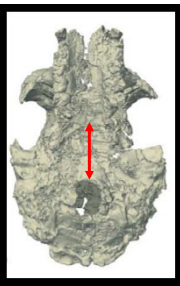

Anteriorly positioned foramen magnum

Relatively short basiooccipital

3-D reconstruction from Zollikofer et al 2005

23

Sahelanthropus tchadensis postcrania?

- Partial left femur and two ulnae discovered in the same layers at the same locality in 2001 (Macchiarelli et al. 2020, Daver et al. 2022)
- Another primate taxon or *Sahelanthropus*? Latter more parsimonious.
- Femur argued to indicate bipedalism (but controversial); ulnae suggest arboreality

TM 266-01-063

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Sahelanthropus tchadensis

- Touted as earliest hominin (and more closely related to humans)
- Even if NOT bipedal, is said to share too many derived traits with hominins not to be close to the lineage
- Differs from apes
  - Smaller canines w/ wear at the tip
  - Non-honing C-P_3 complex (?)
- Others still debating to which ape lineage it is most closely related

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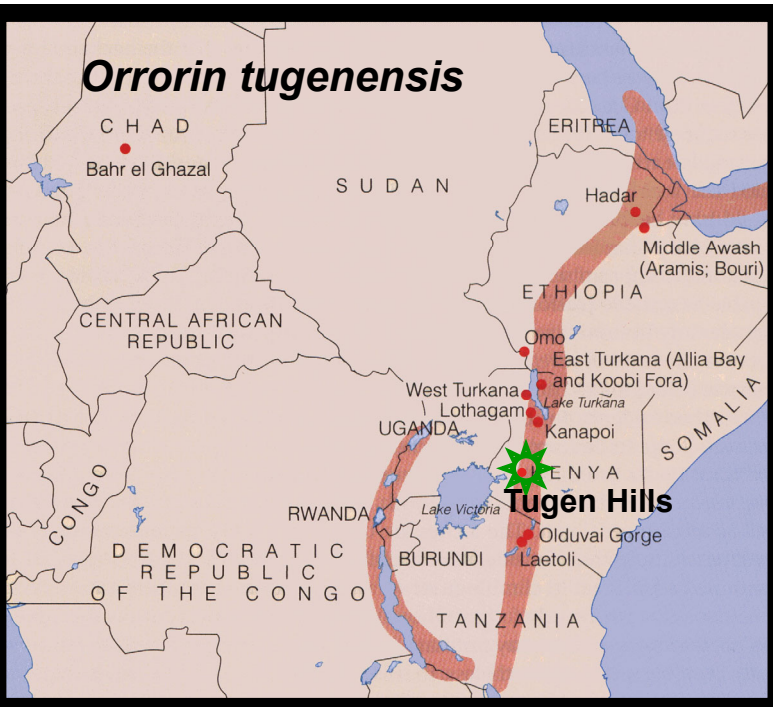

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Orrorin tugenensis

- Discovered in western Kenya in 2000 ("original man" in Tugen)
- At least 5 individuals
- Dated to ~6 mya using radiometric dating
- Femoral & mandibular fragments

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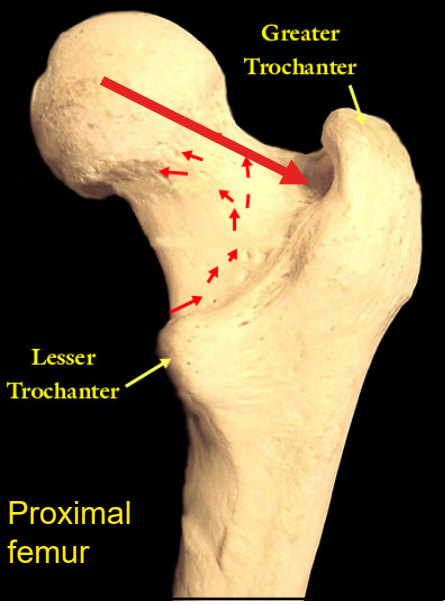
Orrorin tugenensis



- Groove for *obturator externus* muscle on femur suggests bipedalism
- Climbing adaptations in the upper limb
- Is it on the 'human' or 'chimp' lineage? Not everyone convinced it is a hominin!

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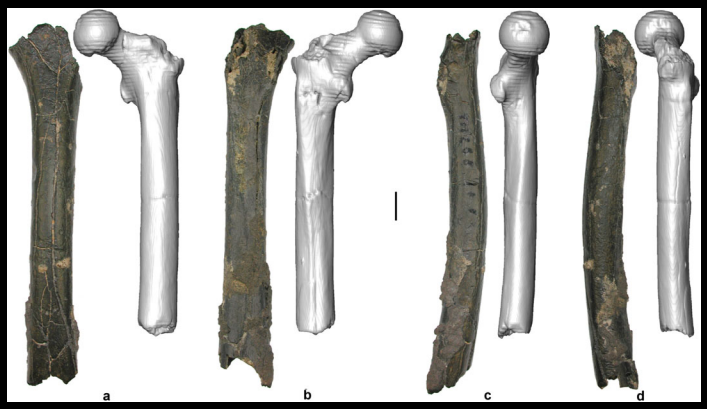
Sahelanthropus vs. Orrorin



- *Sahelanthropus* more similar to *Pan* (A-P curvature, cross-sectional morphology) and Miocene great apes
- *Orrorin* closer to *Homo* and *Pongo*

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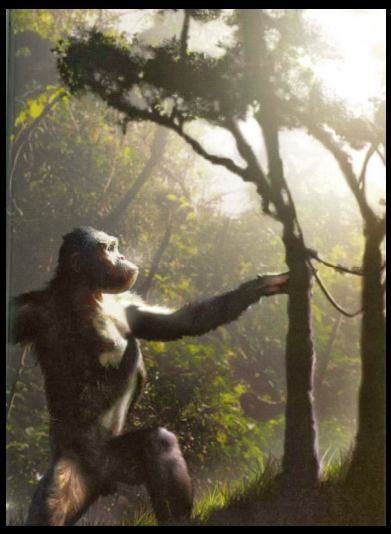
Orrorin cont'd.

- Dentition:
  - Incisors *Ardipithecus*-like
  - Canine and premolars ape-like
  - Small, thick enameled teeth
- Environment: well wooded to forested habitat



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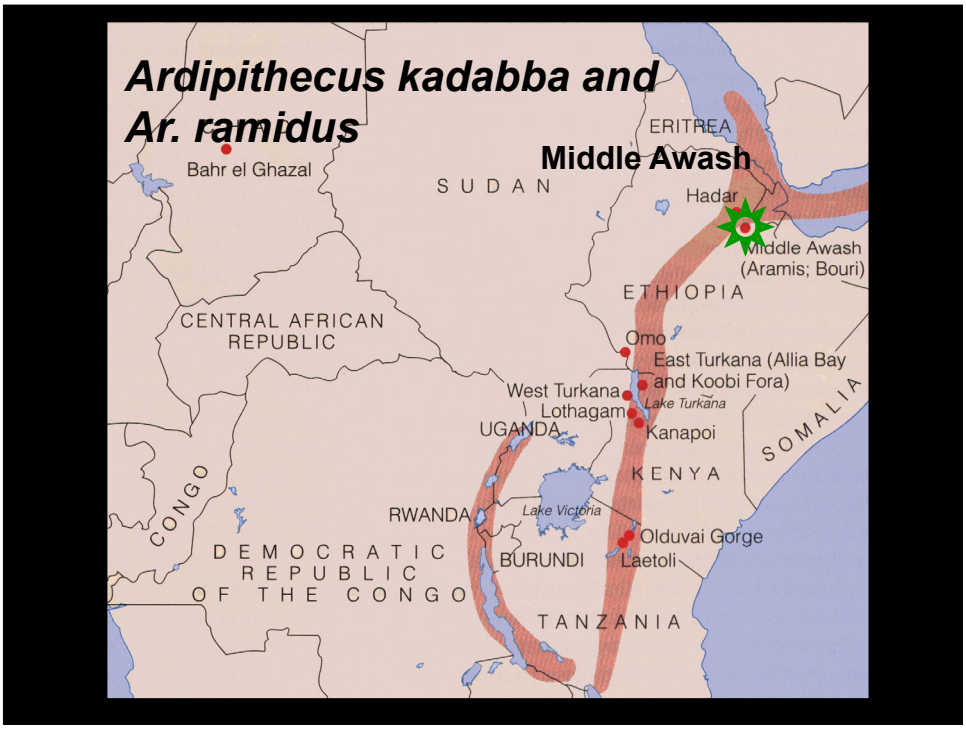

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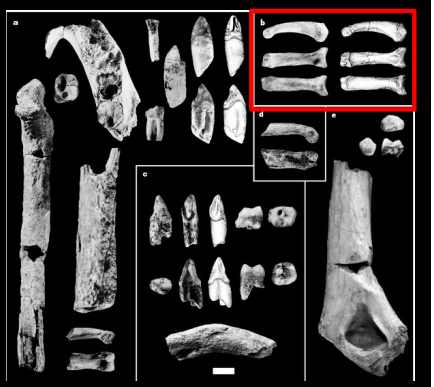
Ardipithecus kadabba

- "Kadabba" – basal family ancestor (in Afar)
- Middle Awash, Aramis, Ethiopia
- 5.8-5.2 Ma (radiometric dating)
- Fragmentary
- Proximal foot phalanx suggests upright posture
- Woodland environment



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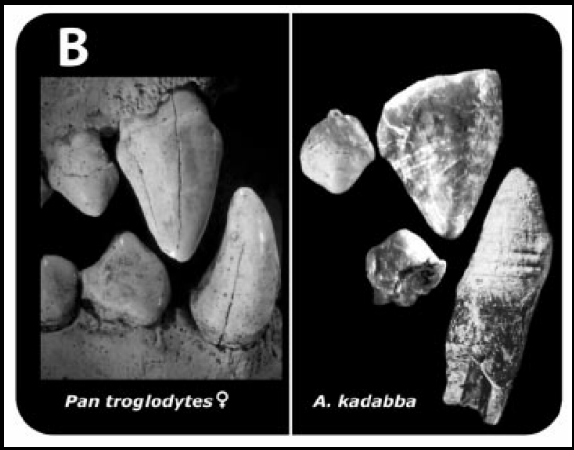
Ardipithecus kadabba

- apelike CP_3 (honing) complex!



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Evidence for bipedalism

- complete left fourth proximal foot phalanx
- strong curvature of the phalanx (apelike)
- dorsally canted proximal joint surface (hominin-like)

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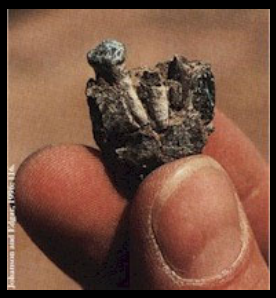
Ardipithecus ramidus

- "Ramid" – 'root' in Afar
- Middle Awash, Aramis, Ethiopia
- Found in 1992/1993, published in 1994 as *Australopithecus*
- Became *Ardipithecus* in 1995
- Finally described in detail in *Science* in 2009



4.4 Ma

35

Ar. ramidus

- Type specimen
  - associated teeth from one individual
- Paratypes
  - Isolated teeth, temporal, mandible, humerus, radius, ulna
- Additional material ultimately adds up to:
  - 110 fragments of multiple individuals
  - Partial skeleton of a female aka "Ardi"

"Ardi"

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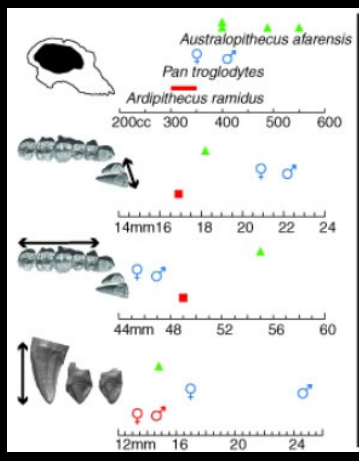
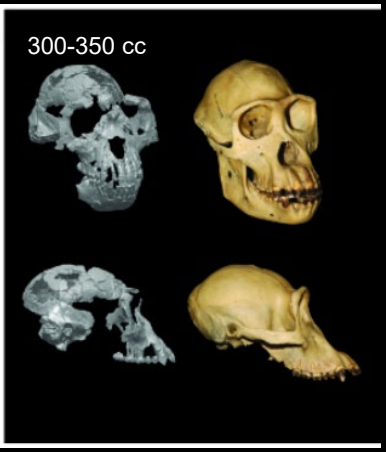
Ar. ramidus craniodental





Suwa et al., 2009

Craniodental remains support it as a basal hominin (Mongle et al. 2019)

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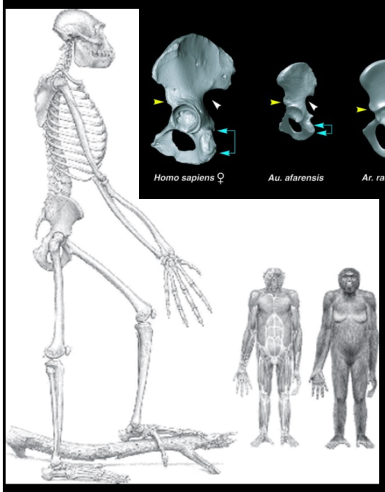
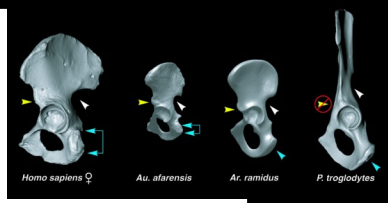
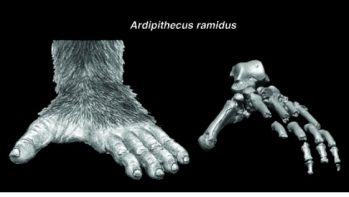
Ar. ramidus postcrania





Lovejoy et al., 2009

- 120 cm tall, 50 kg
- Opposable big toe
- Long arms
- Not a knuckle-walker
- Palmigrade, above-branch quadruped
- Facultative biped?



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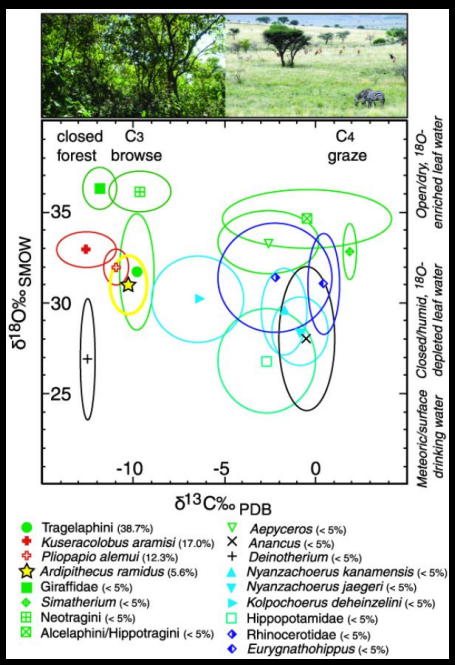
Environment

- Environment
  - Woodland, with small forest patches
  - *Ardipithecus* fossils not present in nearby, more open habitats
- Diet - stable isotopes in dental enamel
  - Similar to arboreal monkeys
  - Little grass or grass-eating animals



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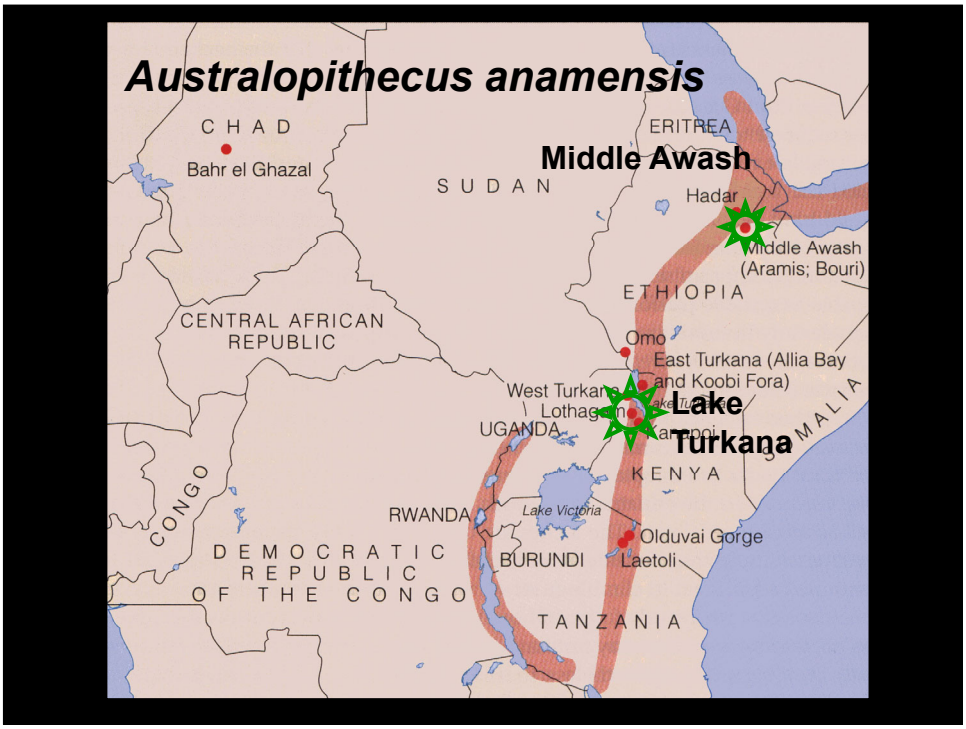
Australopiths: genus *Australopithecus*

- *Au. anamensis* (4.2-3.9 mya)
- *Au. afarensis* (3.9-2.9 mya)
- *Au. deyiremeda* (3.5-3.0 mya)
- *Au. bahrelghazali* (3.5-3.0 mya)
- *Au. africanus* (3.5-2.0 mya)
- *Au. garhi* (2.5 mya)
- *Au. sediba* (2.0 mya)

40



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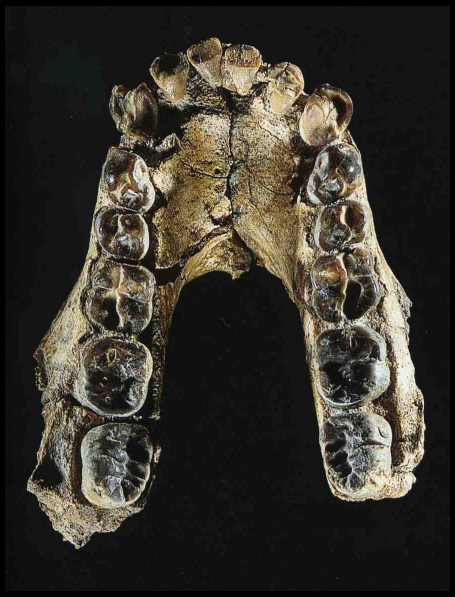
Australopithecus anamensis



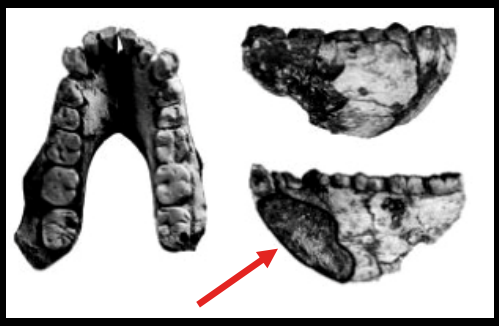
- Found in 1994 near Lake Turkana, Kenya and in 2006 in Middle Awash, Ethiopia
- 4.2-3.9 Ma (radiometric)
- Mixed woodland, riverine forest and open grasslands
- Dental, cranial & postcranial remains

42

A. anamensis mandible

Primitive features
- Relatively large canines
- Parallel cheek teeth
- Receding mandibular symphysis

Derived features
- Broad molars
- Thick tooth enamel



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A. anamensis postcrania

- Expanded proximal tibia (knee joint)
- Downward facing distal tibia (ankle joint)
- *A. anamensis* was a habitual biped at 4.2-3.9 Ma

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A. anamensis cranium

- MRD-VP-1/1, 3.8 mya, Woranso-Mille, Ethiopia (found in 2016, pub. in 2019)

45

https://www.cmnh.org/mrd

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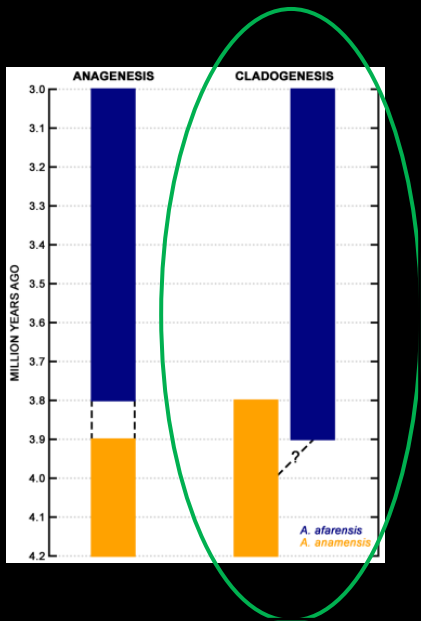
A. anamensis cranium

- Mosaic of ancestral (e.g., *Sahelanthropus* - like) and derived traits (similar to later australopiths)
- 100 Ka overlap with *Au. afarensis*
  - *Au. afarensis* evolved through cladogenesis, not anagenesis



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Conclusions?

- *Au. anamensis* earliest habitual biped (undoubtedly a hominin)
- Phylogenetic status of earliest hominin genera *Sahelanthropus*, *Orrorin*, *Ardipithecus* and the definition of the tribe Hominini are debated
  - By what derived characters should the hominin clade be recognized?
    - Bipedality?
    - Dental characters? (C/P_3 honing)

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